



From Billions of Seedlings to Sustainable Livelihoods: A Critical Review of Ethiopia's Green Economy Strategy, Afforestation Outcomes, and Community Co-Benefits

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Abstract: Ethiopia's Green Legacy Initiative (GLI), launched in 2019, represents one of the most ambitious reforestation programs globally, aiming to plant 50 billion seedlings by 2026. This critical review synthesises evidence on the GLI's policy architecture, ecological outcomes, community co-benefits, and implementation challenges, drawing on peer-reviewed literature, policy documents, and empirical studies published between 2011 and 2026. The review reveals remarkable quantitative achievements: over 48 billion seedlings planted, district forest cover expansion from 17.2% to 24%, soil erosion reduction from 1.9 billion to 208 million tonnes annually, and the creation of over 767,000 jobs. However, significant implementation gaps persist. Independent studies report seedling survival rates as low as 39.80% at the district level, substantially below the 85% officially reported, while 90,000–100,000 hectares of forest continue to be lost annually. Community benefits remain unevenly distributed, with smallholder farmers facing compliance challenges under international regulations such as the EU Deforestation Regulation (EUDR). Institutional weaknesses in law enforcement, data systems, land tenure, and coordination, compounded by a critical financing gap, with only 6% of the required US\$7.5 billion annual budget available, undermine long-term sustainability. The review concludes that transitioning from quantity-focused planting to quality-oriented ecosystem restoration, strengthening participatory governance, enhancing monitoring and evaluation systems, and scaling up private sector engagement are essential pathways forward. Ethiopia's experience offers valuable lessons for the Global South on navigating the complex terrain of environmental restoration, economic development, and social equity, demonstrating that political will and mass mobilization must be complemented by robust institutional frameworks and equitable benefit distribution to achieve lasting impact.

Keywords: Green Legacy Initiative; Ethiopia; afforestation outcomes; community co-benefits; implementation gaps

I. Introduction

1.1 Background and Context

Environmental degradation constitutes one of the most pressing challenges confronting Ethiopia and the broader Global South. Ethiopia, endowed with diverse ecosystems and rich biodiversity, faces severe environmental challenges including deforestation, land degradation, soil erosion, biodiversity loss, and acute climate variability and change (Shibabaw & Wondimneh, 2025). The country's forest cover has declined dramatically from an estimated 40% in the 19th century to approximately 3% by 2000, largely driven by agricultural expansion, rapid population growth, and weak forest governance (Shibabaw & Wondimneh, 2025). More recent estimates indicate that forest cover continued to decline from 15 million hectares in 1990 to 12.2 million hectares in 2010, with conversion of forests to agricultural land and unsustainable fuelwood consumption identified as the two most prominent drivers of deforestation and forest degradation (Forest Carbon Partnership Facility, n.d.). Studies further reveal that between 1973 and 2015, Ethiopia experienced an average forest loss of approximately 91,000 hectares per year (Alemayehu et al., 2026), with approximately 53% of

deforestation attributed to the conversion of forests and woodlands into agricultural land and grasslands (FRL, 2016). Despite recent recovery efforts, Ethiopia's natural forest cover remains critically low, with persistent annual deforestation rates continuing to threaten the country's ecological integrity.

The interconnection between environmental decline and socio-economic vulnerability is profound and mutually reinforcing. Land degradation, characterized by soil erosion and declining fertility, presents a significant challenge to agricultural productivity and economic development (Gebremeskel et al., 2025). Over 85% of Ethiopia's land is degraded due to erosion and unsustainable land use, with the loss of fertile topsoil undermining productivity, limiting water availability, and increasing flood risks and sedimentation, creating a self-reinforcing cycle of poverty and vulnerability (UNCCD, 2025). In the erosion-sensitive highlands, degradation is accelerated by high rates of population growth, deforestation for fuelwood and agricultural lands, and inadequate investment in soil conservation (Bishaw, 2001; Nyssen et al., 2004). Over 50% of agriculturally suitable highland areas are degraded, with annual soil loss estimated to reach approximately 2 billion tons per year (FAO, 2019).

These ecological changes have intensified food insecurity, entrenched rural poverty, and heightened susceptibility to climate extremes including recurrent droughts, floods, and heatwaves. Over 85% of Ethiopia's population of approximately 129 million (2023) depends on agriculture, yet much of the country's arable land is losing its productivity to erosion, nutrient depletion, and unsustainable land use (World Bank, 2025). The 2022 rainy season, the driest in over 40 years, caused widespread crop and livestock losses and acute food insecurity, with an estimated 28 million people requiring emergency food aid across Ethiopia's arid and semi-arid zones (UNCCD, 2025). Degraded landscapes contribute to a self-reinforcing cycle wherein resource-constrained rural households are compelled to further exploit diminishing natural assets, perpetuating environmental decline and socio-economic marginalisation (Lakew Tefera et al., 2024).

1.2 Policy Framework Introduction

In response to these interconnected environmental and developmental challenges, Ethiopia has positioned the green economy at the centre of its national development agenda. A landmark policy intervention was the launch of the Climate Resilient Green Economy (CRGE) Strategy in 2011, representing one of the few comprehensive national strategies in the developing world to embed climate objectives at the heart of economic development planning (Federal Democratic Republic of Ethiopia, 2011). Conceived under the leadership of the late Prime Minister Meles Zenawi and developed through a collaborative process involving seven sectoral teams and over 50 experts from more than 20 leading government institutions, the CRGE strategy articulated a vision for Ethiopia to achieve middle-income status by 2025 while simultaneously developing a green economy to avoid the negative effects of increasing greenhouse gas emissions and unsustainable natural resource use (EFD Initiative, 2011; Federal Democratic Republic of Ethiopia, 2011). The strategy pursues triple goals of economic growth, net-zero emissions, and climate resilience through four interconnected pillars: improving crop and livestock production practices for higher food security and farmer income while reducing emissions; protecting and re-establishing forests for their economic and ecosystem services, including as carbon stocks; expanding electricity generation from renewable sources of energy for domestic and regional markets; and leapfrogging to modern and energy-efficient technologies in transport, industrial sectors, and buildings (Federal Democratic Republic of Ethiopia, 2011). The CRGE further committed to limiting 2030 greenhouse gas emissions to approximately 150 Mt CO_{2e}, around 250 Mt CO_{2e} less than estimated under a conventional development path representing a 64% reduction below business-as-usual levels (EFD Initiative, 2011). Implementation of these initiatives would also offer important co-benefits, including improved public health through better air and water

quality, and rural economic development through increased soil fertility and food security (Federal Democratic Republic of Ethiopia, 2011).

1.3 Problem Statement and Research Gap

Notwithstanding the ambition and scale of Ethiopia's green economy strategy, critical discussions persist regarding the socio-economic compromises, efficiency, and long-term sustainability of these predominantly top-down environmental initiatives. A fundamental tension exists between national-level planting targets and on-the-ground ecological and socio-economic outcomes. While Ethiopia's forest cover has increased from 17.2% in 2019 to 23.6% in 2023 (ENA, 2024), questions remain about the quality of afforestation, seedling survival rates, and the actual ecological functionality of restored landscapes. Despite significant efforts, institutional weaknesses, political instability, land tenure insecurity, and inadequate policy enforcement continue to hinder sustainable forest management and development (Shibabaw & Wondimneh, 2025). Persistent challenges including open grazing, seedling loss, technical gaps, low community participation in some areas, and weak law enforcement threaten the sustainability of restoration gains. Furthermore, natural forest cover remains below 4% of total land area despite massive planting campaigns, indicating that the relationship between seedlings planted and actual forest restoration is far from linear. Moreover, there is limited synthesis of evidence regarding community-level benefits and trade-offs arising from these green strategies. While the GLI has generated substantial employment and livelihood opportunities, the distributional effects, equity implications, and long-term welfare impacts remain inadequately understood. The absence of precise data on survival rates, hydrological effects, and credible ecosystem service values hinders comprehensive cost-benefit analysis and natural capital accounting. Empirical evidence concerning how households navigate overlapping stressors of environmental degradation, climate variability, and policy interventions remain limited (Tefera et al., 2026). These implementation gaps underscore the need for a critical assessment that moves beyond quantitative metrics to evaluate the ecological integrity and social equity dimensions of Ethiopia's green transition.

