Mainstreaming Climate-Resilient Agricultural Policies into the National Framework in Sri Lanka

White Paper

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Executive Summary

Sri Lanka's agricultural sector, vital for national food security and rural livelihoods, faces a severe and escalating threat from climate change. Increased frequency of extreme weather events, rising temperatures, and erratic rainfall patterns are already impacting crop yields, livestock productivity, and coastal fisheries, jeopardizing the nation's economic stability. Projections indicate potential yield reductions of 10-30% by 2050 across major crop zones without targeted adaptation measures, threatening food security, rural livelihoods, and economic stability. These impacts will intensify, potentially leading to significant GDP losses and increased poverty. This white paper presents a comprehensive analysis and strategic framework to mainstream climate resilience into Sri Lanka's national agricultural policies. It synthesizes empirical research, policy reviews, and field-based insights to identify systemic barriers such as policy fragmentation, institutional capacity gaps, inadequate financing, and weak inter-agency coordination, which hinder effective climate-smart agriculture (CSA) adoption. Sri Lanka has developed a comprehensive suite of policies and strategies over the past four decades, including the National Adaptation Plan (2016-2025), the National Agriculture Policy (2021), and the recent Climate-Smart Agriculture Investment Plan (2024). While these policies are ambitious in their objectives, a critical and persistent gap between policy formulation and practical implementation renders them largely ineffective. This gap is not due to a lack of vision but to deep-seated, systemic challenges that consistently undermine progress. Our assessment identifies three core deficits hindering the mainstreaming of climate resilience:

Fragmented Governance and Institutional Weakness: Policies are often developed in silos, with insufficient coordination between key ministries (e.g., Agriculture, Environment, Irrigation) and a lack of integration between national and sub-national authorities. Many frameworks are outdated and do not reflect current climate science, while weak enforcement of existing regulations, such as environmental safeguards, allows for continued degradation.

Inadequate Resources and Capacity: Chronic underfunding, insufficient resource allocation, and a lack of dedicated financial mechanisms are cited as major barriers across nearly every relevant policy. This is compounded by limited technical capacity at both institutional and local levels, along with under-resourced extension services that fail to deliver climate-smart technologies and practices to farmers.

Limited Community Engagement and Adoption: The top-down nature of policy implementation often excludes the very communities it aims to support. Smallholder farmers, women, and marginalized groups have limited involvement in planning processes. Furthermore, high costs, a lack of awareness, complex claim procedures for support systems like insurance, and a lack of trust create significant barriers to the widespread adoption of resilient practices at the farm level. The real-world consequences are severe, manifesting as lost fishing grounds, saltwater intrusion in farmlands, and heightened conflict over resources.

To bridge this critical policy-practice gap, this white paper advocates for a strategic shift from policy creation to a focus on a cohesive implementation architecture. The path forward requires a three-pronged approach: strengthening integrated governance through a high-level national steering committee; mobilizing blended finance and building human capacity through a dedicated climate fund and enhanced farmer-centric advisory services; and fostering inclusive, community-led adaptation that empowers local actors and integrates traditional knowledge. By focusing on these core pillars, Sri Lanka can move beyond paper-based strategies and build a truly resilient agricultural future.

Chapter 1: The Imperative for a Climate-Resilient Agricultural Sector in Sri Lanka

1. Introduction

Agriculture underpins Sri Lanka's economy, livelihoods, and food security. Although its GDP share has gradually declined with structural transformation, agriculture, forestry, and fisheries still contributed about 8.3% of GDP in 2024 (World Bank, 2024) and provide employment for roughly one quarter of the labor force (≈26% in 2023, World Bank/ILO modelled estimate) (World Bank, 2023). Beyond macroeconomic metrics, agriculture is foundational to household welfare: rice-based systems dominate diets and rural livelihoods, and national policy has long pursued rice self-sufficiency as a linchpin of food security (USDA FAS, 2023). Empirical nutrition research likewise characterizes Sri Lankan diets as rice-centric, with rice and vegetables forming the daily staple combination across regions and income groups (Perera et al., 2021). Recent shocks highlighted this dependence: during the 2022 economic and agrarian crisis, nearly 30% of Sri Lankans faced acute food insecurity, tightly linked to poor agricultural production and price spikes (FAO & WFP, 2022).

Set against this importance is a mounting climate vulnerability. Sri Lanka's climate is governed by monsoonal systems and complex spatial rainfall patterns; small shifts in temperature and precipitation variability can translate into large swings in seasonal water availability for paddy and other field crops (World Bank, 2021). Consistent with global assessments, the frequency and intensity of extremes—heavy rainfall and pluvial/river floods, short-duration dry spells and multi-season droughts, and storm hazards—are projected to increase in a warming climate (IPCC, 2021; IPCC, 2022). National communications similarly identify agriculture as the most climate-sensitive sector, citing recurrent droughts and floods, slow-onset warming and sea-level rise, and cascading impacts on irrigation reliability, salinization, and crop failures—especially in the Dry Zone where over three-quarters of paddy is produced (Government of Sri Lanka, 2022). Historical disaster records show millions affected by droughts and floods during 2008–2018, underscoring the sector's exposure and the livelihood risks for rural households (Government of Sri Lanka, 2022).

