



Tea Small Holdings Development Authority

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Strengthening Climate Resilience in Sri Lanka's Tea Smallholdings: Strategic Pathways for Sustainable Sector Transformation

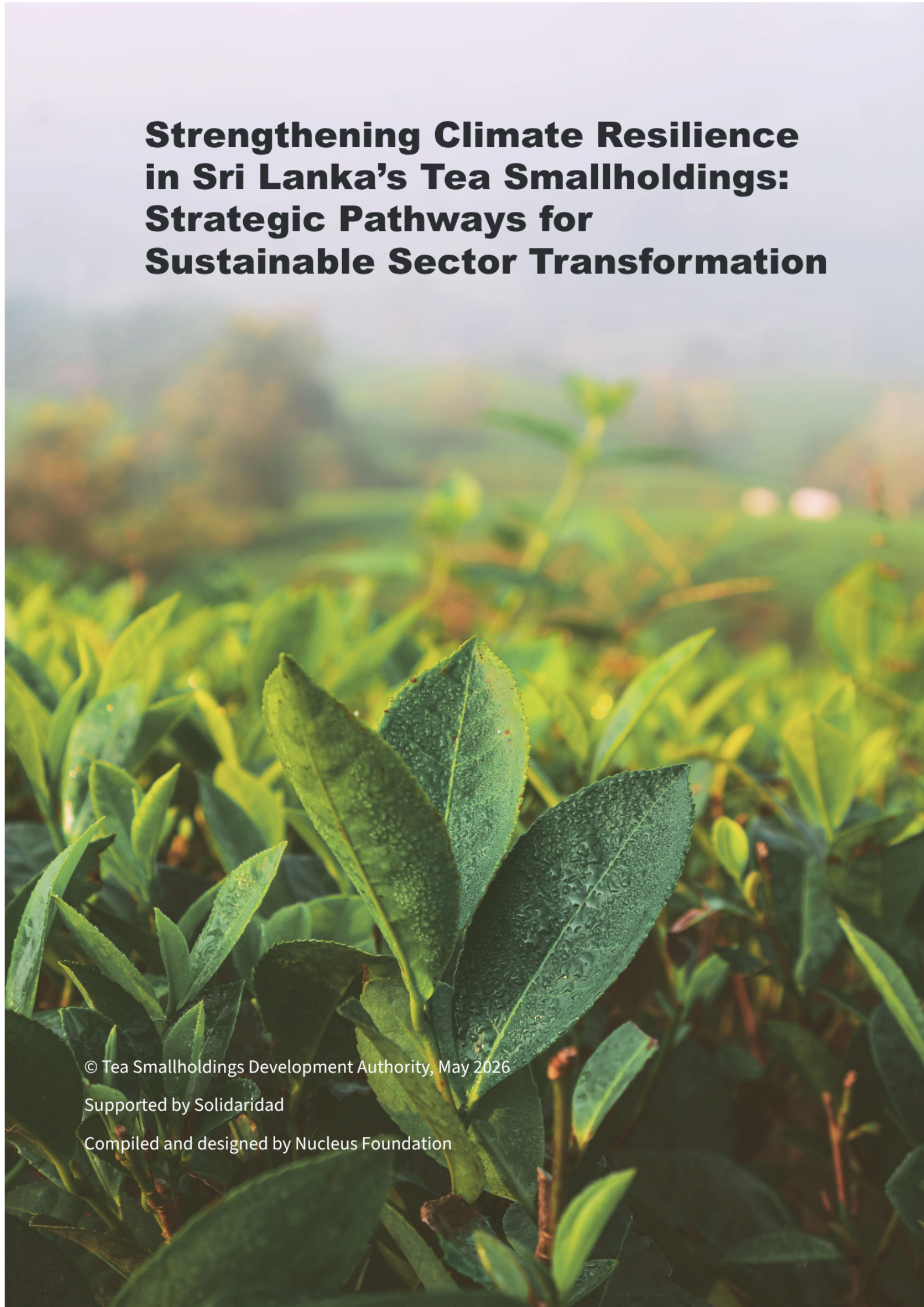
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A close-up photograph of tea leaves, with some leaves in sharp focus showing water droplets and others blurred in the background, creating a sense of depth and freshness.

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Executive Summary

The Tea Smallholder sector in Sri Lanka stands at a decisive moment. As highlighted in the full White Paper, smallholders account for approximately 74% of national tea production and support nearly half a million rural families. Tea remains one of the country's most important export commodities and a cornerstone of rural employment, foreign exchange earnings, and socio-economic stability. Yet, despite their dominant contribution to production, smallholders are among the most vulnerable actors in the value chain exposed simultaneously to climate variability, declining productivity, soil degradation, market volatility, rising input costs, labour shortages, and policy uncertainty.

National tea output has fallen from historic highs of over 340,000 metric tons to approximately 262,000 metric tons in 2024. Average productivity remains at around 1,200 kg of made tea per hectare, significantly below the global benchmark of approximately 2,200 kg per hectare indicating considerable unrealized potential. Ageing tea bushes, replanting rates well below recommended levels, high vacancy ratios, and limited adoption of Good Agricultural Practices (GAP) have weakened productivity. At the same time, escalating costs of fertiliser, fuel, and labour have narrowed margins between green leaf prices and production costs, placing smallholder incomes under increasing strain.

Soil degradation has emerged as a structural threat to both productivity and environmental sustainability. A significant proportion of smallholder lands exhibit low soil organic carbon levels, reduced water-holding capacity, and visible erosion, particularly in steep, low- and mid-country wet zones. Continuous cultivation without adequate contouring, mulching, shade management, or organic matter restoration has diminished long-term soil fertility. In degraded areas, yields can fall to nearly half of their attainable potential. These conditions not only suppress productivity but also increase vulnerability to floods, landslides, and drought.

Climate change functions as a stress multiplier across all these challenges. Rising temperatures, erratic rainfall, prolonged dry spells, intense precipitation events, and increased frequency of floods and landslides are already affecting tea flush cycles, leaf quality, and yield stability. Low-elevation smallholders are particularly exposed to heat stress, while rainfall variability exacerbates soil erosion and water scarcity. Despite the availability of climate-smart practices promoted by research institutions, adoption remains uneven due to financial constraints, limited extension coverage, ageing farmer populations, and weak institutional coordination.

Labour shortages further compound these risks. The tea workforce is ageing rapidly, and younger generations are increasingly disengaged from tea cultivation, perceiving it as labour-intensive and economically uncertain. Fragmented landholdings and hilly terrain limit mechanization options, reinforcing dependence on manual labour. Without meaningful improvements in profitability, innovation pathways, and youth engagement, the sector risks generational discontinuity.

Institutional and market constraints add another layer of vulnerability. Extension services are fragmented and overstretched, with overlapping mandates among institutions and insufficient field-level staffing. Many smallholders still depend on informal advice and have limited access to reliable climate and market information. Their bargaining power is weak in a value chain dominated by Bought Leaf Factories. The Sri Lanka Tea Board sets the minimum statutory green-leaf price payable by each factory, based on the factory's net sale average and the relevant elevation-based auction price average. In practice, pricing is not always transparent: factories may adjust the rate for green-leaf quality, with deductions for poor standards, low quality, or excess moisture. Policy instability, including recent tax reforms, VAT introduction, and uncertainty regarding fiscal frameworks, has further affected liquidity and investment confidence.

The risks of inaction are profound. Continued productivity decline could accelerate land abandonment, deepen rural poverty, and weaken Sri Lanka's export competitiveness. Given that more than 90% of national tea production is exported, failure to align with evolving global sustainability and Environmental, Social, and Governance (ESG) expectations could erode market access and premium positioning. Moreover, persistent land degradation and limited climate adaptation would undermine Sri Lanka's Nationally Determined Contributions (NDCs) and long-term climate resilience goals.

Yet, within these challenges lies a strategic opportunity. Sri Lanka's tea smallholdings represent not only vulnerability but also a climate solution. Well-managed tea landscapes can sequester carbon, restore soil organic matter, stabilize fragile hill-country ecosystems, regulate water flows, and enhance biodiversity. With appropriate policy support, the sector can transition toward regenerative, climate-smart production systems that simultaneously enhance productivity, resilience, and export competitiveness.

To realize this transformation, a coherent and integrated policy response is required.

First, productivity restoration must be prioritized through a national replanting acceleration programme that provides upfront financing rather than reimbursement-based subsidies. Access to climate-resilient cultivars, structured infilling support, soil testing services, and shared mechanization models would help revitalize ageing plantations and improve technical efficiency.

Second, climate and soil resilience must be mainstreamed within national tea policy. A coordinated climate-smart tea initiative should promote agroforestry, shade management, contour planting, organic matter restoration, and watershed-level planning. Investments in water harvesting, micro-irrigation, and slope stabilization are essential to reduce disaster risks in vulnerable districts.

Third, institutional strengthening is critical. Clearer coordination between the Tea Research Institute, the Tea Small Holdings Development Authority, the Sri Lanka Tea Board, and relevant ministries is necessary to reduce duplication and enhance accountability. Expanding extension capacity, adopting cluster-based advisory models, and integrating digital climate advisory systems, including weather alerts and pest warnings, can improve last-mile service delivery. Extension approaches must be gender-responsive and youth-inclusive to ensure broad-based adaptation.

Fourth, access to climate and value-chain finance must be expanded. Aggregated smallholder platforms can enable participation in international climate finance mechanisms such as the Green Climate Fund and Adaptation Fund. Blended finance models, combining public grants, concessional loans, carbon insetting revenues, and private investment can support replanting, soil restoration, and renewable energy adoption. Risk-transfer mechanisms, including index-based insurance and credit guarantees, are necessary to stabilize incomes in the face of increasing climate shocks.

Finally, sustainability standards and market incentives must be aligned with climate resilience objectives. Expanding traceability systems, group certification models, and climate-aligned branding can link farm-level resilience investments with export premiums. By embedding climate criteria within national tea sustainability frameworks, Sri Lanka can reinforce the global reputation of "Ceylon Tea" while ensuring that smallholders benefit directly from sustainability-driven market opportunities.

In conclusion, the smallholder tea sector is at a pivotal juncture. Incremental adjustments will not be sufficient to address the intersecting economic, environmental, and institutional challenges it faces.

A coordinated, climate-smart transformation, grounded in replanting support, soil restoration, institutional reform, inclusive finance, and market-linked sustainability, offers a viable pathway forward. With decisive government leadership and multi-stakeholder collaboration, Sri Lanka can secure the long-term resilience of its tea smallholders, strengthen rural livelihoods, and sustain its global leadership in premium tea exports.

1. Sri Lanka's Tea Smallholding Landscape

1.1. Importance of smallholdings to exports, employment & food security

Sri Lanka's tea sector is a crucial national resource, supporting rural communities, boosting export revenue, and contributing to economic stability. The industry directly sustains almost 115,000 estate workers' families (ILO, 2024) and 419,000 tea smallholder households (TSHDA, 2023), representing about 4% of worldwide tea production (ITC, 2024). Historically, the country's annual tea output has ranged from 300,000 to 340,000 metric tonnes, though production has declined noticeably in recent years.

Tea Smallholders in Sri Lanka constitute the backbone of the sector, contributing approximately 74% of total tea production, with an estimated 419,000 farmers cultivating smallholdings across the country, while corporate and state-owned estates account for the remaining share (TSHDA, 2023). Their contribution is critical to sustaining rural employment, national food security, and export competitiveness. However, smallholders remain structurally disadvantaged within the tea value chain, facing compounded pressures from climate change, declining soil fertility, input cost escalation, price volatility, and limited bargaining power. Green leaf is predominantly processed in private or Regional Plantation Company (RPC) factories and marketed through the Colombo weekly auction reinforcing smallholders' dependence on intermediated and price-taker market systems.

The Colombo Tea Auction, while offering transparency, links domestic producer prices directly to volatile international demand and currency movements. In 2023, global tea prices declined by nearly 12% year-on-year (FAO Tea Market Review, 2024), impacting smallholder incomes more severely than estate producers, who have greater price-hedging capacity. The lack of diversified marketing channels or value addition (e.g., direct exports, speciality teas) further increases vulnerability to market risk.