II. Review of Literature

2.1 The Climate Resilient Green Economy (CRGE) Strategy

The genesis of Ethiopia's green economy ambition can be traced to February 2011, when the Prime Minister's Office, the Environmental Protection Authority (EPA), and the Ethiopian Development Research Institute (EDRI) convened to develop a comprehensive strategy for building a green economy (Environmental Protection Authority, 2011; EFD Initiative, 2011).

This collaborative effort mobilised seven sectoral teams comprising more than 50 experts drawn from over 20 leading government institutions, tasked with identifying green economy opportunities that could help Ethiopia reach its ambitious growth targets while keeping greenhouse gas emissions low (EFD Initiative, 2011). The resulting Climate Resilient Green Economy (CRGE) Strategy was formally launched on 18 November 2011 in Durban, South Africa, during the 17th session of the Conference of the Parties (COP) to the United Nations Framework Convention on Climate Change (UNFCCC) (Ministry of Finance, n.d.).

The CRGE Strategy articulates a transformative vision for Ethiopia to attain middle-income status by 2025 while developing a green economy to avoid the negative effects resulting from increasing GHG emissions and unsustainable use of natural resources (Environmental Protection Authority, 2011). The strategy pursues three interconnected objectives: achieving middle-income status, building climate resilience, and maintaining net-zero greenhouse gas emissions (Federal Democratic Republic of Ethiopia, 2011). To translate this vision into actionable interventions, the CRGE adopts a sectoral approach organized around four strategic pillars: (1) improving crop and livestock production practices for higher food security

and farmer income while reducing emissions; (2) protecting and re-establishing forests for their economic and ecosystem services, including as carbon stocks; (3) expanding electricity generation from renewable sources of energy for domestic and regional markets; and (4) leapfrogging to modern and energy-efficient technologies in transport, industrial sectors, and buildings (EFD Initiative, 2011; Climate Policy Radar, n.d.). These pillars are supported by more than 60 identified and prioritised initiatives across six government ministries (EFD Initiative, 2011).

The strategy's emission reduction ambition is particularly noteworthy. Ethiopia committed to limiting 2030 greenhouse gas emissions to approximately 150 Mt CO₂e, equivalent to 2010 emission levels, representing approximately 250 Mt CO₂e less than projected under a conventional development path (Climate Policy Radar, n.d.). This translates to a 64% reduction below business-as-usual levels by 2030 (Ministry of Finance, n.d.; World Bank, 2020). The CRGE also establishes ambitious renewable energy targets, including increasing generating capacity by 25,000 MW by 2030, comprising 22,000 MW from hydro, 2,000 MW from wind, and 1,000 MW from geothermal sources (Climate Policy Radar, n.d.). Implementation of these initiatives offers important co-benefits, including improved public health through better air and water quality, and rural economic development through increased soil fertility and food security (Environmental Protection Authority, 2011).

2.2 Institutional Architecture

To operationalize the CRGE Strategy, Ethiopia established a multi-layered institutional architecture designed to coordinate, finance, and monitor implementation across government sectors and with development partners.

CRGE Facility (2012): The CRGE Strategy tasked the Ministry of Finance (MoF) with establishing a national climate fund to mobilize climate finance from various sources to realise this vision (Ministry of Finance, n.d.). Accordingly, MoF in collaboration with Environment, Forest and Climate Change (EFCCC) established the CRGE Facility in late 2012 and operationalized it in early 2013 to attract climate finance to support the institutional building and implementation of Ethiopia's CRGE Strategy (Ministry of Finance, n.d.; CDKN, 2017). The Facility serves as Ethiopia's primary national climate fund, designed to mobilize, access, sequence, and blend domestic and international, public and private sources of finance (Climate Policy Radar, n.d.). The Facility is governed by a Management Committee, which is co-chaired by MoF and MEFCC state ministers, with all sector ministries involved in the CRGE strategy represented both at state minister level and by senior technical experts from their CRGE unit (Ministry of Finance, n.d.). An Advisory Board comprising representatives from development partners, the private sector, multilateral development banks, civil society organisations, and academia provides strategic guidance (Ministry of Finance, n.d.). Established in 2012, the CRGE Facility is recognised as one of the world's first institutions set up to coordinate climate finance delivery in this manner (CDKN, 2017). By early 2016, the Ministry of Finance had secured accreditation as the National Implementing Entity (NIE) for both the Green Climate Fund (GCF) and the Adaptation Fund, enabling direct access to climate funds of up to US\$60 million (CDKN, 2017).

CRGE Forum (2018): In January 2018, Ethiopia established the CRGE Forum in close consultation with its development partners, with the objective of ensuring better coordination for effective implementation of Ethiopia's CRGE Strategy (Environmental Protection Authority, 2020). The Forum serves as a coordination platform for ensuring effective donor coordination, resource mobilization and sustainability of development partnership (Environmental Protection Authority, 2020; Development Partners Group Ethiopia, n.d.). The Forum is chaired by the Ministry of Planning and Development and co-chaired by the Norwegian and British Embassies, with the United Nations Development Programme (UNDP) serving as the secretariat. The Forum's structure comprises three interconnected

entities: a High-Level Group (HLG) and Technical Working Groups that facilitate detailed sectoral coordination (Development Partners Group Ethiopia, n.d.). The Forum has been actively involved in the Green Legacy Initiative, with members participating in tree planting campaigns and demonstrating solidarity with national greening efforts (Environmental Protection Authority, 2020).

Monitoring and Evaluation: The Ministry of Planning and Development plays a central role in monitoring and evaluating the implementation of Ethiopia's climate and green economy programmes. The CRGE Strategy is a key component of Ethiopia's Ten-Year Development Plan (2021–2030), ensuring that green economy objectives are integrated into the country's broader development planning framework.

2.3 The Green Legacy Initiative (GLI): Design and Implementation

Building upon the strategic foundation established by the CRGE, Ethiopia launched the Green Legacy Initiative (GLI) in 2019 under the leadership of Prime Minister. The GLI represents one of the world's most ambitious large-scale reforestation and land rehabilitation efforts, designed to restore ecosystems, combat deforestation and soil erosion, expand forest coverage, improve air and water quality, and create millions of jobs.

The initiative is structured around six interconnected dimensions: extensive tree planting; biodiversity conservation; carbon storage; soil and water preservation; public awareness and climate education; and community engagement. The GLI has introduced a diverse mix of seedlings, including fruit trees (such as avocado, mango, and papaya), fodder plants, fuelwood species, and ornamental species to enhance both rural livelihoods and urban landscapes (Ethiopian Broadcasting Corporation, 2026).

The GLI's quantitative ambition is unprecedented. The initiative set an overall target of planting 50 billion seedlings by 2026, with annual planting campaigns progressively scaling from 4.7 billion seedlings in 2019 (surpassing the target of 4 billion) to 5.9 billion in 2020, 6.8 billion in 2021, 7.2 billion in 2022, 7.5 billion in both 2023 and 2024, and 8 billion in 2025. By 2025, Ethiopia had planted approximately 50 billion seedlings (Ethiopian Broadcasting Corporation, 2026). This makes Ethiopia one of the world's leading nations in implementing large-scale, sustainable natural resource development (Ministry of Agriculture, n.d.).