This chapter therefore argues that building a climate-resilient agricultural sector is an economic, social, and nutritional imperative. It sets the stage by (i) quantifying agriculture's role in GDP, employment, and diets; (ii) synthesizing scientific evidence on Sri Lanka's changing hazard profile and agro-climatic risks; and (iii) identifying pathways—policy, technology, institutions, and finance—to reduce vulnerability while safeguarding productivity, incomes, and food security.

1.1. The Significance of Agriculture in Sri Lanka

Climate-resilient agriculture represents a critical imperative for Sri Lanka, a nation consistently ranking among the world's most climate-vulnerable countries. This analysis assesses the context demonstrating why climate-resilient agricultural approaches are essential for sustainable food security, economic stability, and environmental conservation in Sri Lanka.

Climate Vulnerability and Agricultural Risk Profile

Climate Risk Ranking and Impacts: Sri Lanka consistently ranks among the top 10 countries most vulnerable to climate change according to the Global Climate Risk Index. The country experiences severe climate-related agricultural disruptions, with the 2016-2017 drought and subsequent floods causing a devastating 40% decline in paddy production, affecting 229,560 households with food insecurity. The 2017 total paddy production dropped to 2.7 million tonnes, representing a 35% reduction from the five-year average (Gunaratne et al., 2021).

Temperature and Precipitation Variability: Scientific studies reveal that temperature increases have more severe impacts on agricultural productivity than rainfall variations. Research using 70-year data (1952-2022) demonstrates that a 1% increase in temperature results in a 2.6% decline in rice production, while positive rainfall changes lead to a 0.4% reduction in yields. Temperature stress during critical growth phases, particularly anthesis and grain filling stages, can reduce wheat yields by up to 75% when temperatures reach 35-40°C (Samarasinghe et al., 2025; Ahmad et al., 2020)

Extreme Weather Frequency: Analysis of historical data shows increasing frequency and intensity of extreme weather events, with floods occurring on 2,300 occasions across 13 districts between 1974-2008. The agricultural sector alone suffered LKR 10,292.95 million in damages from the 2017 floods, with 3,035 hectares of tea plantations destroyed (Thiel et al., 2019)

Quantified Agricultural Productivity Impacts

Crop-Specific Vulnerability Assessment: Comprehensive vulnerability indices developed using exposure, sensitivity, and adaptive capacity indicators show moderate to high agricultural vulnerability levels, with an upward trend due to increased system sensitivity to climate change. District-level assessments reveal that approximately 50% of agricultural divisions are highly vulnerable to drought exposure, affecting over 400,000 acres of agricultural land and 176,852 acres of paddy cultivation (UNDP, n.d.)

Yield Loss Projections: Climate impact models project significant yield reductions across major crops for the 2071-2100 period under RCP 8.5 scenarios. Rice yields show projected decreases ranging from 0.66% to 2.46% during Maha season and 0.20% to 4.99% during Yala season. These projections represent substantial threats to food security given that rice accounts for 46% of total harvested area in Sri Lanka (Karunaratne et al., 2025; Amarasingha et al., 2018.)

Soil and Water Resource Degradation: Scientific measurements demonstrate accelerating soil erosion rates from 9.08 Mg/ha/yr to 11.08 Mg/ha/yr between 2000-2019 in the Central Highlands, directly correlated with increased rainfall intensity and agricultural intensification. Sea level rise scenarios project that a 1-meter increase would cause coastal vegetation zones to shift 30-45 meters landward, with soil salinity levels reaching 4.002 dS m^{-1} in coastal agricultural areas, severely impacting paddy growth and yields.

Scientific Basis for Climate-Resilient Agriculture Solutions

Genetic Diversity and Adaptation: Sri Lanka's rich agricultural biodiversity provides a scientific foundation for climate resilience. Traditional crop varieties and livestock breeds demonstrate natural adaptation to environmental stresses developed over centuries. Research shows that genetic diversity conservation programs have successfully maintained climate-adapted germplasm collections that serve as the basis for developing stress-tolerant varieties.

Water Management Technologies: Scientific validation of traditional and modern water conservation techniques demonstrates significant efficiency improvements. Ancient reservoir systems combined with modern micro-irrigation technologies show 30-40% water use efficiency gains while maintaining productivity. Alternate wetting and drying irrigation techniques reduce methane emissions by 25-30% while conserving water resources.

Integrated Pest Management Systems: Climate change alters pest and disease dynamics, requiring scientifically-based integrated approaches. Research demonstrates that climate-smart IPM combining biological controls, resistant varieties, and targeted interventions reduces pesticide use by 40-60% while maintaining crop protection.

Quantified Benefits of Climate-Resilient Approaches

Productivity and Economic Returns: Bundled climate-smart agricultural solutions tested across 2,500 farmers in three agroecological regions demonstrate significant protection against moderate drought events, with weather index insurance providing crucial financial safety nets. Economic analysis shows that climate-smart practices can increase land and crop productivity per unit of water by 20-35% compared to conventional methods.