In January 2024, Sri Lanka introduced an 18% VAT on both tea exports and local production inputs, replacing the previous zero-rated structure (World Tea News, 2024). Although exporters are technically eligible for refunds under the Simplified Value Added Tax (SVAT) system, the process is slow and administratively complex, leading to cash flow problems and liquidity constraints, especially among small and medium exporters who lack working capital buffers. According to the Colombo Tea Traders' Association (CTTA, 2024), refund delays often last 4-6 months, significantly disrupting operations and discouraging new entrants into export markets. The government's announced plan to abolish the SVAT scheme in October 2025 has triggered further uncertainty in the tea sector (Lanka Talks, 2024). The SVAT was initially introduced to simplify VAT refunds for exporters and prevent working capital shortages. Its removal is expected to increase transaction costs, reduce liquidity, and undermine export competitiveness, a serious concern given that over 90% of Sri Lankan tea is exported (SLTB, 2024).

Sri Lanka's tea production is dominated by orthodox black tea, accounting for approximately 90% of output, while CTC tea represents less than 9% and green tea about 1%. Despite the availability of CTC processing capacity, supported by government subsidies in the 1990s, production remains limited due to weak domestic and export demand.

Category	Unit	2022	2023	2024	Average	%
Tea Production						
Orthodox	Mn kg	227.44	231.19	236.22	231.62	90%
CTC	Mn kg	22.59	22.62	23.68	22.96	9%
Green	Mn kg	1.81	2.28	2.26	2.12	1%
Total production	Mn kg	251.84	256.09	262.16	256.70	
Exports						
Tea Exports (Excluding Re exports)	Mn kg	241.65	231.46	230.42	234.51	91%
% Exported (Excluding Re exports)	%	96%	90%	88%	91%	

Source: SLTB, 2024

Prior to 2000, small tea growers largely processed green leaf through private factories, benefiting from favourable market conditions and strong tea prices. In order to strengthen smallholder organisation and participation in value addition, the Government established the Tea Shakthi Fund under Act No. 47 of 2000, drawing on the institutional model of Kenya's KTDA. The Fund's mandate included improving the economic and social conditions of smallholders; developing and managing tea factories; strengthening tea marketing; providing fertiliser support; ensuring financial sustainability; and promoting risk management mechanisms.

Key interventions under the Tea Shakthi Fund included the establishment of 12 factories, fertiliser distribution programs, and initiatives to promote local tea sales. Although the Fund recorded significant financial surpluses around 2012, subsequent governance and management failures resulted in substantial losses, leading to the dissolution of its Board in 2016 and a restructuring of operations. At present, lease rentals and management fees from the factories are collected by the fund, with surplus revenues transferred to the Consolidated Fund and a Welfare Insurance Fund amounting to Rs. 135 million.

1.2. Situational assessment of smallholders

Key Challenges Faced by Small Tea Holders in Sri Lanka

Tea small holders have emerged as the backbone of Sri Lanka's tea economy, contributing the majority share of national production. While this structural shift presents significant opportunity, it also exposes systemic vulnerabilities. Without targeted policy and institutional support, these constraints pose risks to rural livelihoods, national supply stability, and long-term sector competitiveness.

1. Structural and Income Vulnerabilities

Tea small holders face persistent income instability driven by price volatility, rising input costs, weak bargaining power, and limited participation in value addition. Their fragmented production base reduces economies of scale and limits leverage in price negotiations, leaving growers highly exposed to market fluctuations.

2. Productivity and Agronomic Constraints

At the farm level, limited awareness and inconsistent adoption of Good Agricultural Practices (GAP) continue to affect productivity and quality. Extended pruning cycles, irregular plucking intervals, and inadequate field maintenance undermine bush health and leaf standards. These agronomic challenges are compounded by:

- Acute labour shortages and rising wage expectations
- Rural-to-urban migration
- Inadequate rural infrastructure and mechanisation support

Collectively, these factors constrain yield optimisation and long-term sustainability.

3. Escalating Cost of Cultivation and Processing

Sharp increases in fertiliser, agrochemicals, fuel, electricity, and transport costs have significantly raised both cultivation and green leaf processing expenses. Given limited pricing power at the farm gate, smallholders are often unable to pass on these cost increases, resulting in shrinking margins and reduced reinvestment capacity.

4. Market Access and Value Chain Limitations

Market access remains a critical bottleneck. Tea small holders face barriers in accessing:

- Branded domestic retail markets
- E-commerce platforms
- Direct export channels

Constraints include low digital literacy, limited aggregation volumes, high transaction costs, and insufficient familiarity with quality assurance systems and certification requirements. As a result, participation in higher-value market segments remains marginal.

5. Financial Exclusion and Credit Constraints

Limited access to formal financial services cuts across all other challenges. Many small tea holders lack affordable credit, adequate banking outreach, and risk-mitigation instruments. Dependence on informal intermediaries and lenders weakens financial resilience and perpetuates structural vulnerability.

6. Institutional and Policy Integration Gaps

While several schemes operate under the Ministry of Plantation Industries, Tea Smallholder Development Authority and the Sri Lanka Tea Board, coordination, convergence, and last-mile delivery remain uneven.

Smallholders have limited participation in structured Public–Private Partnerships (PPPs), government procurement decision making systems, and collective branding initiatives. Strengthening institutional mechanisms for aggregation, traceability, and quality assurance will be critical to modernising the smallholder segment in line with national plantation reform objectives.

Policy Imperative: The convergence of these challenges underscores the urgent need for integrated and coordinated interventions. Policy responses must simultaneously address:

- Productivity enhancement and climate-resilient agronomy
- Market access and value addition
- Financial inclusion and risk mitigation
- Institutional strengthening and enabling regulatory support

The transformation of Sri Lanka’s plantation sector cannot be achieved without strengthening its smallholder foundation. Tea small holders are not merely contributors to production volume; they are central actors in rural development, export competitiveness, and national economic resilience.

Investing in smallholders is therefore a strategic national imperative. An integrated and coordinated policy framework, combining productivity enhancement, market integration, financial inclusion, and institutional reform, will position Sri Lanka’s tea sector for inclusive growth, global competitiveness, and long-term sustainability.

According to stakeholder viewpoints, the main challenges facing Sri Lanka's tea small holders are listed and summarized below in order of priority.

Rank	Priority Area	Key Issues Identified	Representative Evidence
1	Declining productivity & profitability	Low yields, ageing bushes, high-cost inputs	Low yields (1,200 kg/ha vs 2,200 globally)
2	Soil degradation & unsustainable farming	Soil erosion, fertility decline, and low plant density.	Case study in Central Highlands: yield 1,000 kg/ha vs potential 2,400 kg/ha
3	Labour shortages & youth out-migration	Ageing workforce, youth leaving, labour cost and availability issues	Reports of >50% workforce decline in estates, young disinterest
4	Weak institutional & market linkages	Limited extension, weak farmer-orgs, poor bargaining power	Only 25% of TSDS organisations provide full services
5	Policy & regulatory challenges	High VAT, tax burden, unclear subsidies, unstable policies	Abolition of SVAT, introduction of VAT adversely highlighted

1.3. Regional and elevation-based production systems

While the corporate tea sector faltered, the smallholder segment expanded steadily, peaking at about 247 million kg in 2014 and underpinning Sri Lanka's standing as a leading black tea producer. National output reached a historic high of 340,000 metric tons in 2013 (SLTB 2014). However, production declined sharply after 2021, falling to 262,000 metric tons in 2024, around 4% of global output, amid the abrupt transition to organic cultivation and severe economic disruption.

Traditionally, key smallholder districts such as Ratnapura, Galle, Matara, Kalutara, and Kegalle have made substantial contributions to national production. Yet average yields in these areas have dropped below 1,205 kg per hectare. In contrast, highland districts including Nuwara Eliya, Kandy, and Matale continue to record yields exceeding 2,000 kg per hectare, underscoring persistent regional productivity gaps.

Over the past decade, production and productivity have declined across low-, mid-, and high-grown elevations, with the most pronounced contraction occurring after 2021. The low-grown sector dominated by smallholders was disproportionately affected, largely due to fertiliser shortages and input disruptions. Mid- and high-grown regions showed comparatively greater resilience. Nevertheless, the proportional contribution of each elevation category has broadly followed historical trends. A Tea Research Institute study (Sidhakaran et al., 2022) partly attributes the decline to inadequate replanting in the smallholder sector, which averaged only 0.62% annually between 2012 and 2018.

Although Sri Lanka maintains a robust environmental policy framework including the National Environmental Act (amended 2021) and the Soil Conservation (Amendment) Act of 2020, implementation remains uneven, particularly in smallholder-dominated areas. Reports by FAO (2023) and the Asian Development Bank (2022) note limited field-level enforcement of land-use regulations, agrochemical controls, and buffer zone protection. Consequently, unregulated cultivation on steep slopes, soil erosion, and declining water quality have intensified in tea-growing districts such as Ratnapura and Kandy.

1.4. Climate vulnerability profile of tea smallholders

Despite their critical role, smallholders are highly vulnerable to climate change due to the perennial nature of tea, limited resources, and dependence on rain-fed cultivation. Shifts in temperature and rainfall patterns, coupled with extreme weather events, directly affect tea growth, flush cycles, leaf quality, and ultimately, household income. Low-elevation estates are particularly susceptible to heat stress, which can cause leaf dryness and alter chemical composition, reducing both yield and the market value of harvested leaves.

Erratic monsoon patterns, delayed precipitation, and short bursts of intense rainfall contribute to soil erosion, flash floods, and water scarcity, further compromising productivity in smallholder plots. The sudden government-mandated shift to organic cultivation in 2021, compounded by an economic crisis, exacerbated these challenges by restricting access to fertilisers and other critical inputs. Historical trends also reveal chronic vulnerabilities, including low replanting rates in smallholdings averaging only 0.62% between 2012 and 2018 which have led to ageing tea stocks and declining productivity.

The economic impacts of climate vulnerability are significant. Narrowing margins between green leaf prices and production costs, combined with rising living costs, increase the risk of abandonment of tea lands in some regions. Smallholders often lack the financial capacity to adopt climate-resilient practices such as drip irrigation, soil and water conservation, or shade management, creating a cycle of environmental and economic stress. Additionally, the uneven distribution of productivity across districts with low-grown areas yielding less than 1,205 kg/ha compared to over 2,000 kg/ha in highland districts reflects the interaction of climatic, topographical, and socio-economic factors.

Climate variability functions as a stress multiplier, exacerbating both economic and environmental vulnerabilities. Addressing these issues will require a coordinated multi-stakeholder approach that combines climate-smart agriculture, institutional strengthening, policy coherence, and youth-inclusive livelihood strategies to ensure the long-term resilience and sustainability of the smallholder tea sector.

Although the Tea Research Institute (TRI) and the Ministry of Agriculture promote climate-smart agronomic practices, such as soil conservation, organic mulching, and drought-tolerant cultivars, their adoption among smallholders remains limited. For example, on average, only 44.7% of respondents employ soil conservation practices, according to a recent TRI survey (2025). A study published in the *Sri Lanka Journal of Tea Science* (2022) found that over 50% of surveyed smallholders perceived mechanisation as unsuitable for their small, sloped plots, citing topographical constraints, high initial costs, and lack of technical know-how. This perception has limited innovation uptake, leaving the sector reliant on traditional and labour-intensive methods that are increasingly uneconomic.

Replanting, rehabilitation, and mechanisation in the tea sector require substantial upfront capital investment. However, limited access to affordable, sustainable financing remains one of the most persistent challenges for smallholders. According to the IFAD STARR Project (2023), most government subsidy schemes operate on a reimbursement basis, requiring farmers to bear the initial costs before receiving financial support, an impractical model for liquidity-constrained households. Formal financial institutions, meanwhile, often demand collateral and verifiable income documentation, which many smallholders are unable to provide. Consequently, farmers tend to rely on informal lenders or postpone essential investments, resulting in chronic underinvestment across the tea value chain. This financial exclusion perpetuates low productivity, ageing tea bushes, and declining quality (Tea Science International, 2023).

To address these challenges, smallholders require innovative, inclusive, and sustainable financing models, such as revolving funds, blended finance schemes, 4P-based or cooperative-based credit systems, that can ease liquidity constraints and support long-term investment in productivity enhancement and climate resilience.

1.5. Alignment with national development, climate & agricultural priorities

The tea sector, particularly smallholder production, is closely aligned with Sri Lanka's national development and climate agendas. Recognising the vulnerability of agriculture to climate change, the country's Nationally Determined Contributions (NDCs) prioritise adaptation measures in critical sectors, including tea, water resources, and rural livelihoods. These measures aim to enhance climate resilience while supporting sustainable economic growth. For tea smallholders, NDC-aligned strategies include adopting Good Agricultural Practices (GAP) and climate-smart agriculture, promoting energy-efficient practices, implementing sustainable land-use management, integrating agroforestry, and improving soil and water conservation.