The GLI employs a participatory approach, engaging millions of citizens across all segments of society in tree planting and land restoration activities. Over its first four years, the initiative mobilized 20 million citizens to plant more than 25 billion seedlings (Forests of the World, 2024). The initiative has attracted global recognition as a model for climate action, with neighbouring countries joining the fight against desertification and Ethiopia supplying Djibouti and others with multipurpose seedlings (Ministry of Agriculture, n.d.; Ethiopian Broadcasting Corporation, 2026). The GLI is strategically aligned with Ethiopia's broader policy framework, including the CRGE Strategy, the Ten-Year Development Plan (2021–2030), and the National Forest Sector Development Program.

III. Research Methods

3.1 The Scale of Achievement: Planting Numbers

The Green Legacy Initiative (GLI) has achieved remarkable quantitative milestones since its launch in 2019. According to the Ethiopian Ministry of Agriculture, 48 billion tree seedlings have been planted across the country over the past eight years, covering approximately 11 million hectares of land (EBC, 2026; [Press.et](https://www.press.et), 2025). The initiative's annual planting targets have progressively scaled from 4.7 billion seedlings in 2019 to 5.9 billion in 2020, 6.8 billion in 2021, 7.2 billion in 2022, 7.5 billion in both 2023 and 2024, and 8 billion in 2025 (Ministry of Agriculture, n.d.). Prime Minister Abiy Ahmed has expressed confidence

that if the 2025 target is met, Ethiopia will surpass its original plan by planting over 55 billion seedlings ([Press.et](#), 2025).

To support this massive planting effort, Ethiopia has established over 120,000 nursery stations nationwide—a substantial increase from just 45,000 before the GLI's launch ([Press.et](#), 2025). These nurseries are operated through a mix of government bodies, communities, private sector actors, and non-governmental organisations, creating a broad base of engagement in the campaign ([Press.et](#), 2025). Approximately 56% of nurseries produce high-quality fruit varieties, while the remainder focuses on forest development and environmental protection species ([Press.et](#), 2025). The initiative has mobilised over 20 million citizens in planting campaigns, transforming tree planting into a national ritual and cultural practice ([SDGs.un.org](#), n.d.; Forests of the World, 2024).

Figure 1 illustrates the annual seedling planting trajectory under Ethiopia's Green Legacy Initiative (GLI) from 2019 to 2025. The data reveal a consistent upward trend, with annual plantings increasing from 4.7 billion seedlings in 2019 to 8.0 billion in 2025, representing a 70% increase over seven years (Ministry of Agriculture, n.d.). This progressive scaling demonstrates the government's commitment to expanding restoration efforts, with plantings stabilising at 7.5 billion in 2023–2024 before reaching the 8 billion target in 2025 ([Press.et](#), 2025). The cumulative total of approximately 48 billion seedlings planted over this period represents one of the most ambitious afforestation campaigns globally (EBC, 2026).

This quantitative achievement has contributed significantly to Ethiopia's forest cover expansion from 17.2% in 2019 to 24% by 2025 (Shibabaw & Wondimneh, 2025; [Press.et](#), 2025). However, as subsequent sections demonstrate, planting numbers alone provide an incomplete picture of ecological outcomes, necessitating critical assessment of survival rates and ecosystem functionality (Tefera et al., 2025; Frontiers, 2025).

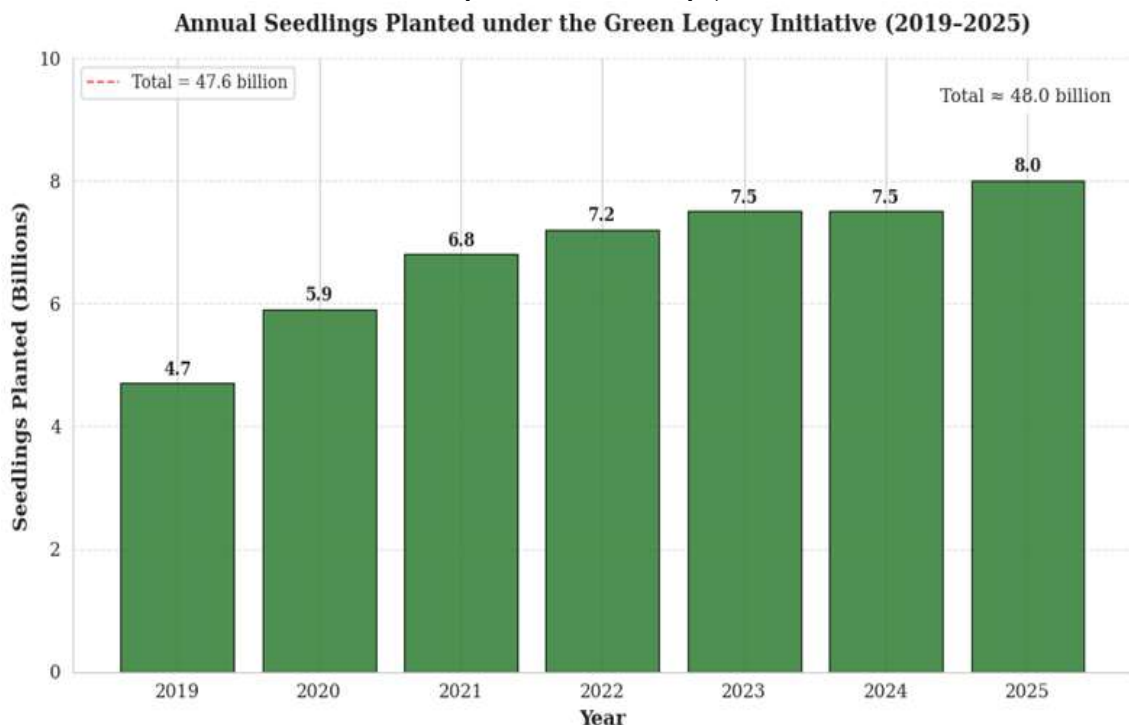


Figure 1: Annual Seedlings Planted under the Green Legacy Initiative (2019–2025)

Source: Ministry of Agriculture (n.d.); [Press.et](#) (2025)

3.2 Forest Cover Expansion

The quantitative planting achievements have translated into measurable increases in national forest coverage. Ethiopia's forest cover increased from 17.2% in 2019 to 23.6% in 2023, representing a 6.4 percentage point increase over four years (Shibabaw & Wondimneh, 2025; [Press.et](#), 2024). By 2025, forest coverage had further increased to approximately 24% ([Press.et](#), 2025). The government has set an ambitious target of achieving 30% forest coverage by 2030, which would require sustained afforestation and reforestation efforts over the coming years (FDRE, 2017, 2021; ENA, 2024). The forestry industry is projected to yield more than 100 million USD in revenue as forest cover expands (Shibabaw & Wondimneh, 2025).

However, these national averages mask significant regional variations. A study evaluating land use and cover dynamics in Gubalafto District, North-eastern Ethiopia, using Landsat-8 and Sentinel-2 imagery processed via Google Earth Engine, found that forest cover fluctuated, declining from 16.43% (165.96 km²) in 2013 to 14.60% (147.47 km²) in 2024, a decline attributed to armed conflict post-2020 that disrupted restoration efforts (Tefera et al., 2025). Despite this, the study documented significant ecological shifts: woodland increased by 41.85 km² (net gain), largely through conversion from agricultural land (76.93 km²) and bareland (16.06 km²), and high-density vegetation rose from 0.98% (9.89 km²) in 2013 to 9.38% (94.71 km²) in 2024, peaking in 2020 with a maximum NDVI of 0.95 (Tefera et al., 2025).