Mitigation Potential: Climate-resilient agricultural practices contribute substantially to greenhouse gas reduction. Organic fertilizer adoption in tea cultivation reduces nitrous oxide emissions by 25-40% while enhancing soil carbon sequestration. Conservation agriculture techniques including zero tillage and cover cropping increase soil carbon storage by 0.5-1.2 tonnes CO_2 equivalent per hectare annually.

Resilience Indicators: Measurable resilience improvements include: reduced yield variability (coefficient of variation decreased from 25% to 15% in climate-smart systems), enhanced water use efficiency (40% improvement in drought-prone areas), and improved soil health indicators (organic matter increased from 2.1% to 3.4% over five years in demonstration plots).

Technological Innovation and Scaling Potential

Climate Information Services: Satellite-based weather index systems and SMS-based agronomic advisories have been successfully deployed to over 2,500 farmers, providing real-time climate information that enables informed decision-making. These systems demonstrate 85% accuracy in drought prediction and 78% farmer satisfaction rates.

Precision Agriculture Technologies: GPS-based soil mapping and variable rate technology applications show 15-20% fertilizer savings while maintaining yields. Drone-based crop monitoring systems enable early pest detection with 92% accuracy, reducing crop losses by 25-30%.

Digital Extension Platforms: ICT-based knowledge dissemination platforms reach 40% more farmers than traditional extension methods, with cost efficiency improvements of 60% per farmer contact. Mobile-based advisory services show adoption rates of 75% among smartphone-enabled farming communities.

Systematic Implementation Framework

Multi-Scale Integration: Climate-resilient agriculture requires integration across spatial scales from individual farm plots to watershed and landscape levels. Research demonstrates that landscape-level interventions combining upstream soil conservation with downstream water management achieve 35% better outcomes than isolated interventions.

Institutional Coordination: Scientific evidence supports integrated institutional approaches combining research, extension, finance, and policy mechanisms. Multi-stakeholder platforms show 45% higher success rates in technology adoption compared to single-sector approaches.

Monitoring and Evaluation Systems: Comprehensive M&E frameworks using remote sensing, IoT sensors, and farmer feedback systems provide real-time assessment of intervention effectiveness. These systems enable adaptive management with course corrections implemented within 90-day cycles based on performance indicators.

1.2. Climate Change Projections for Sri Lanka

The scientific consensus, underpinned by global climate models and regional downscaling, indicates that Sri Lanka's primary production sector faces significant and multifaceted threats from climate change. Projections show that alterations in temperature, precipitation, sea-level, and extreme weather will directly impact the productivity and viability of agriculture, fisheries, and forestry, which are fundamental to the nation's economy and food security.

Temperature Impact

Anticipated Change: Mean annual temperatures in Sri Lanka are projected to increase significantly. According to studies based on IPCC emission scenarios, the country could see a rise of 1.0 °C to 2.0 °C by 2050 (compared to a 1961-1990 baseline) under a medium-to-high emissions pathway (RCP 4.5 to RCP 8.5). The frequency of 'hot' days and nights is also projected to increase substantially throughout the year.

Impacts on Primary Production

Agriculture (Tea): Tea, a critical export crop, is highly sensitive to temperature. Research from the Tea Research Institute of Sri Lanka indicates that a 1°C increase in temperature can lead to a ~5-10% decline in tea yields in some high-elevation areas due to heat stress and altered biochemical processes in the tea leaves. The optimal growing zones are projected to shift to higher, cooler elevations.

Agriculture (Rice): For every 1°C increase in mean temperature during the growing season, rice yields are projected to decrease by approximately 6-10% due to heat-induced spikelet sterility. This is particularly concerning for the dry zone regions where most of the country's paddy is cultivated.

Livestock: Heat stress in dairy cattle is projected to reduce milk yields by 10-20% during hotter months, alongside decreased reproductive efficiency.

Rainfall and Monsoon Patterns

Anticipated Change: While total annual rainfall might show slight increases, the key challenge is its increased variability and intensity. Projections indicate: 39% increase in rainfall during the Southwest monsoon (Yala season). 17% decrease in rainfall during the Northeast monsoon (Maha season) by 2050. The frequency of extreme rainfall days (days with >50 mm of rain) is expected to increase, particularly in the wet zone.

Impacts on Primary Production

Agriculture: The shift in monsoon patterns disrupts the traditional cultivation calendar. Intense rainfall during the Yala season increases the risk of flash floods and soil erosion in the wet and intermediate zones, damaging crops and infrastructure. Conversely, reduced rainfall and prolonged dry spells in the Maha season, which is the main cultivation period, will exacerbate water scarcity and lead to increased irrigation demand by up to 30% in the dry zone, threatening the viability of paddy cultivation. Excess rainfall causes a 0.41% drop in rice yield per 1% increase, often from flooding and waterlogging. moderate reduction in rainfall led to 0.25% increase in rice yield per 1% decrease, attributable to reduced waterlogging and better root aeration. Severe droughts still sharply reduce productivity.