The National Policy on Climate Change (2023) and the National Adaptation Plan (2016–2025) provide a strategic roadmap for climate action, while the Climate Change Secretariat oversees implementation in coordination with relevant ministries. The Tea Small Holdings Development Authority (TSHDA) plays a central role in operationalising these strategies among smallholders, facilitating the adoption of best agronomic and climate-resilient practices in collaboration with the Tea Research Institute (TRI), Sri Lanka Tea Board (SLTB), the National Institute of Plantation Management (NIPM), private sector actors, and international partners.

By integrating climate-resilient practices with certification and labelling schemes, smallholders can gain access to premium markets while reducing the environmental footprint of tea production. Collectively, these coordinated efforts underscore the sector's critical role in achieving Sri Lanka's climate, agricultural, and socio-economic goals, ensuring that smallholders remain both productive and resilient in the face of climate change.

Policy coordination challenges are compounded by overlapping responsibilities among multiple institutions, including the SLTB, TSHDA, TRI, the Ministry of Agriculture (MoA), the Ministry of Plantation and Community Infrastructure (MPCI), and the Sri Lanka Export Development Board (EDB). A governance assessment by Wijeratne et al. (2022) found that fragmented mandates often lead to program duplication, delays in decision-making, and ineffective policy delivery. For instance, both TSHDA and TRI engage in smallholder training and extension yet lack a unified monitoring framework to measure outcomes or avoid overlap.

1.6. Smallholder representation in policy making

Although smallholders produce over 74% of Sri Lanka's total tea output, they remain underrepresented in key policy forums such as the Sri Lanka Tea Board (SLTB) and Plantation Human Development Trust (PHDT).

According to TSHDA (2023), local cooperative societies and farmer associations rarely participate in higher-level decision-making processes, limiting the feedback loop between policy design and on-ground realities. This top-down policy approach has contributed to poorly targeted subsidies, misaligned quality standards, and limited policy responsiveness to smallholder needs.

In summary, policy and governance constraints in the tea sector reflect a combination of regulatory uncertainty, taxation burdens, and institutional fragmentation. The 2024 VAT policy and pending SVAT reforms have worsened liquidity and market competitiveness, while overlapping institutional mandates continue to dilute accountability. Strengthening inter-agency

coordination, improving fiscal predictability, and enhancing smallholder representation in sectoral governance are essential steps to ensure equitable and sustainable growth.

2. Climate Change Risks to Tea

2.1. Climate trends affecting tea-growing regions

Climate change impacts on tea yields in Sri Lanka vary significantly across elevation zones. Projections for 2050 indicate potential yield reductions in the up-country intermediate (IU), mid-country wet (WM), and low-country wet (WL) zones, while yields in the up-country wet (WU) zone may increase (Wijeratne et al., 2007). This suggests that production could rise at higher elevations but decline in low-lying areas, where vulnerability to heat and drought stress is greatest (Mohotti & Mohotti, 2020). Consequently, smallholders in low- and mid-elevation regions, who constitute the majority of growers in the regions, will need to implement targeted adaptation strategies to mitigate productivity losses and sustain their livelihoods in the face of climatic variability.

Agronomically, the smallholder landscape is highly heterogeneous. A survey of 300 low-country smallholders revealed that technical efficiency averaged 68.8 %, with a wide range (~15 % to ~93 %), indicating potential yield increases of roughly 30 % under improved management practices without increasing input levels. Fertiliser and chemical inputs, alongside labour and management practices, remain key determinants of productivity variation (Shyamalie et al., 2020). Tea smallholders' contribution is critical in supplying quality tea, particularly from the wet low and mid-country regions, where favourable agroclimatic conditions prevail. Productivity varies widely between regions and management practices, with yields ranging from 800 kg to 1600 kg of made tea per hectare annually (Sri Lanka Tea Board, 2025). Variations are linked to differences in soil fertility status, input use, age and pruning cycle, bush densities, and smallholders' access to extension services.

2.2. Yield, quality, and income risks under different climate scenarios

Climate change poses significant risks to tea yields and quality in Sri Lanka due to rising atmospheric CO₂ concentrations, increasing ambient temperatures, and heightened rainfall variability (TRI, 2019). While elevated CO₂ levels may temporarily enhance photosynthesis, these gains are increasingly offset by heat stress, water scarcity, and soil degradation, leading to reduced yield stability and declining tea quality over time (Wijeratne et al., 2007).

Projections suggest that atmospheric CO₂ concentrations could reach approximately 600–700 ppm by 2100 (Wijeratne et al., 2007). Elevated CO₂ levels influence photosynthesis, plant physiology, and broader ecosystem functions, thereby affecting tea growth and productivity. While short-term increases in CO₂ may stimulate plant growth, the long-term effects interact with other climatic variables, often exacerbating stresses such as heat and water scarcity.

Temperature increases in Sri Lanka are projected to range from 0.4 °C to 3.0 °C by 2070. Historical data show a steady rise in mean annual air temperature of approximately 0.016°C per year between 1961 and 1990. Notably, major tea-growing regions such as Ratnapura, Badulla, and Nuwara Eliya exhibit significant linear warming trends in decadal mean temperatures. In most of these areas, the warming rate has exceeded the global average of 0.074°C per decade (Mohotti & Mohotti, 2020). Elevated temperatures shorten optimal growing periods, disrupt flush cycles, and intensify heat stress, particularly in low- and mid-elevation tea areas dominated by smallholders.

Erratic rainfall patterns—characterised by prolonged droughts, intense rainfall events, flash floods, and landslides—further compromise productivity. Despite projections of increased Wet Zone rainfall, long-term records show declining mean annual precipitation and growing rainfall

unpredictability (Mohotti & Mohotti, 2020). These extremes accelerate soil erosion, reduce water availability, and degrade land productivity, especially in rain-fed smallholder systems. Ageing tea plantations, low replanting rates (averaging 0.6%), high vacancy levels in fields, and limited access to quality planting material exacerbate climate-induced yield losses. As tea quality declines, smallholders receive lower prices at auctions, directly reducing household income and increasing vulnerability to poverty.

Rainfall forecasts for the Wet Zone indicate an annual increase of around 10% during both dry and wet seasons. However, long-term records show a decline of 144 mm (7%) in mean annual precipitation during 1961–1990 compared with 1931–1960. This variability, combined with prolonged droughts, heavy rainfall events, flash floods, and landslides, poses severe risks to tea production and rural livelihoods (Mohotti & Mohotti, 2020).

2.3. Implications for export earnings and rural poverty reduction goals

Tea smallholders contribute nearly 74% of Sri Lanka’s national tea output, making their performance central to export earnings and rural livelihood outcomes (Sidhakaran et al., 2021). Districts such as Ratnapura, Galle, Matara, Kalutara, Kegalle, and Colombo, accounting for approximately 81% of smallholdings, are located within highly climate-vulnerable agro-ecological zones (FAO, 2016). Approximately 77% of smallholders cultivate less than one acre, resulting in high dependence on tea as a sole or primary income source. Climate-induced declines in productivity therefore translate directly into income losses, increased rural poverty, and heightened socio-economic instability.

Post-2013 declines in production, particularly among smallholders, have already begun to constrain national output. Continued climate stress, combined with limited adoption of Good Agricultural Practices (GAP), high production costs, and weak extension support, threatens Sri Lanka’s ability to maintain consistent export volumes and quality standards. As global tea markets become increasingly competitive and quality-sensitive, failure to safeguard smallholder productivity risks eroding Sri Lanka’s premium “Ceylon Tea” brand, with long-term implications for export revenues, employment, and poverty reduction objectives.

2.4. Risks of inaction for Sri Lanka’s NDC adaptation and mitigation targets

Sri Lanka ranks among the world’s most climate-vulnerable countries, underscoring the urgency of effective adaptation (Eckstein et al., 2018; 2019). The Nationally Determined Contributions (NDCs) prioritise climate resilience in agriculture through soil and water conservation, climate-smart practices, sustainable land use, and livelihood protection. However, persistent constraints among tea smallholders—such as ageing plantations, low replanting rates, poor access to climate-resilient planting material, inappropriate fertiliser use, and dependence on non-professional technical advice—pose serious risks to achieving these targets.

Failure to address these vulnerabilities could lock the tea sector into a cycle of declining productivity, land degradation, and livelihood insecurity, undermining both adaptation and mitigation outcomes. Inaction would also limit the sector’s contribution to low-carbon development pathways, including agroforestry, afforestation, soil carbon sequestration, and efficient resource use. Strengthening research–extension linkages, scaling up “no-regret” adaptation measures, and providing targeted financial and institutional support to smallholders are therefore essential to align tea sector resilience with Sri Lanka’s NDC commitments and broader climate and development goals.

Recent extreme weather events in Sri Lanka have caused widespread damage across tea-growing regions, with floods and landslides resulting in loss of life, displacement of communities, and severe damage to agricultural land and infrastructure. These impacts have been particularly pronounced in tea-growing districts, where extensive land clearing for agriculture, settlements, and infrastructure development has often occurred without adequate environmental impact assessments. Such practices have increased slope instability, reduced natural drainage capacity, and heightened exposure to climate-related hazards. As climate variability intensifies, these risks are expected to escalate, underscoring the urgent need for effective climate risk mitigation measures. Strengthening land-use planning, enforcing environmental safeguards, restoring vegetation cover, and integrating disaster risk reduction into agricultural and development planning are therefore critical to safeguarding tea-growing landscapes, protecting vulnerable communities, and ensuring the long-term sustainability of the tea sector.

3. Tea Smallholdings as a Climate Solution

3.1. The Pivithuru Initiative: An Integrated Framework for Sri Lanka's Tea Smallholder Sector

The challenges set out in this document; declining productivity, degraded soils, climate stress, fragmented extension, weak collective bargaining, and the steady disengagement of youth, increasing cost of production and decreasing income levels are not isolated problems with isolated remedies. They are interlocking pressures on a single sector, and they require an interlocking response. The Pivithuru (Immaculate) Green Tea Leaves Initiative, launched in 2025 by the Tea Small Holdings Development Authority (TSHDA), provides that response. By using green leaf quality standard as the entry point, Pivithuru binds together regenerative agronomy, value-chain integration, digital monitoring, capacity building of smallholders, strengthening smallholder societies and youth-led extension into a single operational framework that can be scaled across the smallholder sector.

The Framework at a Glance

Pivithuru is being piloted with Bought Leaf Factories in eight major tea-growing regions in Sri Lanka including Ratnapura, Uva (Bandarawela), Kalutara, Kandy, Kegalle, Matara, Nuwara Eliya, and Galle. Each partner factory engages 350 to 400 smallholders organised into six to thirty clusters, with continuous supervision by TSHDA regional staff, factory extension officers and trained cluster leaders. Baseline assessments captured the structural realities of the sector: most plots are between half an acre and one acre; bush vacancies exceed 20 per cent on average; over half of the harvest is performed by hired labour; and adoption of the five core Good Agricultural Practices: harvesting, pruning, soil conservation, soil fertility management, and shade management, is poor to average across regions (Rathnayake, 2025). Against this baseline, *Pivithuru* is designed not as an extension campaign but as a complete delivery system for the proposed transformation agenda.

Leveraging the insights gained during the pilot phase, *Pivithuru* will be transitioned to full-scale implementation by August 2026. Under this expanded model, Tea Smallholder Societies registered with the TSHDA will be considered as farmer clusters. The initial phase will target 500 societies out of the total 1,482.

Preliminary work is already underway, including the selection of cluster leaders from each society and their training in leaf quality standards, regenerative agriculture (regenagri), and entrepreneurship. These leaders' lands will be developed as demonstration models for their respective societies, aligned with the *Pivithuru* Framework (Figure 1).