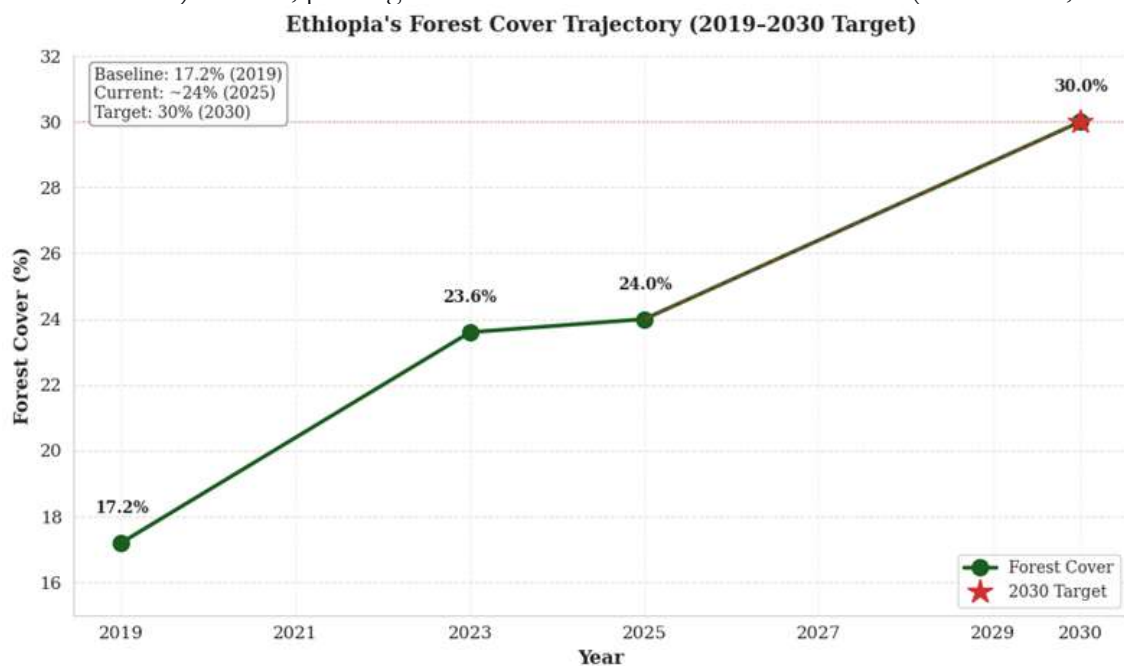


Figure 2: Ethiopia's Forest Cover Trajectory (2019–2030 Target)

Source: Shibabaw & Wondimneh (2025); [Press.et](#) (2025); FDRE (2017, 2021)

Figure 2 illustrates Ethiopia's forest cover trajectory from 2019 to the 2030 target, revealing a compelling narrative of progress and ambition. The data show that forest cover increased from 17.2% in 2019 to 23.6% in 2023, representing a 6.4 percentage point gain over four years, a substantial achievement directly attributable to the Green Legacy Initiative's intensive planting campaigns (Shibabaw & Wondimneh, 2025; ENA, 2024). By 2025, forest cover reached approximately 24.0%, reflecting continued but decelerating gains ([Press.et](#), 2025). The government has set an ambitious target of 30% forest coverage by 2030 (FDRE, 2017, 2021), requiring an additional 6 percentage point increase over five years, a pace comparable to the 2019–2023 period.

However, several critical observations emerge from this trajectory. First, the slowing rate of forest cover increase between 2023 and 2025 (0.4 percentage points) compared to the 2019–2023 period (6.4 percentage points) suggests emerging challenges in maintaining afforestation momentum. Second, achieving the 2030 target demands sustained annual planting of 7.5–8 billion seedlings coupled with significant improvements in seedling survival rates, which current independent studies indicate average only 39.80% at the district level (Tefera et al., 2025). Third, these national averages mask considerable regional heterogeneity, with some areas experiencing forest cover declines due to armed conflict and land use pressures (Tefera et al., 2025). The trajectory ultimately depends not merely on planting numbers but on the ecological quality of restored landscapes, including survival rates, biodiversity regeneration, and ecosystem service provision. Bridging the gap between quantitative planting achievements and qualitative ecological outcomes remains the central challenge for Ethiopia's green transition.

3.3 Ecological Outcomes

Beyond forest cover expansion, the GLI has generated a range of measurable ecological benefits that extend to soil conservation, water resource restoration, biodiversity regeneration, and carbon sequestration.

Soil Erosion Reduction: Perhaps the most dramatic ecological outcome concerns soil conservation. Previously, an estimated 1.9 billion tonnes of fertile soil were lost annually due to erosion (Xinhua, 2025; ENA, 2025). Currently, average losses have dropped to 208 million tonnes thanks to the GLI, helping preserve farmland and prevent siltation in dams (Xinhua, 2025; Ministry of Agriculture, 2025). At the per-hectare level, soil loss from agricultural land has dropped from 130 tons to 54 tons since the program's inception, representing more than a 50% reduction (ENA, 2025). Over 28 million hectares of land have been preserved and protected from degradation through soil conservation measures ([Press.et](#), 2024).

Water Resource Restoration: The initiative has facilitated significant improvements in water resources, including the revival of long-dried natural springs and improved groundwater levels (ENA, 2025; Fanamc, 2025). Research has documented notable improvements in water availability in rehabilitated areas, with restored vegetation enhancing watershed protection and increasing water retention capacity ([Press.et](#), 2024). A multi-scale hydrological ecosystem services evaluation in the Ethiopian Rift Valley Lakes Basin found that the Normalised Difference Vegetation Index (NDVI) increased from 0.48 to 0.53, while the Curve Number declined from 82.62 to 81.60, reflecting reduced runoff and improved flood regulation (Wiley Online Library, 2026).

Biodiversity Regeneration: A study conducted by the Alliance of Bioversity International and CIAT, hosted by the International Livestock Research Institute (ILRI), provided compelling evidence of biodiversity benefits. Researchers found that planting just one tree species can lead to the regeneration of more than ten local tree species, while also reclaiming degraded land and restoring habitats for migrating animals (ENA, 2025). At the Yekotegn GLI site in the Gurage zone, 24 native species were documented regenerating naturally (Alliance Bioversity CIAT, 2025). The program has facilitated the restoration of habitats, leading to the return of migratory animals, such as the Colobus guereza and Gray Birds, to their original habitats (ENA, 2025; Fanamc, 2025). The study also assessed ecosystem services including climate moderation, enhanced scenery, and the preservation of cultural heritage, noting that trees have become integral to the daily lives of local communities for various cultural practices and negotiations (ENA, 2025).

3.4 The Survival Rate Question

Perhaps the most contentious aspect of the GLI's assessment concerns seedling survival rates—a critical indicator that reveals the gap between planting efforts and sustainable ecological outcomes.

Official government reports have consistently reported high survival rates. The Ethiopian Ministry of Agriculture announced that approximately 85% of the 7.5 billion seedlings planted during the rainy season survived, based on the first round of biannual surveys conducted after the rainy season (ENA, 2023; FBC, 2023). This official figure has been widely cited, with some sources reporting survival rates of 84–85% (Garoweonline, 2026; Sputnik, 2023). More recently, the Ethiopian Forest Development reported that last year's first-round seedlings achieved a survival rate of 88.6%, with an average survival rate of over 81% over the past six years (Press.et, 2025).