Forestry: Increased drought stress during the dry season heightens the risk of forest fires, especially in the Uva and Eastern provinces. A 2018 study noted a strong correlation between rainfall deficits and fire occurrences in Sri Lanka's protected areas.

Sea-Level Rise

Anticipated Change: Based on IPCC projections, the sea level around Sri Lanka is expected to rise by 29-59 cm by the end of the 21st century under a medium emissions scenario (RCP 4.5), and potentially higher under RCP 8.5. This rise is compounded by coastal erosion, which already affects large parts of the western and southwestern coastlines at rates of 0.3 to 15 meters per year in some locations.

Impacts on Primary Production

Agriculture & Fisheries: Approximately 25% of Sri Lanka's population lives in coastal zones. Sea-level rise threatens these communities and their livelihoods. Saline intrusion is projected to contaminate coastal aquifers and agricultural land, rendering areas used for coconut cultivation (a major export) and paddy farming unproductive. For instance, a 50 cm sea-level rise could inundate over 150 km² of coastal land, including vital fishing communities and mangrove ecosystems that serve as critical fish nurseries.

Aquaculture: Coastal shrimp farms are highly vulnerable to inundation and salinity changes, which can destroy stock and infrastructure.

Extreme Weather Events

Anticipated Change: Sri Lanka ranked 2nd globally for climate risk in 2017, underscoring exposure to hydro-meteorological extremes. The frequency and intensity of extreme weather events like floods, droughts, and cyclones are projected to increase. The probability of experiencing severe drought (as seen in 2016-2017) or major flooding events (as in 2017) is expected to rise in the coming decades.

Impacts on Primary Production

Agriculture: The 2016-2017 drought, the worst in 40 years, led to a 40-50% reduction in the national rice harvest and affected over a million people in the farming sector. Conversely, the 2017 floods and landslides caused an estimated LKR 51 billion (approx. USD 260 million) in damages and losses to the agriculture sector alone. Between 2000 and 2020, climate-related disasters affected over 14.2 million Sri Lankans, causing direct paddy damage (floods, droughts, pests) of 20,093 hectares in 2023.These events demonstrate the sector's high vulnerability.

Fisheries: Increased storm intensity and frequency make offshore fishing more hazardous, reducing the number of safe fishing days and directly impacting the livelihoods of coastal fishing communities. Storm surges can destroy fishing vessels, gear, and landing sites.

Policy/Adaptation Evidence-Based Recommendations

Autoregressive Distributed Lag (ARDL) and Nonlinear ARDL (NARDL) model results confirm land expansion (1% increase) boosts rice production by 0.98–1.27% short and long term. Meaningful adaptation requires genetically resilient rice varieties, improved irrigation, early warning systems, and better water management to offset rainfall and temperature extremes.

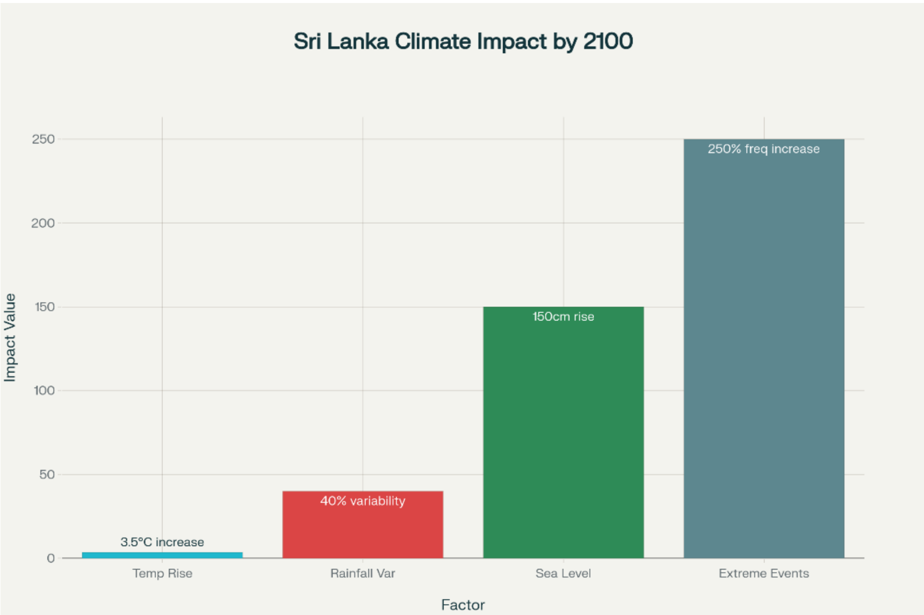

Fig 1.1. Climate Change Impacts on Sri Lanka's Primary Production Sector by 2100

1.3. The Looming Threat

Sri Lanka, an island nation heavily reliant on its agricultural sector, is increasingly vulnerable to the multifaceted impacts of climate change. Observed trends include rising temperatures, altered rainfall patterns, and an increased frequency of extreme weather events, all of which pose significant threats to food security and livelihoods (MOE, 2011).