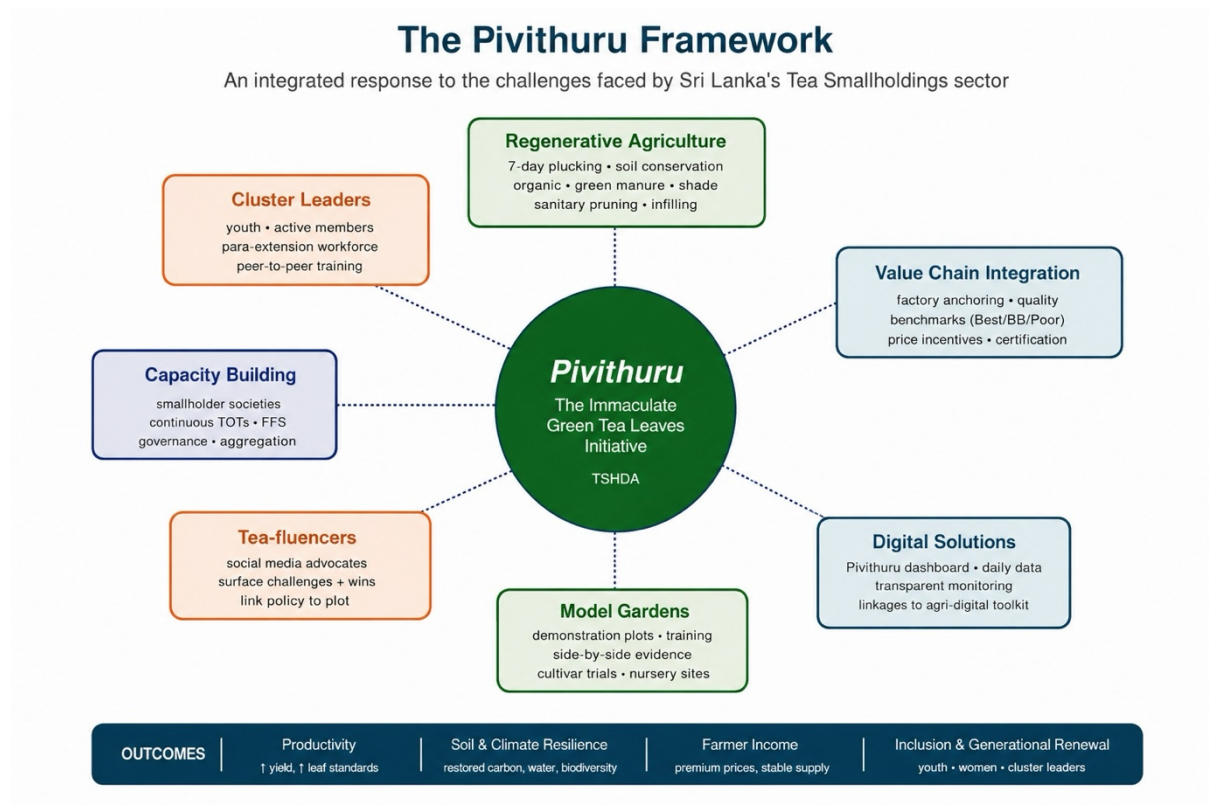


Figure 1. The Pivithuru Initiative — seven integrated pillars and the outcomes they deliver.

Good Agricultural Practices, Regenerative Agriculture for Soil Health and Productivity

The first pillar of Pivithuru is the disciplined re-introduction of climate-smart, regenerative practices that the Tea Research Institute has long recommended, but which adoption data show are unevenly applied. Cluster training prioritises a strict seven-day plucking round and correct harvesting principles, contour-based soil conservation, organic and green manure incorporation alongside balanced inorganic site-specific fertiliser, low- and high-shade management to provide a conducive micro-environment, and sanitary pruning followed by block infilling with Jumbo nursery plants. These practices directly address the structural drivers of the productivity gap between Sri Lanka's smallholder average of around 1,200 kilograms of made tea per hectare and the global benchmark of approximately 2,200 kilograms (Tea Smallholdings Development Authority, 2023). They also rebuild soil organic carbon, restore water-holding capacity, and reduce erosion in the steep wet-zone landscapes most exposed to climate shocks. Pivithuru therefore operationalises, at the plot level, the regenerative agronomy that this document calls for at the policy level.

Value Chain Integration: Linking Farmers to Bought Leaf Factories

The second pillar redesigns the smallholder–factory relationship. Each pilot factory implements established transparent quality benchmarks; Best, Below Best, and Poor, and pays differentiated prices that reward higher leaf standards. Factories invest alongside farmers in rehabilitating low-productivity plots, supply standard nursery material, and underwrite logistical improvements such as standardised baskets, leaf sheds, and inspection at collection points to minimise post-harvest losses. The model converts the Bought Leaf Factory from a price-setting bottleneck (identified in this document as a structural weakness of the value chain) into an anchor for quality, certification, and shared improvement. By tying premium prices to evidence of GAP and GMP compliance, *Pivithuru* creates the commercial foundation on which group certification, traceability, and ESG-aligned export branding can subsequently be built.

Digital Solutions: An AI Powered App and Dashboard

The third pillar is digital. The Regen Tea Hub App records daily and monthly data on leaf quantity and quality standards at each factory, classifies supply against the Best / Below Best / Poor benchmark, and feeds a transparent loop of monitoring, feedback, and incentive payment. Because data is collected at the cluster and farm level, the accompanying dashboard provides a foundation on which the wider digital toolkit envisaged in this document; agro-meteorological alerts, soil-probe diagnostics, AI advisory chatbots, and traceability platforms (Varghese & John, 2025), can be layered without further institutional duplication. The dashboard therefore becomes the data backbone that closes the information gap separating smallholders from climate-smart decision-making.

Capacity Building of Smallholder Societies

Pivithuru invests deliberately in the institutional fabric of the sector. Continuous Training-of-Trainers programmes, demonstration plots, and farmer-field-school sessions equip smallholder societies with the governance, technical, and managerial capacity that this document identifies as one of the lower impressed layers between national policy and household-level adoption. By embedding training inside existing societies rather than creating parallel structures, the initiative strengthens collective bargaining, transforms societies into platforms for shared services such as transport and grading, and lays the groundwork for aggregation models capable of accessing climate finance and certification markets.

Cluster Leaders: Engaging Youth and Active Society Members

The fourth pillar reshapes extension itself. With approximately 120 government extension officers serving close to 400,000 smallholders, last-mile advisory has long been the binding constraint. *Pivithuru* responds by identifying active society members, particularly younger and digitally literate ones, as cluster leaders, and training them as para-extension workers who deliver continuous, peer-to-peer guidance within their own communities under the close supervision of TSHDA regional staff. This both multiplies effective extension capacity and creates an aspirational role for youth in a sector they are otherwise leaving. By linking cluster-leader status with recognised technical authority and a clear pathway into agripreneurship, *Pivithuru* directly addresses the generational discontinuity that the Document flags as one of the sector's most serious risks.

Tea-fluencers: Amplifying Voice and Adoption

A fifth pillar, emerging through the *Pivithuru* rollout is the cultivation of *tea-fluencers*: smallholder leaders, often youth or female cluster heads, who use social media and short-form digital content to support cluster-level digitalisation, surface field challenges in real time, celebrate adoption successes, and link smallholders to wider audiences of consumers, certifiers, and policymakers. Tea-fluencers shorten the feedback distance between policy and plot, make the sector's transformation visible to a national audience, and reposition tea cultivation as a modern, knowledge-intensive livelihood rather than a declining tradition.

Model Gardens: Showing What Is Possible

The sixth pillar makes change tangible. Each cluster maintains model gardens that demonstrate full GAP adoption; proper plucking rounds, contour conservation, organic-matter restoration, shade architecture, and infilling. Visible side-by-side comparisons with conventional plots translate abstract recommendations into evidence farmers can see and trust. Model gardens also serve as training venues for nursery plant raising, climate-resilient cultivar trials, and the participatory on-farm research that the Document identifies as essential to bridging research and adoption.

Scaling the Framework

Early results across the eight pilot regions are encouraging: improved leaf standards, more consistent plucking discipline, measurable productivity gains, stronger farmer–factory relationships, and the establishment of a para-extension workforce that did not previously exist to this extent (Rathnayake, 2025). The challenges are well known; ageing tea bushes, skilled-labour shortages, the cost of replanting, and accelerating climate variability, and they will not be solved by *Pivithuru* alone. But the initiative offers something the Sri Lankan tea sector has lacked: a single, replicable, factory-anchored framework that integrates the agronomic, institutional, financial, digital, and social dimensions of resilience. With sustained policy support, blended climate-and-value-chain finance, and the certification and ESG (Environmental, Social, and Governance) market alignment proposed elsewhere in this document, *Pivithuru* can move from pilot to national delivery system; the operational expression of Sri Lanka’s commitment to a competitive, climate-resilient, and inclusive smallholder tea sector.

3.2. Role of tea smallholdings in carbon sequestration and ecosystem services

Sri Lanka’s tea landscapes, particularly those managed by smallholders in the Wet and Intermediate Zones, function as multifunctional agro ecosystems that provide critical ecosystem services beyond commodity production. When well-managed, tea systems contribute to carbon sequestration through perennial biomass, root systems, litter accumulation, and soil organic carbon storage. Shade trees, shelterbelts, ground cover, and agroforestry components enhance above- and below-ground carbon pools while stabilising fragile hill-country landscapes.

However, decades of forest clearance, monoculture expansion, and soil degradation have weakened the ecosystem service functions of many tea-growing areas. Declining soil organic matter, erosion, and loss of vegetative cover have reduced the capacity of tea landscapes to store carbon, regulate water flows, and buffer climate extremes. Restoring these functions is therefore not only an environmental priority but also a strategic pathway for aligning tea production with national climate mitigation and adaptation objectives.

3.3. Soil health, water regulation, and biodiversity co-benefits

Healthy soils underpin the resilience of tea landscapes. Soil organic carbon (SOC) plays a central role in improving water-holding capacity, aggregate stability, nutrient cycling, and biological activity. Evidence from Sri Lanka’s Mid Country and Low Country Wet Zones shows that nearly 45% of tea smallholdings have SOC levels below 1%, contributing to poor productivity, increased runoff, and heightened erosion risk. Increasing SOC by even 1% has been shown to significantly raise green-leaf yields, highlighting strong productivity–environment synergies (Dandeniya et al. 2022).

Degraded soils reduce infiltration and accelerate surface runoff, exacerbating downstream flooding, sedimentation, and landslide risk—particularly in steep tea-growing regions already exposed to extreme rainfall events. Conversely, practices such as contour planting, vegetative barriers, mulching, and compost application enhance soil structure and water regulation, reducing both on-site productivity losses and off-site environmental damage.

Biodiversity co-benefits are closely linked to soil and water management. Monoculture tea systems with limited shade or ground cover reduce habitat diversity and disrupt soil microbial communities essential for nutrient cycling. Integrating shade trees, cover crops, and agroforestry elements increases above- and below-ground biodiversity, improves pest regulation, and strengthens ecosystem resilience under increasing climate variability.

3.4. Climate change adaptation and mitigation potentials through agroforestry, efficient input use, and sustainable energy systems

Sri Lanka's tea smallholder sector presents a significant opportunity to contribute to **climate change mitigation and adaptation** through integrated, land-based and value-chain interventions. By combining agroforestry, improved input management, and sustainable energy use, tea systems can reduce greenhouse gas emissions while enhancing productivity, resilience, and long-term sustainability.

Agroforestry as a climate-smart production system

Agroforestry represents one of the most effective nature-based solutions within tea smallholding systems. The integration of tea with shade trees, timber species, fruit crops, and nitrogen-fixing plants creates multifunctional landscapes that deliver both ecological and economic benefits.

From a mitigation perspective, agroforestry systems enhance **carbon sequestration** through increased above- and below-ground biomass, including tree cover, litter fall, and root systems that contribute to long-term soil carbon storage. At the same time, these systems reduce soil erosion, improve water retention, and enhance nutrient cycling, thereby restoring degraded lands.

From an adaptation standpoint, diversified tree cover regulates microclimatic conditions by reducing temperature extremes, buffering wind exposure, and improving moisture availability. This reduces climate-induced yield variability and strengthens resilience to droughts and erratic rainfall patterns which are key risks in Sri Lanka's tea-growing regions.

Evidence from local trials and pilot initiatives indicates that well-designed agroforestry systems can also improve **nutrient-use efficiency (NUE)** by enhancing biological nitrogen fixation and nutrient recycling. In addition to stabilizing yields, these systems provide diversified income streams through timber, fruits, and other tree-based products, thereby reducing economic vulnerability due to climate change among smallholders.

Regenerative and efficient input use

Improving input efficiency is another critical pathway for reducing emissions intensity in tea production. Current practices in some regions are characterized by excessive or imbalanced application of chemical fertilisers, particularly nitrogen, which contributes to soil acidification, nitrous oxide emissions, and declining soil biological health.

Transitioning towards **integrated and regenerative nutrient management** can significantly address these challenges. This includes the adoption of:

- Site-specific fertiliser recommendations based on soil testing
- Slow-release and precision fertiliser applications
- Increased use of organic amendments such as compost and mulch
- Integration of cover crops and nitrogen-fixing species

Such practices enhance nutrient-use efficiency, reduce input costs, and rebuild soil organic matter over time. Regenerative approaches further strengthen ecosystem functions by improving soil structure, increasing microbial activity, and enhancing water retention capacity. Collectively, these interventions contribute to both mitigation (through reduced emissions and increased carbon storage) and adaptation (through improved system resilience).