However, independent academic studies have revealed significant inconsistencies. A comprehensive study evaluating the GLI's impact on land use and cover dynamics in Gubalafto District found that, despite the nationwide planting of 38.6 billion seedlings, district-level survival rates averaged only 39.80%, with a range of 7.59% to 76.50% (Tefera et al., 2025). This indicates a critical gap between planting efforts and sustainable outcomes. Similarly, studies in the Amhara and Tigray regions reported survival rates of approximately 55% and 58%, respectively, primarily due to harsh climatic conditions and limited access to water resources (UNEP, 2021a,b,c, cited in Frontiers, 2025). Low seedling survival has been attributed to inadequate watering, insufficient soil preparation, competition, low soil moisture, and nutrient content (Frontiers, 2025).

The discrepancy between official and independent survival estimates, 85% versus 39.80% at the district level highlights fundamental challenges in monitoring and evaluation. The gap between planting and survival: 48 billion planted versus an estimated 34+ billion surviving plants based on official figures, or substantially fewer based on independent assessments. This disparity underscores the need for more rigorous, transparent, and spatially explicit monitoring systems (Table 1).

Table 1. Comparative Seedling Survival Rates

Source	Survival Rate (%)	Context
Ministry of Agriculture (Official)	85	National average, first-round survey (ENA, 2023)
Ministry of Agriculture (Official)	88.6	First-round seedlings, 2024 (Press.et, 2025)
Ministry of Agriculture (Official)	81+	Six-year average (Press.et, 2025)
Tefera et al. (2025) – Gubalafto District	39.80	District-level average (range: 7.59–76.50%)
UNEP (2021) – Amhara Region	~55	Regional estimate
UNEP (2021) – Tigray Region	~58	Regional estimate

3.5 Methodological Approaches to Assessment

Assessing the outcomes of Ethiopia's afforestation efforts requires a diverse array of methodological approaches, each offering distinct insights while also revealing persistent data gaps.

Systematic Review Protocols: Several reviews have applied the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) framework to synthesise evidence on land use and land cover changes, ecosystem service values, and forest dynamics in Ethiopia (MDPI, n.d.; F1000Research, n.d.). These systematic reviews have examined the link between changes

in land use and cover and ecosystem/m service values, with emphasis on mountainous landscapes, providing a comprehensive evidence base for policy and practice (MDPI, n.d.). Remote Sensing and GIS: Advanced geospatial techniques have become central to assessing GLI outcomes. Studies have utilised Landsat-8 and Sentinel-2 imagery processed via Google Earth Engine (GEE) employing the Random Forest (RF) algorithm and Normalised Difference Vegetation Index (NDVI) analysis to evaluate land use and cover dynamics (Tefera et al., 2025). The RF classifier achieved high accuracy (OA = 99% for 2016–2024 and OA = 73% in 2013) in mapping six land use and cover classes (Tefera et al., 2025). Geospatial evidence has also been used to assess soil organic carbon distribution, moisture stability, and microclimate mitigation, with NDVI values steadily increasing and Land Surface Temperature dropping from 12.3°C in 2022 (Springer, 2026). The Normalised Difference Moisture Index (NDMI) has been employed to assess moisture conditions, with strong correlations ($r = 0.666\text{--}0.780$, $p < 0.001$) confirming humidity availability as a key driver of restoration success (DTIC, n.d.).

Multi-Scale Hydrological and Ecosystem Services Assessment: Proxy-based evaluation frameworks have been applied to assess ecohydrological responses and ecosystem service benefits. The Multi-Scale Hydrological Ecosystem Services Proxy (MS-HES Proxy) framework has been used to evaluate improvements in vegetation cover, runoff reduction, and flood regulation across scales (Wiley Online Library, 2026).

Thematic Synthesis and Comparative Matrices: Qualitative and mixed-methods approaches, including thematic synthesis of stakeholder perceptions and comparative matrices of ecological and socio-economic outcomes, have been employed to provide a more holistic understanding of GLI impacts (Alliance Bioversity CIAT, 2025).

IV. Result and Discussion

4.1 Economic Benefits at Household Level

The Green Legacy Initiative (GLI) has generated substantial economic benefits at the household level, fundamentally improving rural livelihoods and national economic performance. The programme has significantly contributed to household incomes through the strategic planting of edible plants, including vegetables and fruits, which have directly improved family incomes and the broader food system (ENA, 2025c). Massive plantations of papaya, avocado, mango, and apple trees are enabling both rural farmers and urban dwellers to meet their nutritional needs and generate surplus income, with this agricultural transformation already reaching global markets through avocado exports to Europe and the Middle East (EBC, 2026).

In the coffee sector, Ethiopia's most significant agricultural export the GLI has overseen the planting of millions of coffee seedlings, contributing to a marked increase in export volumes and foreign exchange earnings (ENA, 2025b). Deputy Prime Minister Temesgen Tiruneh revealed that Ethiopia earned US\$2.6 billion in coffee exports during the recently concluded fiscal year, crediting this achievement in part to coffee seedlings planted in the early years of the programme (ENA, 2025a). Planning and Development Minister Fitsum Assefa affirmed that the GLI is playing an "irreplaceable role" in Ethiopia's national economic revival (ENA, 2025b).

Beyond export crops, the GLI is contributing to food sovereignty by transforming drought-prone and marginalised areas into productive agricultural lands (ENA, 2025c). The programme has also created favourable conditions for honey production, increasing the benefits of beekeepers by boosting forest coverage (ENA, 2025c). The United Nations Industrial Development Organization (UNIDO) has reported that Ethiopia's beekeeping drive, supported by the GLI, is a major intervention linking environmental restoration with

sustainable livelihoods, with organized cooperatives, many led by women producers playing a central role in transforming the sector (ENA, 2026).

4.2 Employment and Green Jobs

The GLI has emerged as a major engine for Ethiopia's labour market, creating substantial employment opportunities across the country. The initiative has generated more than 767,000 jobs in areas such as nursery management, seedling production, agroforestry, and sustainable land management (WRI, 2025). With over 120,000 nurseries established nationwide, the project provides a steady stream of permanent and temporary jobs in seedling cultivation and long-term care, particularly benefiting women and youth (EBC, 2026; Dar, 2025).

These employment opportunities extend beyond direct nursery work. The programme creates jobs in transport, afforestation teams, and various service-providing institutions (Press.et, 2025). Seasonal planting campaigns provide temporary employment for young people, while women's cooperatives growing seedlings for commercial sale build sustainable income sources and empower female entrepreneurs (Daily News Africa, 2025). The Ethiopian Economics Association has recognised that Ethiopia is taking a leading role in Africa in creating substantial job opportunities while promoting environmental protection, due to its strong emphasis on the GLI (EBC, 2026). In rural Ethiopia, where incomes are fragile, these jobs carry real weight, linking ecological recovery directly to livelihoods (Corporate Knights, 2025).

4.3 Women and Youth Empowerment

The GLI has demonstrated a strong commitment to gender-inclusive and youth-focused employment generation. Women and youth account for a substantial proportion of the jobs created, with the initiative creating annual employment for thousands of citizens, particularly women and youth (EBC, 2026). According to reliable sources, close to 700,000 people have been engaging in cultivating seedlings and earning their living, with significant benefits for women and youth (Press.et, 2025). UNIDO has reported that the GLI is opening new income opportunities for women and young people, with organized cooperatives, many led by women producers, playing a central role in transforming the apiculture sector (ENA, 2026).