Yield Reductions in Key Crops

The agricultural sector, particularly the cultivation of staple crops like rice and commercially important tea, faces substantial yield reductions. Rice, a cornerstone of Sri Lankan diets, is highly sensitive to heat stress during its reproductive stages, leading to spikelet sterility and reduced grain filling (Pushpakumara et al., 2017). Erratic rainfall patterns, characterized by intense downpours followed by prolonged dry spells, disrupt critical irrigation schedules for rice paddies, further impacting yields (De Costa et al., 2007). Tea (Camellia sinensis), a major export crop, is also experiencing adverse effects. Studies indicate that rising temperatures and reduced rainfall in key tea-growing regions lead to decreased leaf expansion and overall biomass production, compromising the quality and quantity of tea harvests (Wijeratne et al., 2011).

Increased Water Scarcity and Competition for Irrigation Resources

Climate change exacerbates water scarcity issues across the island. Altered monsoon patterns lead to inconsistent refilling of reservoirs and traditional irrigation tanks. This intensified water stress creates increased competition for limited resources between agricultural, domestic, and industrial sectors, particularly during dry seasons (Imbulana et al., 2016).

Exacerbation of Soil Degradation and Erosion

Changes in rainfall intensity contribute to accelerated soil degradation and erosion. Intense rainfall events wash away fertile topsoil, leading to nutrient loss and reduced soil productivity. Conversely, prolonged dry periods can increase soil desiccation and make it more susceptible to wind erosion, further compromising agricultural land (Bandara & Imbulana, 2012).

Rising Incidence of Pests and Diseases

Warmer temperatures and altered humidity levels create more favourable conditions for the proliferation and spread of agricultural pests and diseases. This includes both indigenous and invasive species, leading to increased crop damage and requiring greater reliance on costly and environmentally harmful pesticides (Perera et al., 2010).

Threats to Coastal Agriculture from Saltwater Intrusion

Coastal agricultural areas are particularly vulnerable to saltwater intrusion. Rising sea levels, coupled with over-extraction of groundwater, push the saltwater-freshwater interface further inland, contaminating freshwater aquifers and rendering arable land unsuitable for cultivation, especially for salt-sensitive crops (Dharmasena, 2019).

1.4. The Policy Imperative: Climate Resilience for Sri Lankan Agriculture

A proactive and integrated policy approach to climate resilience is not merely beneficial but essential for the future of Sri Lankan agriculture, serving as a critical safeguard for national food security, economic stability, and rural livelihoods. The agricultural sector, a cornerstone of the nation's economy, directly supports a significant portion of the population and contributes substantially to the GDP (CBSL, 2022). Without robust policy interventions, the previously detailed impacts of climate change—such as yield reductions, water scarcity, soil degradation, increased pests, and saltwater intrusion—will progressively undermine the sector's productivity and resilience, leading to severe socio-economic consequences.