Sustainable energy use and low-carbon processing

Energy use along the tea value chain, particularly during processing, offers additional mitigation opportunities. While smallholders are primarily engaged in green leaf production, the quality and consistency of leaf supplied to factories have a direct influence on processing efficiency and energy consumption. Improved agronomic practices that enhance leaf quality can therefore indirectly contribute to reducing energy intensity at the processing stage.

At the industry level, transitioning towards **sustainable energy systems**, including the use of sustainably sourced biomass for thermal energy, biodigesters, other renewable energy integration, and energy-efficient processing technologies, can significantly lower the carbon footprint of tea manufacturing. Biomass, particularly from sustainably managed fuelwood lots and pruning residues of the tea smallholders, remains a viable low-carbon alternative to generate thermal energy in tea drying processes when managed responsibly.

Integrated impact

Taken together, these interventions position the tea smallholder sector as a key contributor to Sri Lanka's **low-emission, climate-resilient development pathway**. Agroforestry, regenerative input use, and sustainable energy systems not only reduce greenhouse gas emissions but also enhance productivity, restore ecosystems, and improve farmer livelihoods.

Scaling these approaches across tea-growing regions will be critical for aligning the sector with national climate commitments, including **Nationally Determined Contributions (NDCs)**, while strengthening the global sustainability positioning of Sri Lanka's tea industry.

3.5. Contribution to low-emission, climate-resilient development pathways

Strengthening the sustainability of Sri Lanka's tea smallholder systems presents a strategic opportunity to advance the country's transition towards low-emission, climate-resilient development pathways. Given the sector's extensive land footprint, socio-economic importance, and ecological sensitivity, particularly in the Central Highlands, tea landscapes are uniquely positioned to deliver integrated outcomes across climate adaptation, mitigation, and rural development.

Climate-smart tea production systems characterized by improved soil health, diversified agroforestry-based landscapes, efficient input use, and strengthened extension services offer a holistic framework for addressing multiple sectoral challenges. These systems enhance the resilience of smallholder farmers, who remain highly vulnerable to climate variability due to limited resources and exposure to environmental risks.

Improving soil health is central to this transition. Practices such as organic matter enrichment, mulching, and reduced chemical dependency increase soil water retention, improve nutrient cycling, and enhance overall ecosystem stability. As a result, tea systems become more resilient to droughts, erratic rainfall, and temperature stress, while sustaining productivity under changing climatic conditions.

At the landscape level, integrating agroforestry and restoring degraded lands contribute significantly to both adaptation and mitigation outcomes. Tree cover within tea systems reduces soil erosion, stabilizes slopes, and lowers the risk of climate-induced disasters such as landslides and floods—an increasing concern in Sri Lanka's hill-country regions. At the same time, these systems enhance carbon sequestration, supporting national greenhouse gas mitigation targets and contributing to Sri Lanka's commitments under its Nationally Determined Contributions (NDCs).

Regenerative agriculture in tea smallholder systems

The adoption of regenerative agriculture practices within the tea smallholder sector further strengthens this transition. Regenerative approaches emphasize restoring soil health, enhancing biodiversity, minimizing external inputs, and rebuilding ecosystem functions over time. In the context of tea cultivation, this includes practices such as cover cropping, compost application, reduced tillage, integrated pest management, and diversified shade tree systems.

For smallholders, regenerative agriculture offers multiple co-benefits. It reduces dependency on costly external inputs, improves long-term soil fertility, and enhances yield stability. Moreover, diversified systems create additional income opportunities through intercropping, timber, fuelwood, and non-timber forest products. These practices not only improve farm-level resilience but also contribute to broader landscape restoration and ecological sustainability.

Socio-economic and developmental co-benefits

From a development perspective, transitioning towards climate-resilient and regenerative tea systems can play a pivotal role in rural transformation. By stabilizing yields and reducing production costs, these systems improve farm profitability and income security. Diversified production models further reduce economic risks and create alternative livelihood opportunities, including eco-tourism and value-added products.

Importantly, embedding sustainable land management within tea landscapes enables Sri Lanka to position its tea sector as a global model for climate-resilient and low-emission agriculture. Such a transition aligns closely with national priorities, including poverty reduction, ecosystem restoration, and sustainable export growth.

3.6. Case Study: Regenagri – Transforming Sri Lanka’s Tea Smallholder Sector through Regenerative Agriculture

Sri Lanka’s tea smallholder sector faces declining productivity, soil degradation, climate vulnerability, and increasing global competition. National priorities therefore focus on improving green leaf quality and productivity, strengthening climate resilience through sustainable land and soil management aligned with Sri Lanka’s NDCs, enhancing smallholder–factory linkages and value-chain governance, and accelerating adoption of GAPs through responsive, research-driven extension services. Within this policy landscape, **regenerative agriculture** offers a systems-level approach that strengthens soil health, stabilises yields, and builds climate resilience, addressing both agronomic and institutional constraints in Sri Lanka’s smallholder-dominated tea sector.

Regenagri is a third-party regenerative agriculture certification system that incentivises soil-building practices through credible monitoring and value-chain incentives. Core principles include:

- Soil organic carbon enhancement, improving water retention and nutrient cycling.
- Diversified, low input cropping systems, reducing reliance on synthetic fertilisers and pesticides.
- Agroecological practices such as cover cropping, reduced tillage, intercropping, and residue retention.

Regenagri’s carbon insetting programme enables tea exporters and buyers to reduce Scope 3 emissions within their own supply chains while financially rewarding farmers for on-farm regeneration. This aligns with Sri Lanka’s policy emphasis on green export competitiveness and climate action.

Regenagri practices directly support key tea-sector policy goals by:

1. **Improving Soil Health and Productivity:** Regenerative practices such as cover crops, residue retention, and reduced tillage improve soil structure and fertility, stabilising yields and lowering vulnerability to rainfall variability, critical for ensuring consistent green leaf quality.
2. **Increasing Climate Resilience:** Enhanced soil organic carbon improves resilience to drought and heat stress; priority concerns identified in Sri Lanka's climate vulnerability profiles. Stronger soil water retention reduces yield volatility and supports smallholders in adapting to climate shifts.
3. **Strengthening Smallholder Extension and Knowledge Systems:** Regenagri's emphasis on locally adapted management mirrors national calls for strengthening extension systems. Demonstration plots, tailored agronomy support, and farmer learning communities are core elements that complement existing GAP-based extension efforts.
4. **Linking Quality to Market Value:** By linking regenerative outcomes to verified carbon insetting units and premium sourcing contracts, Regenagri provides market incentives for higher-standard leaf production. This responds to policy goals of value-chain integration, price incentives, and smallholder income enhancement.

In 2024–2025, Lumbini Tea Factory and its network of over 1,500 smallholder suppliers achieved group Regenagri certification, the first of its kind for a tea value chain. This model reduced the risk and cost burden for individual smallholders, strengthened factory–supplier collaboration on soil and leaf quality, created a framework for premium, climate-aligned sourcing and built capacity for soil and landscape management under local conditions.

The Sri Lanka experience highlights several insights directly relevant to national tea policy:

- Group certification models can make regenerative transition practical and scalable in smallholder contexts.
- Outcome-based incentives (e.g., carbon insetting and premium sourcing) unlock investment and align farmer and factory priorities.
- Monitoring with local agronomy metrics supports both farm-level improvement and credible reporting for export markets.
- Strong extension and technical support are essential to translate regenerative principles into consistent adoption across diverse landscapes.

Regenagri's approach presents a practical pathway to strengthen soil health, increase yield stability, and build climate resilience in Sri Lanka's tea smallholder sector. By aligning regenerative practices with value-chain incentives and national policy priorities, productivity, resilience, quality, and competitiveness, Regenagri supports a transformation that benefits farmers, factories, markets, and the environment.

4. Building Climate Resilience among Smallholders

4.1. Climate-smart tea agronomy and adaptive practices

Climate-smart tea agronomy is increasingly critical for sustaining productivity and livelihoods in Sri Lanka's smallholder tea sector amid rising temperatures, erratic rainfall, and economic volatility. Evidence from stakeholder consultations and empirical studies indicates that low adoption of recommended agronomic practices, such as balanced nutrient management, proper pruning cycles, soil rehabilitation, and timely plucking, has significantly reduced yields and green leaf quality. Average productivity levels of around 1,200 kg/ha, compared to a global benchmark of 2,200 kg/ha, suggest substantial scope for climate-resilient yield gains without expanding cultivated area.

Climate-smart practices promoted by the Tea Research Institute (TRI), including soil conservation, organic mulching, judicious fertiliser application, and improved field sanitation, have demonstrated the potential to stabilise yields under climate stress. However, adoption remains uneven due to ageing farmer populations, labour shortages, limited access to extension services, and financial constraints. Strengthening farmer capacity to apply these practices consistently, through targeted training, demonstration plots, and outcome-based extension, emerges as a central adaptation priority.

4.2. Shade management, soil conservation, and water harvesting

Stakeholders consistently identified inadequate shade management, weak soil conservation, and limited water management as major contributors to climate vulnerability in tea smallholdings. Continuous cultivation on steep slopes without effective contouring, terracing, or vegetative barriers has accelerated soil erosion, nutrient loss, and land degradation, particularly in districts such as Ratnapura, Kegalle, and Badulla. Degraded soils with low organic matter have reduced water-holding capacity, amplifying the impacts of prolonged dry spells and intense rainfall events.

Proper shade management through regulated shade trees and shelterbelts has been highlighted by TRI and FAO as a low-cost, high-impact adaptation measure. Shade regulates microclimates, reduces heat stress, conserves soil moisture, and improves leaf quality, yet remains underutilised in many smallholdings. Similarly, water harvesting measures such as contour drains, small ponds, and runoff capture systems are rarely adopted, despite increasing rainfall variability. Scaling up integrated soil, shade, and water management practices is essential to reduce climate risk, stabilise production, and minimise disaster impacts such as floods and landslides in tea-growing regions.

4.3. Climate-resilient planting material and diversification models

The ageing of tea bushes and low replanting rates well below the recommended 2% annually represent a major structural barrier to climate resilience. Nearly half of Sri Lanka's smallholder tea lands now exceed their optimal productive lifespan, making them more susceptible to heat stress, drought, pests, and diseases. Continued reliance on older cultivars and poor-quality planting material from unregulated nurseries further undermines productivity and resilience.

TRI-recommended climate-resilient cultivars, including improved vegetatively propagated (VP) plants and grafted seedlings, offer higher yield potential, better drought tolerance, and improved disease resistance. However, high upfront replanting costs, long gestation periods, labour shortages, and limited access to finance discourage adoption. In this context, infilling of vacant patches and phased replanting supported by targeted credit mechanisms emerge as pragmatic entry points.

Crop and income diversification including intercropping, agroforestry, livestock integration, and beekeeping has also been identified as a resilience-enhancing strategy. Diversification reduces income risk, improves soil health, and strengthens household coping capacity during climate shocks or price volatility. Yet uptake remains limited due to weak extension guidance and lack of market linkages, highlighting the need for structured diversification models tailored to smallholder conditions.

4.4. Digital advisory services, climate information, and early warning systems

Limited access to timely, reliable technical information is a critical constraint to climate adaptation among tea smallholders. Evidence indicates that most farmers rely on informal sources such as leaf collectors, factory staff, or agro-input dealers for agronomic advice, often resulting in inconsistent or inaccurate practices. Formal extension coverage remains weak, with nearly half of smallholders reporting rare or no contact with advisory services.

Digital advisory platforms offer a scalable solution to bridge this gap. Despite relatively high smartphone ownership among smallholders, the use of mobile-based agricultural applications for climate information, pest alerts, or price updates remains low. Strengthening digital literacy, reducing data costs, and integrating TRI-validated advisory content into mobile platforms could significantly improve decision-making.

Early warning systems for droughts, excessive rainfall, and pest outbreaks are particularly important given increasing climate variability. Linking meteorological data, localised climate forecasts, and agronomic recommendations through SMS, mobile apps, or cooperative-based dissemination channels would enhance preparedness and reduce climate-related losses. Institutional collaboration between TRI, TSHDA, the Department of Meteorology, and farmer organisations is essential to operationalise these systems effectively.

4.5. Case Study: Aligning Tea Smallholders with National Digitalisation Priorities

Sri Lanka's tea smallholder sector, vital to rural livelihoods and export earnings, is increasingly exposed to climate risks such as erratic rainfall, drought, soil degradation, and rising pest pressure. While farmers have strong traditional knowledge, rapid climate change has created information gaps, limiting access to timely, localised data for decisions on irrigation, inputs, pest control, and harvesting. This results in inefficient input use, higher costs, and declining productivity. Integrating agri-digital systems in the tea sector directly supports Sri Lanka's national digitalisation agenda, offering a practical means to improve resilience, productivity, and evidence-based decision-making at smallholder level.