The initiative provides skills training in seedling management, business development, and sustainable practices, enabling participants to transition from extractive livelihoods, such as firewood and charcoal production to sustainable employment (Daily News Africa, 2025). The programme also creates job opportunities in animal husbandry, beekeeping, poultry farming, and fruit and vegetable production. The GLI is described as "more than a restoration effort; it is about building climate resilience, creating green jobs, improving food security, and empowering women and youth, while strengthening ecosystems across Ethiopia" (UNEP, 2026). By providing skills that contribute to nature-positive development, the GLI is creating pathways for women and youth to participate meaningfully in Ethiopia's green economy transition.

4.4 Social and Cultural Benefits

Beyond measurable economic outcomes, the GLI has generated profound social and cultural transformations reshaping Ethiopian society. Each year, more than 20 million Ethiopians take part in the GLI, with schools integrating tree planting into lessons, churches and mosques turning holy days into planting days, and ministries coordinating calendars to maximise labour around the rainy season (Corporate Knights, 2025). The initiative has mobilized citizens from all walks of life; students, farmers, civil servants, and religious leaders fostering a strong culture of civic engagement (Corporate Knights, 2025).

In urban areas, the GLI is physically reshaping cityscapes through high-profile projects like "Dine for Sheger," where new parks act as "green lungs" that mitigate urban heat and provide residents with essential recreational spaces (EBC, 2026). Perhaps the most enduring

result is the cultural shift it has triggered. The philosophy of "planting tomorrow, today" has permeated the national consciousness, turning tree planting into a shared civic duty for the next generation (EBC, 2026). The initiative represents a reimagining of how a country can build ecological infrastructure as a foundation for economic renewal, with trees framed not merely as carbon sinks but as ecological infrastructure anchoring food systems, water cycles, and national dignity (Corporate Knights, 2025). This model breaks with Ethiopia's past dependency on foreign aid, asserting ecological sovereignty rooted in local agency (Corporate Knights, 2025).

4.4 Challenges, Trade-Offs, and Implementation Gaps

a. Ecological and Technical Challenges

Despite the Green Legacy Initiative's (GLI) remarkable quantitative achievements, significant ecological and technical challenges threaten its long-term sustainability. The most critical concern is seedling survival. While official government reports indicate survival rates of approximately 85% (FBC, 2023), independent academic studies reveal substantial regional variations. Research in the Amhara and Tigray regions reported survival rates of approximately 55% and 58%, respectively, primarily due to harsh climatic conditions and limited access to water resources (UNEP, 2021a,b,c, cited in Frontiers, 2025). In the eastern and southeastern regions, where droughts are more frequent, survival rates were recorded at less than 40% in some cases (Wolde, 2020a,b, cited in Frontiers, 2025). A district-level study in Gubalafto found an average survival rate of only 39.80%, ranging from 7.59% to 76.50% (Tefera et al., 2025). Factors contributing to low survival include inadequate post-planting management, insufficient soil preparation, competition from invasive species, low soil moisture, and nutrient content (Frontiers, 2025; [Agris.fao.org](https://agris.fao.org), 2026). Forest ecologist Kitessa Hundera has also warned against poor site planning and the mixing of exotic and indigenous species, noting the lack of published survival rates for past plantings ([Commonspace.eu](https://commonspace.eu), 2025).

Open grazing and seedling loss further threaten sustainability. Livestock grazing in newly planted areas frequently damages or destroys young seedlings, undermining restoration efforts. Technical gaps persist in monitoring carbon storage, with limited capacity for accurate Measurement, Reporting, and Verification (MRV) systems ([Addisfortune.news](https://addisfortune.news), 2025) (Table 2). Species selection presents another challenge: a study assessing genetic considerations found that restoration initiatives have predominantly relied on a few exotic species, including *Eucalyptus globulus*, *Grevillea robusta*, and *Cupressus lusitanica* leaving native species underrepresented and raising concerns about genetic diversity and long-term ecological resilience ([Journals.hu.edu.et](https://journals.hu.edu.et), 2024). Water scarcity remains a fundamental constraint, particularly in Ethiopia's arid and semi-arid regions where rainfall variability makes plantation establishment increasingly challenging (Frontiers, 2025).

Table 2. Regional Seedling Survival Rates under the Green Legacy Initiative

Region	Survival Rate (%)	Key Challenges	Source
National (Official)	85	—	FBC (2023)
Gubalafto District	39.80 (range: 7.59–76.50)	Inadequate post-planting management, low soil moisture	Tefera et al. (2025)
Amhara Region	~55	Harsh climatic conditions, limited water access	UNEP (2021a,b,c)

Tigray Region	~58	Harsh climatic conditions, limited water access	UNEP (2021a,b,c)
Somali/Oromia (Eastern)	<40	Frequent droughts, extreme heat	Wolde (2020a,b)

b. Socio-Economic Trade-Offs

The GLI presents complex socio-economic trade-offs that challenge the assumption that improved environmental management automatically translates into equitable development outcomes (Bimir, 2026). A fundamental tension exists between immediate household expenses and long-term societal benefits. Smallholder farmers must allocate labour, land, and financial resources to tree planting and maintenance activities that may not yield immediate returns, creating opportunity costs that disproportionately affect resource-constrained households (Frontiers, 2025) (Figure 3).

Tensions between private and public returns are evident. While the GLI generates broad public goods, including carbon sequestration, watershed protection, and biodiversity conservation, the private benefits to participating households may be insufficient to justify their investments. This disconnect between national efficiency gains and local equity concerns is particularly acute for land-deprived farmers and women, who may bear the costs of participation without receiving proportional benefits (Bimir, 2026).

The "green squeeze" phenomenon has emerged as a critical concern, particularly for smallholder coffee farmers facing compliance challenges with international regulations such as the European Union Deforestation Regulation (EUDR) (EU 2023/1115). The EUDR mandates that companies importing coffee and other commodities into EU member states demonstrate that their products do not contribute to deforestation or forest degradation (ScienceDirect, 2025). For Ethiopia's millions of smallholder coffee farmers, many of whom lack access to electricity and modern farming techniques, meeting these requirements is a daunting task (ODI, 2024). The regulation imposes strict traceability, documentation, geolocation, and plot-level data requirements that create a "compliance paradox": farmers who have protected Ethiopia's forests for generations now face market exclusion simply because they lack the digital paper trail (ODI, 2025). Coffee exports to Europe account for roughly 35% of Ethiopia's total coffee trade, supporting over five million smallholder farmers (EuroCham Ethiopia, 2025). The stringent requirements of the EUDR may disproportionately affect these smallholder farmers, threatening their livelihoods and potentially exacerbating poverty and inequality ([Business-HumanRights.org](https://www.business-humanrights.org/en/latest/news-and-events/press-releases/detail/12/2024/06/2024-06-12-odhpn-releases-report-on-the-impact-of-the-eudr-on-smallholder-coffee-farmers-in-ethiopia), 2024).

Figure 3 quantifies the socio-economic trade-offs between national/public and local/private perspectives across four critical dimensions of the Green Legacy Initiative (GLI). The results reveal a consistent divergence, with national perspectives scoring positively (3.5 to 4.4) while local perspectives score negatively (−3.0 to −4.0). The widest gap occurs in benefit distribution (4.4 vs −4.0), reflecting tension between broad public goods, carbon sequestration and watershed protection, and limited private returns from fruit production and fuelwood (Bimir, 2026). Regulatory burden shows the largest negative local score (−4.0), as international compliance (EUDR) imposes costs threatening smallholder livelihoods (ODI, 2024). Time horizon (3.9 vs −3.5) highlights disconnects between long-term national benefits and immediate household expenses (Frontiers, 2025). Land use (4.0 vs −3.0) reveals conflict between reforestation for ecosystem services and agricultural production for food security.