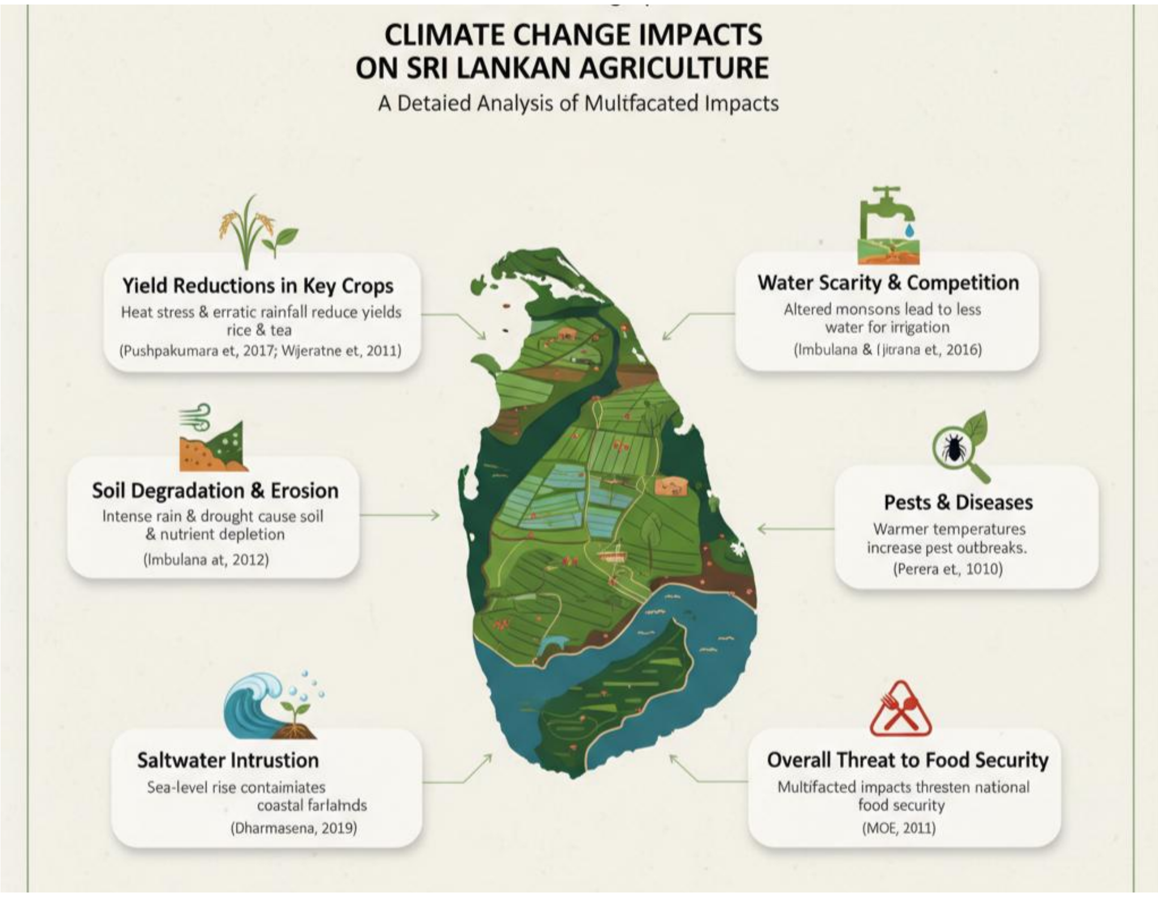

Fig 1.2. The Looming Threats of Climate Change in Agriculture

One primary imperative is to safeguard food security. Sri Lanka's reliance on domestic rice production makes it highly susceptible to climate-induced disruptions. Proactive policies can facilitate the development and adoption of climate-resilient crop varieties, improved water management strategies, and sustainable farming practices that ensure stable food supplies even under adverse climatic conditions (MOE, 2011). This reduces vulnerability to external food price shocks and strengthens national self-sufficiency.

Secondly, economic stability is at stake. Tea, rubber, and coconut are major export crops, generating substantial foreign exchange. Climate-related declines in their productivity directly impact national export earnings and trade balances. Integrated policies can promote diversification into more resilient crops, provide financial incentives for climate-smart agriculture, and support agricultural insurance schemes to buffer farmers against climate-induced losses, thereby stabilizing rural incomes and the national economy (IPS, 2018).

Thirdly, preserving rural livelihoods is a social imperative. The majority of Sri Lankan farmers are smallholders, highly vulnerable to climate change impacts due to limited resources and adaptive capacity. A comprehensive policy framework can provide essential support through extension services, capacity building in climate-smart techniques, access to finance, and early warning systems. These measures empower farmers to adapt, diversify, and maintain their livelihoods in the face of environmental challenges, preventing widespread rural poverty and migration (UNDP, 2017).