Agri-digital systems combine IoT sensors, mobile platforms, satellite data, artificial intelligence (AI), and analytics to transform raw environmental data into actionable insights. In tea smallholdings, these systems function as a "digital nervous system" that supports climate-smart, precision decision-making. Key applications relevant to Sri Lanka include:

- Hyper-local weather stations providing short-term forecasts to guide irrigation, fertiliser application, and pest management.
- Soil sensors and instant analysers measuring moisture, temperature, pH, and nutrients to prevent over- or under-application of inputs.
- AI-powered advisory tools and chatbots, delivering real-time guidance in local languages via mobile phones.
- Digital tea leaf analysers, enabling consistent, objective quality grading aligned with factory standards and

- Digital traceability systems, tracking leaf collection, transport, and processing to support transparency, certification, and market access.

International evidence shows that similar digital systems can significantly improve yields, reduce input costs, and strengthen supply-chain resilience—outcomes directly relevant to Sri Lanka’s tea economy.

Agri-digital systems deliver differentiated but complementary benefits across stakeholders:

- Smallholder farmers gain early warnings on weather and pests, optimise water and fertiliser use, reduce climate risk, and improve income stability.
- Tea factories and manufacturers benefit from more predictable green leaf supply, consistent quality, improved traceability, and credible sustainability data for export markets.
- Government agencies gain access to aggregated, anonymised data that supports targeted subsidies, climate risk mapping, and evidence-based policy decisions.
- Certification bodies can strengthen audit integrity and efficiency through digital records, remote sensing, and continuous compliance monitoring.

Experience from digital agriculture pilots highlights several lessons relevant to Sri Lanka’s tea sector:

- Inclusive design is essential: voice-based advisories, IVR, and local-language interfaces help overcome literacy and digital-skills barriers.
- Integration matters: combining weather, soil, and crop data generates stronger advisories than standalone tools.
- Connectivity and cost constraints can be managed through low-power wide-area networks (LPWAN), offline-first mobile apps, and shared or cooperative service models.
- Public–private partnerships are critical to de-risk early adoption and scale solutions sustainably.

This agri-digital approach directly supports Sri Lanka’s national push towards data-driven agriculture, by embedding digital tools into extension, monitoring, certification, and value-chain governance. It complements existing initiatives on climate resilience, productivity enhancement, and digital public infrastructure, while enabling practical, farm-level adoption among smallholders.

Agri-digital systems are no longer optional innovations but a core enabler of climate-resilient, competitive tea production in Sri Lanka. By aligning farmer-centric digital tools with national digitalisation priorities, the tea sector can shift from reactive adaptation to proactive, data-informed resilience. With coordinated investment, strong governance, and capacity building, digital agriculture can help secure Sri Lanka’s tea smallholder livelihoods while strengthening the country’s position in global tea markets.

5. Enabling Systems for Resilient Tea Smallholdings

5.1. Strengthening extension services and climate advisory delivery

Sri Lanka's tea smallholders face persistent constraints in accessing effective extension and climate advisory services, despite their central role in national tea production. Extension delivery is fragmented across multiple institutions, including the Tea Research Institute (TRI), the Tea Small Holdings Development Authority (TSHDA), private input suppliers, and factory-linked advisors resulting in overlapping mandates, weak coordination, and inconsistent messaging. Capacity limitations are acute: with only around 120 extension officers serving nearly 400,000 smallholders, advisory contact is infrequent, uneven, and often limited to short-term project cycles rather than continuous engagement.

As a result, many smallholders exhibit low adherence to recommended agronomic, soil, and climate-resilient practices, including balanced fertiliser use, erosion control, pruning schedules, and shade management. Climate risks such as prolonged droughts, intense rainfall, floods, and landslides further amplify the consequences of weak advisory systems, particularly in steep and environmentally fragile tea-growing regions. Current extension approaches tend to emphasise standardised recommendations, with limited adaptation to local microclimates, elevation zones, slope conditions, or socio-economic realities.

Strengthening extension systems therefore requires a shift toward coordinated, climate-smart advisory delivery. This includes clarifying institutional roles between TRI and TSHDA, increasing field staffing and mobility, and upgrading extension officer skills in climate risk assessment, soil and water conservation, and post-harvest quality management. Digital and mobile-based advisory platforms offer an important complement, enabling wider dissemination of climate forecasts, early warnings, and site-specific guidance, particularly in remote areas. However, digital solutions must be paired with investments in farmer digital literacy, affordable connectivity, and trusted local intermediaries to ensure effective uptake.

5.2. Research, innovation, and localised climate solutions

Sri Lanka possesses a strong research base in tea science, led by the TRI, yet a persistent disconnect remains between research generation and field-level adoption. Innovations related to climate-resilient cultivars, integrated pest management, soil fertility restoration, and shade-tree systems often fail to reach smallholders in practical, locally relevant forms. Where information does reach farmers, it is frequently fragmented or filtered through commercial actors, limiting its credibility and applicability.

Climate change impacts on tea productivity vary significantly by elevation and agro-ecological zone, underscoring the need for localised solutions. Research indicates declining yields in low- and mid-elevation zones due to heat and moisture stress, while some high-elevation areas may experience productivity gains. Despite this variability, advisory recommendations are rarely tailored to zone-specific climate risks or livelihood strategies. Innovation systems must therefore prioritise adaptive, location-specific responses, such as differentiated planting material, water-harvesting designs, soil organic matter enhancement strategies, and diversified agroforestry models.

Participatory research approaches, such as on-farm trials, demonstration plots, and farmer field schools, are essential to bridge the gap between scientific knowledge and traditional practices. Socio-cultural norms, intergenerational knowledge transfer, and gendered labour roles strongly influence innovation uptake. Women, who perform much of the day-to-day tea cultivation work, often have limited access to training and decision-making forums, reducing household-level

adoption of improved practices. Embedding research and innovation within local social structures, and ensuring inclusive access to knowledge, is therefore critical for developing climate-resilient tea systems that are both technically sound and socially acceptable.

5.3. Smallholder organisation, aggregation, and collective action

Weak bargaining power remains a defining structural challenge for tea smallholders in Sri Lanka. The green-leaf market is characterised by a high degree of buyer concentration, with smallholders' dependent on a limited number of Bought Leaf Factories (BLFs) due to the perishability of tea leaf and limited transport options. This creates monopsonistic conditions in which factories largely determine quality standards (i.e. moisture levels & leaf quality etc.), and payment terms, often with limited transparency.

Although tea smallholder societies are widespread, their effectiveness as vehicles for collective bargaining, market engagement, or value addition remains limited. Many function primarily as administrative or input-distribution units, constrained by weak governance, limited financial capital, low managerial capacity, and poor member participation. As a result, smallholders typically sell individually, forfeiting economies of scale and collective leverage. Information asymmetries further exacerbate this imbalance, as farmers lack timely access to market prices, quality premiums, and export-market trends.

Strengthening collective action is therefore essential to improving both resilience and equity in the tea value chain. Investments in organisational capacity-building covering governance, financial management, leadership, and business planning can enable producer organisations to negotiate more effectively with factories, aggregate supply, and explore shared services such as transport, quality grading, or even small-scale processing. Collective platforms also provide an entry point for bundling extension, climate advisory services, input access, and financial products, reducing individual transaction costs and risks.

Importantly, collective action must be designed with sensitivity to local socio-cultural norms, land fragmentation, and trust dynamics. Inclusive approaches that recognise gender roles, encourage youth participation, and build on existing community networks are more likely to succeed than externally imposed cooperative models. When effectively supported, strong smallholder organisations can enhance bargaining power, improve price transmission, facilitate climate-smart practice adoption, and anchor smallholders more securely within low-emission, climate-resilient tea value chains.

5.4. Gender, youth, and social inclusion in climate adaptation

Climate adaptation in Sri Lanka's tea smallholder sector is deeply shaped by social relations, labour structures, and generational dynamics. Gender inequality, weak youth retention, and entrenched socio-cultural norms directly influence who accesses climate information, who adopts adaptation practices, and who benefits from resilience investments. As women and youth constitute the backbone of labour and future innovation in the tea sector, inclusive adaptation strategies are essential for sustaining productivity, livelihoods, and ecosystem resilience under increasing climate stress.

Women play a central role in climate-exposed agricultural tasks in tea smallholdings, accounting for over 60% of field labour hours, including plucking, weeding, nursery management, fertiliser application, and soil conservation activities. Despite this, women's agency in decision-making related to land use, crop management, investment, and adaptation remains constrained by entrenched patriarchal norms. Control over productive assets, access to extension services, credit, and membership in tea societies is disproportionately held by men, even where women are primary farm operators.

These gendered asymmetries reduce household adaptive capacity. Many climate adaptation measures such as adoption of climate-resilient cultivars, soil and water conservation practices, agroforestry systems, or changes in labour allocation require informed, day-to-day management decisions. When women lack access to climate advisory services or training, implementation of adaptation practices is often partial or ineffective. Moreover, extension programmes frequently fail to reach women due to scheduling conflicts with unpaid care responsibilities, limited mobility, and male-dominated delivery systems.

Climate impacts also compound women's workload and vulnerability. Droughts, erratic rainfall, floods, and landslides increase labour demands for soil repair, replanting, and household coping strategies, often without corresponding increases in control over income or support services. Without gender-responsive design, adaptation interventions risk reinforcing existing inequities by increasing women's labour burdens without enhancing their decision-making power or economic returns.

Youth participation is critical for the long-term adaptive capacity of Sri Lanka's tea sector, yet youth disengagement remains a growing risk. Younger generations increasingly perceive tea cultivation as physically demanding, low-status, and offering limited career progression, particularly in the context of climate uncertainty and declining profitability. Climate change further exacerbates this perception by increasing production risks and income volatility, discouraging long-term investment by youth.

At the same time, youth represent a key source of innovation, digital literacy, and openness to climate-smart technologies. Programmes that engage youth in modern agronomy, climate-resilient practices, biodiversity management, precision agriculture, and value addition demonstrate strong potential for transforming adaptation outcomes. Initiatives such as youth agripreneurship schemes, sustainability training through certification bodies, and innovation hubs provide pathways for integrating climate adaptation with entrepreneurship and livelihood diversification.

However, youth engagement strategies must address structural barriers, including limited access to land, finance, and decision-making platforms. Climate adaptation policies that fail to create viable, aspirational roles for youth risk accelerating labour shortages, loss of local knowledge, and weakened community-level resilience. Integrating youth into extension systems, producer organisations, climate monitoring, and innovation pilots is therefore essential to sustaining adaptive capacity across generations.

Social inclusion extends beyond gender and age to encompass power relations within households, communities, and institutions. Smallholders who are marginalised by land fragmentation, low literacy, poverty, or social norms often face compounded barriers to accessing climate finance, extension, and adaptation technologies. Weak collective organisation further limits inclusive adaptation, as individual farmers, particularly women and youth, lack bargaining power and voice in shaping local responses to climate risks.

Strengthening inclusive institutions such as tea societies, cooperatives, and community-based organisations is therefore central to climate adaptation. When designed inclusively, these platforms can facilitate collective learning, shared risk management, aggregation of climate-resilient inputs, and access to financial and technical support. Evidence from women-led groups and youth networks shows that inclusive collective action can enhance adoption of sustainable land management, diversification, and income stabilisation strategies.

6. Financing Climate-Resilient Tea Smallholdings

6.1. Climate finance needs and investment gaps in tea smallholdings

Sri Lanka's tea smallholders face a substantial climate finance gap that limits their ability to invest in adaptation, mitigation, and productivity-enhancing measures. High input costs, dependence on imported agrochemicals, ageing plantations, degraded soils, and rising climate risks have eroded farm profitability and reduced reinvestment capacity. Although many smallholders adopt sustainable land management practices such as soil conservation, agroforestry, organic inputs, and reforestation, these efforts remain largely unfunded or self-financed.

A key structural constraint is the absence of mechanisms to quantify, aggregate, and monetise environmental services generated by smallholder tea landscapes, particularly carbon sequestration and ecosystem services. Fragmented landholdings, weak collective institutions, and limited technical capacity for measurement, reporting, and verification (MRV) exclude smallholders from climate finance and carbon markets. As a result, climate-smart practices remain under-scaled, and investment in low-carbon transitions, renewable energy, and regenerative land management is insufficient to meet national climate and rural development objectives.