This divergence underscores the need for policies equitably distributing benefits and addressing community opportunity costs.

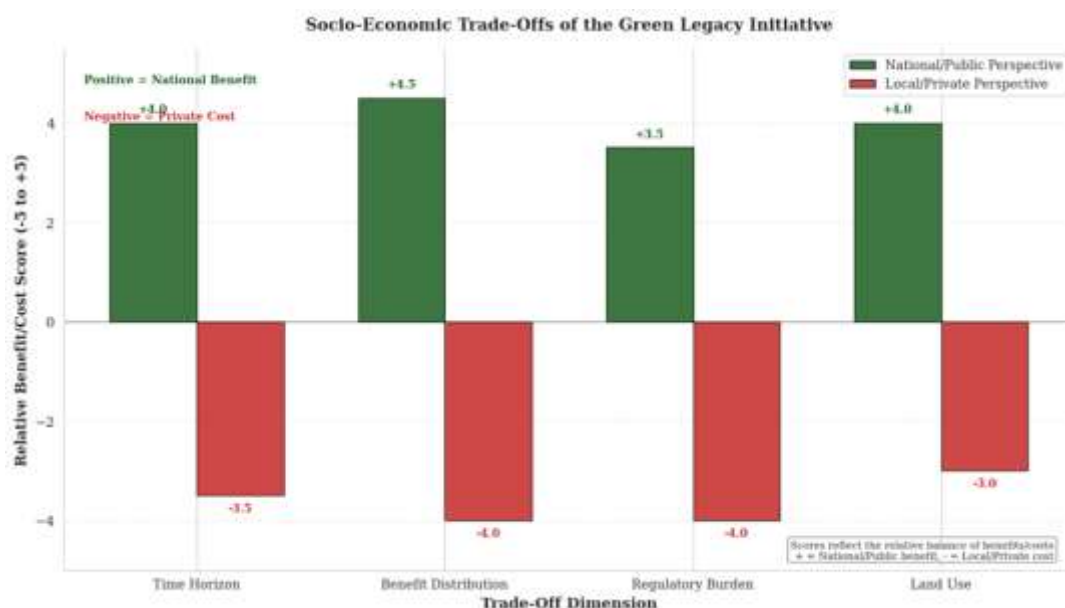


Figure 3: Socio-Economic Trade-Offs of the Green Legacy Initiative

c. Institutional and Governance Gaps

Institutional and governance weaknesses significantly constrain the GLI's effectiveness. Weak law enforcement undermines forest protection efforts, with inadequate policy enforcement hindering sustainable forest management (Shibabaw & Wondimneh, 2025; [Journals.eanso.org](https://journals.eanso.org), 2025). Fragmented data systems complicate monitoring and evaluation: most coffee farmers sell through informal channels, complicating traceability and compliance with international regulations (ODI, 2025). Land tenure and mapping challenges persist, with inadequate protection for indigenous communities and weak recognition of customary tenure ([Agris.fao.org](https://agris.fao.org), 2026). The GLI's plantations have been

carried out by campaign without having safeguards tools and site-maps.

Bureaucratic delays and implementation bottlenecks are pervasive. Project implementation is negatively affected by delayed budget disbursements, minimal administrative budgets, and a mismatch between project structure and government hierarchy (Green Climate Fund, n.d.). The initiative is also hampered by overlapping responsibilities between government departments and a lack of clarity regarding forest ownership (Dialogue Earth, 2024). Green economy-related activities are often performed annually without sustained community engagement, raising issues of comprehensiveness and sustainability

([SOS-Ethiopia.org](https://sos-ethiopia.org), n.d.).

Limited private sector engagement represents a significant gap. While the GLI has created sizable jobs and nurtured entrepreneurs, investment gaps and weak market linkages persist ([Press.et](https://press.et), 2024). The green finance market remains underdeveloped and heavily reliant on grants and concessional financing ([Africachinacentre.org](https://africachinacentre.org), 2025).



Figure 4: Institutional and Governance Gaps in GLI Implementation

Figure 4 illustrates the institutional and governance gaps constraining Ethiopia's Green Legacy Initiative (GLI) implementation across five critical dimensions. The lollipop plot reveals that all governance dimensions exceed the moderate threshold (score > 3.0), with Law Enforcement (4.5) and Data Systems (4.0) registering at critical levels. Law enforcement's highest severity reflects weak policy enforcement and inadequate protection, driving continued deforestation and illegal logging that undermines restoration gains (Shibabaw & Wondimneh, 2025). Data Systems' critical score stems from fragmented, informal channels and limited traceability, creating poor monitoring capacity and significant EUDR non-compliance risk for Ethiopia's coffee sector (ODI, 2025).

Land Tenure (4.0) highlights weak customary tenure recognition and inadequate mapping, generating land use conflicts and insecure restoration investments that discourage community participation ([Agris.fao.org](https://www.agris.fao.org/), 2026). Coordination (3.5) captures overlapping responsibilities and bureaucratic delays causing inefficient implementation and resource waste (Green Climate Fund, n.d.). Private Sector (3.5) reveals limited engagement, investment gaps, and weak market linkages constraining capital mobilization and market development ([Africachinacentre.org](https://www.africachinacentre.org/), 2025).

The collective severity of these gaps, with all dimensions scoring high and two exceeding critical thresholds underscores the systemic nature of governance challenges facing the GLI. Addressing these institutional weaknesses through strengthened enforcement, integrated data systems, secure land tenure, streamlined coordination, and enhanced private sector engagement is essential for the initiative's long-term sustainability and effectiveness (Bimir, 2026; Frontiers, 2025).

d. Persistent Deforestation

Despite the massive planting efforts of the GLI, persistent deforestation continues to undermine restoration gains. According to Agriculture Minister Girma Amente, 90,000 to 100,000 hectares of forest are destroyed every year in Ethiopia (ENA, 2025). This deforestation trend has led to droughts, floods, and various natural disasters (ENA, 2025).

Global Forest Watch data confirms that in 2025, Ethiopia lost 31 kha of natural forest, equivalent to 14 Mt of CO₂ emissions ([GlobalForestWatch.org](https://www.globalforestwatch.org/), 2026). In 2020, Ethiopia had 14 Mha of natural forest, extending over 12% of its land area, indicating that natural forest

cover remains below 4% of total land area when considering the country's total land area ([GlobalForestWatch.org](https://globalforestwatch.org), 2026).

The continued demand for fuelwood, construction materials, and agricultural expansion drives this persistent deforestation. Ethiopia loses 1.4 million hectares of forest annually according to United Nations estimates, with shifting agriculture, livestock production, and fuelwood collection in drier areas identified as the main causes (Table 3). This creates a paradox: while the GLI plants billions of seedlings annually, ongoing deforestation effectively cancels out a substantial portion of these gains. The gap between planting and forest preservation highlights the need for integrated approaches that address both the supply (reforestation) and demand (reducing deforestation drivers) sides of forest management.

Table 3. Ethiopia's Forest Cover and Deforestation Indicators

Indicator	Value	Year	Source
Natural forest cover	14 Mha (12% of land area)	2020	GlobalForestWatch.org (2026)
Natural forest loss	31 kha	2025	GlobalForestWatch.org (2026)
Annual deforestation	90,000–100,000 ha	2025	ENA (2025)
Natural forest cover (% of total land)	<4%	2025	GlobalForestWatch.org (2026)
Historical forest cover (peak)	~40%	Early 20th century	ENA (2025)

e. Financial and Capacity Constraints

Financial constraints represent one of the most significant barriers to achieving Ethiopia's green economy ambitions. The **estimated cost of achieving the 2030 emission reduction target is US\$154 billion over 30 years**, with US\$86 billion earmarked for mitigation efforts including power generation, waste management, and cleaner transport ([Addisfortune.news](https://addisfortune.news), 2025). The CRGE strategy requires an annual spending commitment of US\$7.5 billion** (Oxfam, 2026). However, federal budgetary resources for climate-relevant actions are estimated at only **US\$440 million annually, while international sources add an uncertain amount that may be in the tens of millions of dollars per year (Oxfam, 2026). The heavy reliance on international support is stark: 80% of Ethiopia's emission reduction target depends on external financing, with only US\$63.2 billion (20%) classified as unconditional.