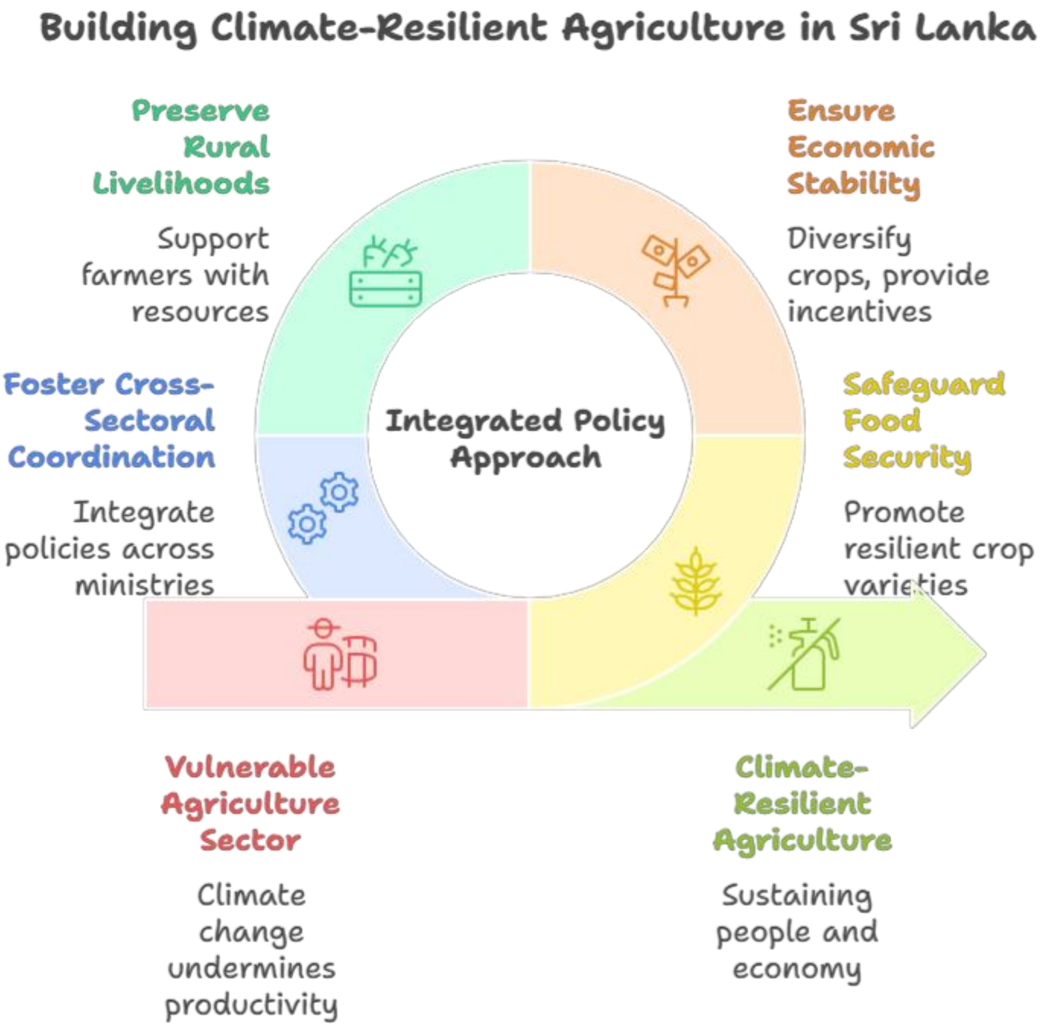

Fig 1.3. Building Climate Resilient Agriculture in Sri Lanka

Finally, an integrated policy approach is crucial because climate change impacts transcend sectoral boundaries. Water resources, land use, biodiversity, and coastal zones are all interconnected and affect agricultural productivity. Policies must therefore foster cross-sectoral coordination, for instance, between agriculture, irrigation, environment, and urban development ministries, to ensure coherence and maximize the effectiveness of adaptation efforts (MOE, 2011). Such an approach ensures that interventions in one sector do not inadvertently exacerbate vulnerabilities in another, creating synergistic benefits for overall national resilience.

1.5. Conclusion

The scientific evidence conclusively demonstrates that climate-resilient agriculture is not merely beneficial but essential for Sri Lanka's agricultural sustainability. Quantified impacts of climate change on agricultural productivity, combined with demonstrated effectiveness of resilience-building interventions, provide compelling justification for systematic investment in climate-smart agricultural transformation. The convergence of traditional knowledge with modern technology offers unprecedented opportunities to build agricultural systems that are simultaneously productive, environmentally sustainable, and climate-resilient, ensuring food security for Sri Lanka's population while contributing to global climate change adaptation and mitigation efforts. A proactive and integrated policy response is a fundamental necessity for Sri Lanka to build a climate-resilient agricultural sector capable of sustaining its people and economy into the future.