6.2. Accessing international climate finance (e.g. GCF, GEF, Adaptation Fund)

International climate finance mechanisms such as the Green Climate Fund (GCF), Global Environment Facility (GEF), and Adaptation Fund offer significant opportunities to address these gaps but remain underutilised by the tea smallholder sector. Current barriers include limited pipeline development, weak alignment between national climate commitments and smallholder-level interventions, and insufficient aggregation of benefits to meet the scale requirements of global funds.

Smallholder-focused programme designs such as aggregated carbon finance models, landscape-level adaptation projects, and climate-resilient value-chain initiatives can enhance eligibility for international funding. Integrating tea smallholders into nationally endorsed programmes under Sri Lanka's NDCs, National Adaptation Plan, and Green Growth Strategy would enable access to concessional finance for replanting, soil restoration, agroforestry, renewable energy, and climate-resilient livelihoods. Strengthening institutional coordination among the Ministry of Environment, Ministry of Agriculture, TSHDA, and the Climate Change Secretariat is critical to translating global finance into locally accessible investment flows.

6.3. Blended finance, public–private partnerships, and value-chain finance

Blended finance models are essential to crowd in private investment while reducing risks associated with smallholder agriculture. Combining grants, concessional loans, carbon revenues, and private capital can support scalable investments in climate-smart tea systems. Public–private–people partnerships (PPPPs) involving government agencies, plantation companies, exporters, financial institutions, and smallholder organisations provide a practical pathway to operationalise such models.

Value-chain finance mechanisms linked to exporters, certification schemes, and ethical or carbon-positive tea markets can channel investment directly to farm-level adaptation and mitigation. Initiatives such as carbon-integrated tea certification, local bio-input micro-enterprises, and village-level climate funds allow sustainability performance to be monetised through premium pricing, carbon credits, and reduced financing costs. These approaches also

strengthen local entrepreneurship, reduce dependency on imported inputs, and enhance circular bio-economy practices within tea-growing regions.

6.4. Risk-transfer mechanisms: insurance, guarantees, and resilience funds

Climate risk transfer instruments are critical to stabilising smallholder incomes and protecting investments against increasing climate shocks. Insurance schemes particularly index-based weather insurance can reduce vulnerability to droughts, floods, and landslides, while credit guarantees and risk-sharing facilities can incentivise financial institutions to lend to smallholders adopting climate-smart practices.

Village Climate Funds and community-based resilience funds offer an additional mechanism to pool resources from carbon revenues, public finance, and donor support. These funds can be reinvested locally in replanting, soil conservation, disaster recovery, renewable energy, and organic input production, enhancing both adaptive capacity and financial resilience. Integrating insurance and guarantee mechanisms with carbon finance and green credit lines further strengthens incentives for sustainable land management and reduces the long-term fiscal burden of climate-related losses.

7. Scaling Sustainability Standards and Market Incentives

7.1. Integrating climate resilience into national tea sustainability frameworks

Climate change has emerged as a systemic risk to Sri Lanka's tea smallholding sector, threatening productivity, livelihoods, and export stability through rising temperatures, erratic rainfall, floods, droughts, and landslides. These risks are amplified in tea-growing regions where land has been cleared for agriculture and construction without adequate environmental impact assessments, increasing exposure to soil erosion and slope failure. Recent extreme weather events have caused widespread damage across tea-growing districts, displacing households, disrupting leaf supply, and underscoring the urgency of climate risk mitigation.

National sustainability frameworks for tea must therefore move beyond productivity alone and explicitly integrate climate resilience as a core objective. This includes promoting replanting with climate-resilient cultivars, regenerative soil management, shade-tree systems, watershed protection, and disaster-risk-sensitive land use planning. Donor-supported projects such as IFAD's STaRR demonstrate that resilience outcomes are strongest when agronomic interventions are paired with medium-term finance and strong farmer organisations. Embedding these approaches within national plantation policy, the National Strategic Plan for the Tea Industry, and Sri Lanka's NDC and adaptation priorities would allow climate resilience to be mainstreamed rather than treated as a project-level add-on.

7.2. Leveraging certification and traceability for climate finance access

Certification and traceability systems provide a practical bridge between smallholder-level climate action and international climate finance. Many climate-smart practices already adopted by tea smallholders, such as agroforestry, soil carbon enhancement, reduced chemical inputs, and biodiversity conservation, remain unmonetized due to weak measurement, reporting, and verification (MRV). Group-based certification and digital traceability can aggregate smallholder impacts and make them legible to climate finance mechanisms.

Initiatives aligned with Rainforest Alliance, Regenagri, organic, and emerging low-carbon tea standards offer entry points for accessing premium markets and, potentially, results-based climate finance. National-level systems, such as QR-code farmer registries and traceability platforms led by MPCl, SLTB, and TSHDA, can be extended to capture climate indicators (e.g., land under shade, soil management practices, reduced fertiliser use). When linked to donor-backed MRV frameworks, these systems can unlock access to GCF, GEF, Adaptation Fund resources, and voluntary carbon or biodiversity markets, particularly when smallholders are organised through federations or factory-linked supply chains.

7.3. Aligning export competitiveness with climate and ESG expectations

Sri Lanka's tea export competitiveness increasingly depends on compliance with environmental, social, and governance (ESG) expectations in global markets. Buyers, retailers, and consumers are demanding traceable, climate-resilient, and ethically produced tea, while trade and finance regulations in key markets are tightening sustainability requirements. Climate resilience and ESG alignment are therefore no longer optional but central to maintaining market access and price premiums.

Private exporters and brands have already invested in traceability, branding, and sustainability narratives for “Ceylon Tea.” However, the benefits to smallholders remain uneven due to weak upstream integration. Aligning export competitiveness with climate objectives requires structured mechanisms whereby quality premiums, long-term offtake agreements, and buyer commitments are directly linked to smallholder investments in resilience and sustainability. Blended finance instruments combining donor concessional funds, buyer co-investment, and commercial credit can support replanting, certification, renewable energy, and climate-smart processing, ensuring that ESG compliance strengthens rather than marginalises smallholder participation.

7.4. Role of the Sri Lanka Tea Board and regulatory institutions

The Sri Lanka Tea Board (SLTB), Tea Small Holdings Development Authority (TSHDA), and related regulatory institutions play a pivotal coordinating role in aligning climate resilience, finance, and market access.

The Sri Lanka Tea Board (SLTB) is the sector's apex regulator, with a broad mandate across the tea value chain. Its functions include supporting overseas buyers and brand owners; advising exporters, traders, manufacturers, and growers; protecting and promoting the “Ceylon Tea” brand and regional origin claims; safeguarding the quality and purity of tea exports; promoting Ceylon tea globally; and collecting and disseminating market data and industry information.

Accordingly, the SLTB's statutory role in quality standards, branding, and promotion makes it a natural platform for embedding sustainability and climate criteria in national tea strategy. Building on existing co-funded promotions with the private sector, the Board could extend its work to climate-aligned standards, traceability requirements, and incentives for certified, low-carbon tea.

TSHDA's grassroots reach and data systems are critical for implementing climate-smart practices at scale, but capacity constraints limit effectiveness. Strengthening these institutions to act as neutral conveners, facilitating multi-stakeholder coordination among donors, exporters, financial institutions, and farmer organisations is essential. Regulatory oversight is also needed to ensure fair contract farming arrangements, transparent input-credit systems, and consumer protection in finance. Together, SLTB and TSHDA can anchor permanent coordination platforms that align national policy, donor finance, private investment, and smallholder resilience outcomes under a unified sustainability and climate framework.

8. Scaling Climate-Resilient Tea Systems: Pathways, Investments, and Enabling Frameworks

8.1. Scenario-based adaptation pathways (incremental to transformative)

Agricultural systems, particularly smallholder landscapes such as Sri Lanka's tea sector, require adaptation pathways that range from incremental adjustments to transformative shifts. Incremental strategies focus on gradually integrating regenerative and agroforestry practices into existing production systems. For instance, smallholders may start with limited cover cropping, residue retention, or test plots for new crop rotations, thereby building soil organic matter, enhancing nutrient cycling, and improving microclimate conditions without risking the entire farm system. Over time, these incremental measures can evolve into transformative interventions, including full-scale adoption of integrated regenerative practices such as agroforestry, reduced tillage, and livestock integration. Transformative adaptation emphasizes systemic change, creating multifunctional landscapes that improve nutrient-use efficiency (NUE), stabilize yields, conserve biodiversity, and sequester carbon, ultimately building long-term resilience against climate variability, input cost pressures, and soil degradation. The trajectory from incremental to transformative approaches requires careful alignment with local agroecological conditions, crop types, and farmer capacities, ensuring that adaptation strategies are context-sensitive and sustainable.

8.2. Institutional coordination across climate, agriculture, and trade

Achieving widespread adoption of sustainable agricultural practices necessitates strong coordination between institutions governing climate action, agriculture, and trade. Government agencies, research institutions, and extension services must work together to provide region-specific guidance on regenerative practices, soil and nutrient management, and agroforestry integration. Aligning policy incentives, subsidies, and certification frameworks with climate objectives ensures that farmers are supported in adopting regenerative practices that improve soil health and nitrogen-use efficiency. Simultaneously, trade institutions and market actors can incentivize sustainable production by offering preferential procurement, multi-year contracts, and carbon-insetting opportunities, reducing financial risks for farmers. Effective coordination also includes integrating climate reporting and agricultural productivity goals, fostering linkages between national sustainability frameworks, smallholder capacity-building initiatives, and international trade standards. Such integrated governance ensures that climate-resilient and nitrogen-efficient farming practices are not only technically feasible but also economically viable and widely adopted.

8.3. Investment priorities for short, medium, and long-term resilience

Building resilience in agricultural systems requires strategic investments across multiple temporal scales. In the short term, investments should focus on enhancing technical capacity and providing financial support for smallholders, including access to soil testing, organic inputs, and pilot agroforestry or cover-cropping interventions. Medium-term investments must aim at scaling these interventions, establishing demonstration plots, strengthening extension services, and fostering market mechanisms that reward sustainable production and reduce risk for farmers. Long-term priorities include systemic investments in landscape-level interventions, such as integrated agroforestry systems, reduced tillage across regions, and adoption of nitrogen-efficient and resilient crop varieties. Investments in research and innovation are critical to optimize nitrogen-use efficiency, support localized adaptation strategies, and validate carbon

sequestration potential for climate mitigation. Across all timeframes, investments must balance ecological benefits with socioeconomic returns, ensuring that smallholder farmers can maintain productivity, improve incomes, and contribute to broader climate and sustainability goals.

8.4. Monitoring, reporting, and verification (MRV) for NDC outcomes

Robust monitoring, reporting, and verification mechanisms are essential to track the effectiveness of regenerative and nitrogen-efficient practices in achieving climate and agricultural targets. MRV systems allow farmers to monitor indicators such as soil organic matter, nitrogen uptake, yield stability, water efficiency, and biodiversity outcomes, informing adaptive management at the farm level. At the supply chain and policy levels, verified data enable credible reporting of climate mitigation outcomes, including carbon sequestration and reductions in nitrogen-related environmental impacts. Third-party verification enhances trust among brands, businesses, and policymakers, ensuring that claims regarding sustainable production, yield improvements, and emissions reductions are scientifically substantiated. By integrating MRV into NDC (Nationally Determined Contributions) frameworks, countries can align smallholder adoption of regenerative practices with national climate objectives, enabling measurable contributions to mitigation, adaptation, and food security goals. The systematic collection and sharing of verified outcomes also foster transparency, build institutional capacity, and support long-term scaling of climate-smart and nitrogen-efficient agriculture.

9. Roadmap and Way Forward

Drawing on the National Action Plan (NAP) for smallholder tea revitalisation, stakeholder consultations, and international best practices, the following recommendations provide a comprehensive roadmap to enhance productivity, resilience, and sustainability in Sri Lanka's smallholder tea sector. The recommendations are organized under five key areas: policy, financing, research and capacity-building, public-private collaboration, and integration with the country's NDC commitments.

9.1. Priority policy actions for government ministries

Institutional and regulatory strengthening: Strengthening institutional and regulatory frameworks is critical for enhancing the efficiency and sustainability of Sri Lanka's tea industry. The National Adaptation Plan (NAP) should be integrated within the proposed National Stakeholder Committee on the Tea Industry, creating a unified platform for oversight and coordination. This approach will reduce redundancy and foster closer collaboration among key actors, including the Tea Small Holdings Development Authority (TSHDA), Sri Lanka Tea Board (SLTB), Tea Research Institute (TRI), Export Development Board (EDB), provincial councils, and smallholder cooperatives. By aligning these institutions under a common governance structure, the sector can achieve more coherent policy implementation and improved support for stakeholders at all levels.