Volatile carbon prices affect revenue predictability from carbon markets. Carbon credit prices for African projects have averaged only \$3 to \$5 per tonne of CO₂, significantly lower than prices in other regions (African Leadership Magazine, 2025). The global Voluntary Carbon Market is undergoing a reset, with credit issuances tracking for a five-year low in 2025 (IETA, 2025). This volatility, combined with bureaucratic delays, complicates Ethiopia's efforts to position itself as a climate finance leader ([Addisfortune.news](https://addisfortune.news), 2025).

The shortage of finance, technology, and skilled labour further constrains implementation. Land degradation costs Ethiopia an estimated \$4.3 billion per year due to reduced agricultural productivity and loss of ecosystem services (JA Resource Hub, 2025). The green finance market remains underdeveloped, and domestic markets for climate-aligned capital are still nascent ([Africachinacentre.org](https://africachinacentre.org), 2025).

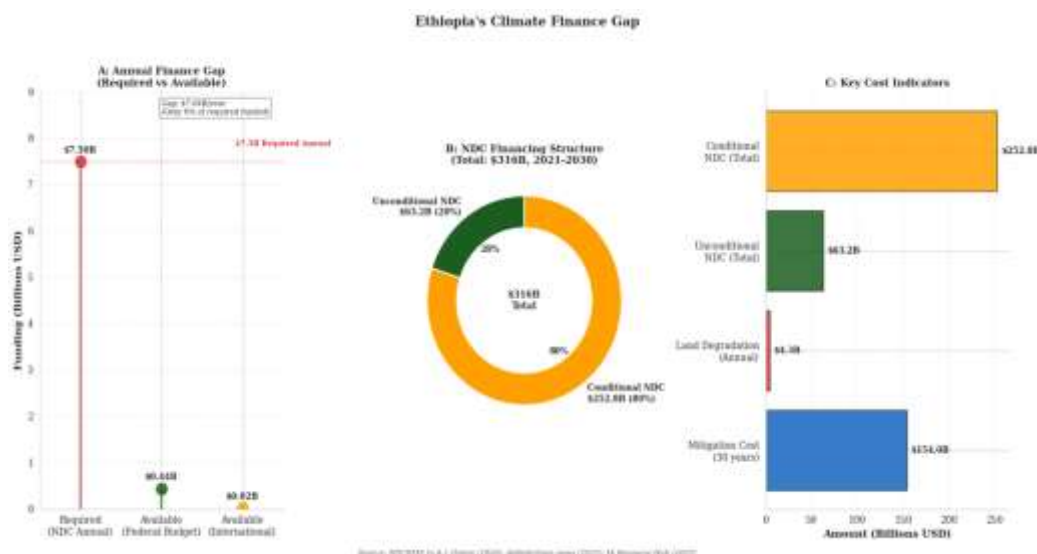


Figure 5. A) Ethiopia's climate finance gap showing annual funding deficits, B) NDC financing structure, and C) major climate investment requirements for sustainable development.

Figure 5 presents a comprehensive assessment of Ethiopia's climate finance gap, highlighting the scale of funding requirements, financing composition, and major investment priorities. Figure 5A demonstrates a substantial disparity between annual climate finance needs and currently available resources. The country's Nationally Determined Contribution (NDC) requires approximately US\$7.50 billion annually, whereas only US\$0.44 billion is allocated through the federal budget and approximately US\$0.02 billion is obtained from international sources. This results in an annual financing deficit of about US\$7.04 billion, indicating that only 6% of the required funding is presently secured. Such a deficit poses a significant challenge to implementing Ethiopia's climate adaptation and mitigation commitments.

Figure 5B illustrates the financing structure of Ethiopia's NDC for 2021-2030, with total investment requirements estimated at US\$316 billion. Of this amount, US\$63.2 billion (20%) represents unconditional commitments expected to be financed through domestic resources, while US\$252.8 billion (80%) depends on conditional international financial support. This distribution highlights Ethiopia's strong dependence on external climate finance and international partnerships to achieve its long-term climate objectives.

Figure 5C compares major climate-related investment categories. Conditional NDC financing constitutes the largest component (US\$252.8 billion), followed by mitigation investments totaling US\$154.0 billion over thirty years. Unconditional financing contributes US\$63.2 billion, while annual land degradation management requires approximately US\$4.3 billion. Collectively, these findings reveal that Ethiopia's climate ambitions substantially exceed its domestic fiscal capacity, emphasizing the importance of expanded international climate finance, concessional lending, technology transfer, and private-sector investment. Without closing this financing gap, progress toward achieving the country's climate resilience, low-carbon development, and sustainable development objectives will remain significantly constrained (Oxfam, 2026; Addisfortune.news, 2025; JA Resource Hub, 2025).

V. Conclusion

Ethiopia's green economy strategy, operationalized through the Climate Resilient Green Economy (CRGE) Strategy and the Green Legacy Initiative (GLI), represents one of the most ambitious and pioneering models for environmental restoration in the Global South. The GLI has achieved remarkable quantitative success, with over 48 billion seedlings planted since 2019, contributing to a forest cover increase from 17.2% to approximately 24%. Significant ecological outcomes include soil erosion reduction from 1.9 billion to 208 million tonnes annually, water resource restoration, and biodiversity regeneration. Substantial community co-benefits encompass over 767,000 jobs created, income diversification through fruit and coffee production, and women and youth empowerment. However, these benefits remain inconsistent and limited by poor seedling survival rates, with independent studies reporting district-level survival averaging only 39.80%, inadequate post-planting management, weak monitoring systems, and persistent deforestation of 90,000–100,000 hectares annually.

Theoretical and Policy Implications

The GLI can be reconceptualised as addressing market failure arising from the insufficient provision of environmental public goods, including carbon sequestration, watershed protection, and biodiversity conservation. The initiative's experience underscores the critical importance of reconciling environmental externalities with socio-economic opportunity costs, particularly for smallholder farmers bearing the immediate burdens of participation. A comprehensive economic perspective drawing on public goods theory, externality valuation, and behavioural insights is essential for designing policies that align national environmental objectives with local livelihood realities.

Recommendations for Policy and Practice

Based on this review, several evidence-based recommendations emerge. First, shift from quantity to quality by transitioning from a tree-counting paradigm to an ecosystem restoration framework that prioritizes ecological functionality, biodiversity, and long-term sustainability. Second, strengthen monitoring and evaluation systems to generate precise, spatially explicit data on seedling survival rates, hydrological effects, and credible ecosystem service values to enable comprehensive cost–benefit analysis and natural capital accounting. Third, enhance community participation by moving beyond top-down approaches toward inclusive, participatory governance that empowers local communities in decision-making and benefit-sharing. Fourth, address survival bottlenecks by improving post-planting management, soil moisture, and nutrient conditions through technical support and investment in sustainable land management practices. Fifth, strengthen law enforcement to protect planted areas from open grazing, illegal logging, and encroachment. Sixth, scale up private sector engagement by unlocking investment and market linkages through blended finance mechanisms, carbon market development, and public-private partnerships.

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