Market-oriented support: Market-oriented interventions are essential to incentivize sustainable and competitive production. Fiscal and trade measures, such as preferential tax treatment, reduced VAT/SVAT for certified tea, and import duty exemptions for sustainable inputs, can encourage the adoption of Good Agricultural Practices (GAP) and Regenerative Agricultural Practices (RAP).

These measures not only support environmental sustainability but also enhance the global competitiveness of Sri Lankan tea by aligning production standards with international market expectations.

These revisions to fiscal and trade policies are expected to enhance the global competitiveness of certified, sustainably produced Ceylon Tea. By expanding market share and reaching new markets, annual tea export volumes will likely grow. This approach will significantly support the government's industry goals of achieving \$2.5 billion in revenue and producing 400 million kilograms of tea by 2030.

Labour and human capital policies: Policies addressing labour and human capital development are crucial for revitalizing the tea value chain. Apart from the current on farm training and extension programs conducted by public and research institutions, as well as private companies etc. well-structured and targeted programmes designed to meet National Vocational Qualification (NVQ) or similar standards to attract youth, and women can broaden participation and strengthen the workforce. Initiatives may include vocational training, subsidized employment pathways (i.e., training allowance for unskilled youth, and women undergoing specific training period) and retention incentives (i.e., biannual ex gratia payment for certified tea harvesters by leaf collecting tea factory) ensuring that the sector benefits from a skilled, diverse, and motivated labour pool capable of supporting modernization and innovation across plantations.

Land and productivity governance: Effective land and productivity governance is another priority. Strategies such as field consolidation, block infilling with “jumbo” plants of high yield cultivars, and soil rehabilitation, guided by standardized nurseries and Soil Quality Index (SQI) assessments, can significantly enhance productivity. Integrating climate-smart replanting standards into national policy and extension curricula ensures that productivity gains are environmentally sustainable and resilient to climate variability, safeguarding long-term sectoral viability.

Climate resilience integration: The current revision of Sri Lanka's Nationally Determined Contributions (NDCs) for 2026–2035 has incorporated climate resilience strategies across the agricultural, forestry, and plantation sectors. As a result, revisiting plantation policies is essential to align the tea sector with the updated NDCs. These policies should be enhanced to promote and prioritise climate-smart agriculture, soil conservation, and carbon finance initiatives, thereby ensuring that the industry makes a meaningful contribution to national climate objectives while maintaining both economic and environmental sustainability.

9.2. Financing /investment roadmap and the roll of the Government

Blended finance mechanisms: The Ministry of Plantations and Community Infrastructure, along with relevant stakeholders, have indicated their intention to implement innovative financial models, including blended finance approaches and public-private people partnership (PPPP) initiatives, as outlined in the Draft Tea Sector Strategic Plan 2026–2030.

Blended finance mechanisms can play a pivotal role in scaling sustainable interventions for smallholder tea farmers. By combining public grants, contributions from development partners such as IFAD, ADB, FAO, and UNDP, concessional credit, and private sector co-investment, these approaches help de-risk initiatives including replanting, micro-enterprises, and soil rehabilitation. Such structured financing ensures that smallholders can access the resources necessary to adopt sustainable practices while minimizing their exposure to financial risk.

Factory-based revolving funds: Private tea factory operators and tea smallholders are deeply interdependent. Majority of private tea factories belong to the Sri Lanka Tea Factory Owners' Association, enabling them to collectively launch factory-based revolving funds to improve local capital access. These funds, managed by tea factories alongside Tea Smallholder Development societies or cooperatives, provide working capital for areas such as mechanization, green-leaf collection, and quality inputs. With repayments tied to green leaf supplies, the available capital is continually reused within local communities, creating a self-sustaining investment cycle that promotes productivity and operational efficiency at the grassroots.

Cooperative microfinance and cluster credit: Complementing these mechanisms, cooperative microfinance and cluster-based credit schemes can facilitate pooled savings and joint lending among smallholders. Access to loans can be tied to verified adoption of Good Agricultural Practices (GAP) and Regenerative Agricultural Practices (RAP), thereby incentivizing sustainable behaviour while ensuring financial support reaches those committed to climate-smart and productivity enhancing methods.

Green and carbon finance integration: Integrating green and carbon finance into smallholder operations further strengthens the sector’s sustainability framework. The establishment of a Smallholder Carbon Facility would aggregate verified carbon credits generated through replanting, agroforestry, and soil carbon sequestration. Revenues from these credits could be reinvested into Village Climate Funds (VCFs), supporting community-level sustainability projects and reinforcing local ownership of climate adaptation efforts.

Performance-based incentives: Performance-based incentives provide an additional layer of motivation for smallholders to enhance productivity and environmental outcomes. Payments linked to measurable improvements in yield, leaf quality, soil health, and verified emission reductions, monitored through a digital Monitoring, Reporting, and Verification (D-MRV) platform, ensure accountability and reward tangible progress.

Youth and women entrepreneurship fund: Targeted interventions for youth and women can catalyses green entrepreneurship and economic diversification within the tea value chain. Dedicated grants, mentorship programmes, and market access support can stimulate employment, empower underrepresented groups, and foster locally driven enterprise development, creating a more inclusive and resilient tea sector.

This financing roadmap ensures inclusivity, sustainability, and alignment with environmental and economic objectives, while mobilizing over LKR 10 billion in public–private investment and expanding smallholder credit access by 30–40% within five years.

9.3. Research, extension, and capacity-building agenda

Applied research: Applied research is essential to drive innovation and sustainability within Sri Lanka’s tea sector. The Tea Research Institute (TRI) and universities should prioritize studies on soil health restoration, nitrogen-use efficiency (NUE), climate-resilient clones, integrated pest management, and mechanization trials. These targeted research efforts will provide the scientific foundation for higher productivity, resource efficiency, and climate resilience across smallholder and estate operations.

Digital advisory systems: As Sri Lanka aims to modernise its tea industry by aligning with the National Digital Economy Strategy for 2030, one of the first important steps is to introduce a digital advisory system. The Tea Research Institute (TRI) has already made progress in this area, but there is a need to speed up these efforts through better planning and increased collaboration with organisations like TSHDA and SLTB. This approach will help ensure that tea smallholders can fully benefit from digital advisory services.

Digital advisory systems offer a scalable pathway for knowledge transfer and real-time decision support. Expanding mobile platforms such as Dialog’s “*Govi Mithuru*,” SMS alerts, and remote learning tools can deliver modular training, leaf-quality monitoring, and harvest scheduling guidance. By leveraging digital channels, smallholders gain timely access to information that enhances farm-level decision-making, reduces losses, and improves overall productivity.

Farmer Field Schools (FFS+) and peer learning: The existing Farmer Field Schools (FFS+) and peer-to-peer learning networks implemented by Tea Smallholding Development Authority and TRI can further strengthen knowledge diffusion within communities. Establishing demonstration hubs and Lead Farmer networks promotes hands-on learning, community-based problem solving, and the certification of skilled operators. These platforms not only build technical

expertise but also foster collaboration and collective problem-solving, empowering farmers to adopt and maintain best practices.

Institutionalization of training: Institutionalizing training ensures that capacity-building is sustainable and standardized. Integrating Good Agricultural Practices (GAP) and Regenerative Agricultural Practices (RAP) curricula into Technical and Vocational Education and Training (TVET) programs and universities, alongside embedding continuous monitoring, evaluation, and learning (MEL) frameworks into all initiatives, creates a robust system for ongoing skill development and performance improvement.

Post-harvest innovation: Enhancing post-harvest practices is essential for retaining value and minimizing losses. The Sri Lanka Tea Board (SLTB) mainly oversees post-harvest processes such as monitoring leaf collection, transportation, and production to maintain the high standards of "Ceylon Tea." Focusing on specific improvements like upgrading harvesting equipment, refining green-leaf handling methods, and implementing quality-driven incentive programs can further boost both efficiency and tea quality. By integrating advancements in technology, education, and processes, the industry stands to gain in productivity, sustainability, and global competitiveness.

9.4. Public–private collaboration and international cooperation

Village Enterprise Hubs and PPPP model: As the Ministry of Plantations and Community Infrastructure is looking forward for commencing PPPP projects with wider partner collaborations, there is a great potential for Enterprise Hubs, implemented through a Public-Private-People-Participation (PPPP) model, that will offer a transformative approach to local economic development within the tea sector. These micro-enterprise hubs can produce bio-inputs, mechanization services, and value-added tea products by clearly delineating the roles of each stakeholder: the public sector provides policy guidance, grants, and extension services; the private sector contributes market access and co-investment; and communities supply labour and cooperative governance. This collaborative framework ensures that interventions are locally owned, economically viable, and aligned with broader sustainability objectives.

Market integration: Integrating Tea Smallholders' sustainability initiatives into the market is critical for enhancing their competitiveness and securing access to high-value markets. Rather than remaining isolated or fragmented, tea smallholders can bolster their collective influence by establishing Smallholder Marketing Collectives (SMCs) and adopting digital traceability systems. These strategies provide robust branding opportunities for SL GAP (the national standards established by the Sri Lanka Standard Institute) and RAP-certified tea, effectively linking local producers to both domestic and international buyers. This methodology increases visibility, fortifies quality assurance, and fosters transparency throughout the supply chain.

International cooperation: International cooperation further reinforces the sector's sustainability and competitiveness. Strategic engagement with donors, climate finance institutions, and certification bodies can provide technical assistance, carbon verification, and investment support. Aligning interventions with global standards such as Gold Standard, Plan Vivo, and Verra ensures that Sri Lanka's tea sector meets international expectations for climate resilience, environmental stewardship, and market credibility.

Knowledge exchange: Structured knowledge exchange accelerates innovation and the adoption of best practices. Cross-border learning tours, research partnerships, and peer-to-peer networks facilitate the dissemination of technical insights and operational experience, enabling smallholders, cooperatives, and institutions to continuously upgrade their capabilities and remain adaptive in a rapidly changing global tea market.

9.5. Embedding tea smallholdings into Sri Lanka's NDC delivery

Climate-smart agriculture integration: Integrating climate-smart agriculture into the tea sector is essential to ensure both environmental sustainability and long-term economic resilience. Practices such as Good Agricultural Practices (GAP), Regenerative Agricultural Practices (RAP), agroforestry, and soil carbon sequestration should be embedded into standard operating procedures across plantations and smallholder farms. This integration not only enhances productivity and ecosystem health but also positions the sector to contribute meaningfully to national climate objectives.

Carbon accounting and verification: Effective carbon accounting and verification systems are essential for monetizing the environmental advantages of these practices. The Ministry of Plantations and Community Infrastructure may work alongside the Ministry of Environment, in accordance with Sri Lanka's National Climate Finance Strategy (2025–2030), the Carbon Net Zero 2050 Roadmap and Strategic Plan, and the Sri Lanka Climate Fund, to establish a national Smallholder Carbon Registry. This registry, paired with village-level carbon funds, will allow smallholders to verify their carbon sequestration activities and access income from carbon credits. Tying these incentives to local sustainability projects ensures that climate action brings real economic benefits to communities.

Green finance linkage: Green finance mechanisms further support this transition by connecting smallholders to climate-linked loans and carbon revenue streams. By aligning financial incentives with low-carbon practices, farmers are encouraged to adopt sustainable methods that reduce emissions, improve soil health, and increase long-term productivity, while simultaneously enhancing livelihoods.

Monitoring and reporting: Monitoring and reporting are essential to track progress and ensure accountability. The digital Monitoring, Reporting, and Verification (D-MRV) platform can capture data on greenhouse gas reductions, soil improvements, and productivity gains, providing a reliable evidence base for national NDC reporting and guiding adaptive management at both local and national levels.

Policy alignment: Policy alignment is key to embedding climate action within the broader tea sector framework. Fiscal incentives, sectoral reforms, and extension programs should be formally recognised within Sri Lanka's NDC action plans, linking farm-level interventions to national climate targets. By aligning local practices with national objectives, the tea sector can play a leading role in meeting the country's commitments to climate mitigation and sustainable development.

Implementing these strategic recommendations will transform Sri Lanka's smallholder tea sector into a productive, climate-resilient, and socially inclusive system. Coordinated policy action, innovative financing, applied research, capacity-building, and robust public-private partnerships, aligned with national and international climate commitments, will ensure sustainable growth, increased livelihoods, and strengthened contribution to the country's Nationally Determined Contributions by 2030.

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