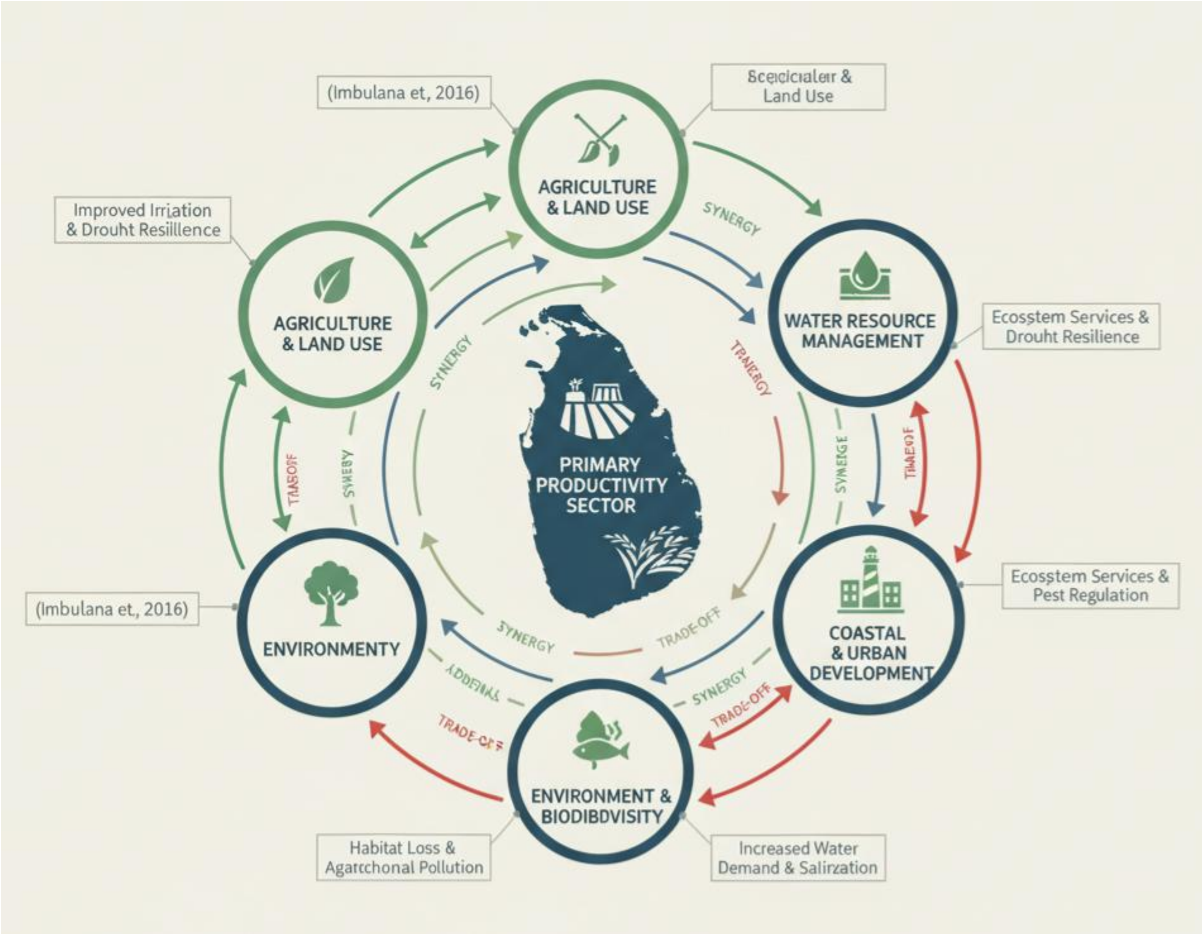

Fig 1.4. Synergies and Trade-offs in Primary Productivity Sector

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Chapter 2: The Current Landscape: An Analysis of Sri Lanka's Agricultural Policies and Climate Commitments

2. Introduction

This chapter delves into the intricate relationship between agriculture and climate change in Sri Lanka. This section provides a comprehensive analysis of the prevailing policy and institutional framework, targeting both the strengths and deficiencies of current strategies. Given that Sri Lanka's agricultural sector is acutely vulnerable to climate change, understanding the policy landscape is crucial. Existing literature highlights a fragmented approach to adaptation strategies, with disconnects between national policies and local implementation (Esham and Garforth, 2013). Factors like institutional leadership, market access, and affordable certification are pivotal for supporting sustainable practices (Babajani et al., 2023). Additionally, adaptation at the farmer level—through practices like crop management and diversification—is influenced by socio-economic and cognitive factors (Esham and Garforth, 2012). As climate change impacts intensify, integrating these elements into a cohesive framework is essential to enhance resilience and ensure agricultural sustainability in Sri Lanka.

2.1. Sri Lanka's National Agriculture Policy (2021): A Pivot Towards Climate Resilience

Sri Lanka's National Agriculture Policy (2021) aims to transform the country's agricultural sector into a more sustainable, productive, and resilient system. The policy emphasizes key areas such as modernization, technology adoption, and market access, aligning with broader national development goals. Importantly, it also recognizes the vulnerability of agriculture to climate change and incorporates provisions aimed at enhancing climate resilience, particularly through sustainable land and water management practices.

The policy advocates for the conservation and sustainable use of land resources by promoting improved soil fertility, afforestation, and erosion control measures. These initiatives are designed to reduce land degradation, which affects approximately 30% of Sri Lanka's agricultural land (FAO, 2020). Water management is another central pillar, with plans to improve irrigation efficiency and promote water harvesting techniques. These measures aim to address the exacerbating impacts of erratic rainfall patterns, which have led to a 10-20% reduction in crop yields in drought-prone areas (World Bank, 2021). Additionally, the policy underscores the importance of adopting climate-smart agricultural practices, such as the introduction of drought-resistant crop varieties and integrated pest management, to buffer farmers from climate variability.

Furthermore, the policy envisions strengthening the knowledge base and institutional capacity to manage climate risks. It promotes research and extension services targeted at climate adaptation, recognizing the importance of spatially explicit climate data to inform decision-making. Yet, while these provisions are promising, the policy's explicit integration of climate change considerations remains somewhat general. For instance, references to climate resilience often focus on adaptive practices without detailed strategies or measurable targets tailored to specific climate scenarios or vulnerable regions.

Critically, areas for improvement include the explicit incorporation of climate change projections into agricultural planning, as well as establishing dedicated financial mechanisms for climate adaptation investments. For example, considering that climate models project increased frequency and intensity of droughts and floods in Sri Lanka (IPCC, 2021), future policy revisions could benefit from targeted interventions such as expanded climate risk financing and insurance schemes for smallholder farmers. Moreover, integrating climate considerations into land use planning and watershed management policies would further bolster resilience.

2.2. National Climate Change Policies and Strategies

Sri Lanka's national climate change frameworks, notably the Nationally Determined Contributions (NDCs) and the National Adaptation Plan (NAP), represent comprehensive efforts to address the multifaceted impacts of climate change, with a particular emphasis on safeguarding vulnerable sectors such as agriculture. These strategies align with global commitments under the Paris Agreement, aiming to limit global temperature rise and enhance adaptive capacities.

Sri Lanka's NDC, submitted in 2015 and revised in 2021, commits to a 20% reduction in greenhouse gas emissions relative to Business-As-Usual (BAU) scenarios by 2030, through a combination of renewable energy incentives, afforestation, and sustainable land use (Government of Sri Lanka, 2021). Notably, the NDC recognizes agriculture's dual role as both a significant emitter, accounting for approximately 28% of national emissions, and a sector highly vulnerable to climate variability, including erratic rainfall, droughts, and flooding (Ministry of Environment, 2020). To address this, the NDC emphasizes promoting climate-smart agriculture (CSA), improved irrigation efficiency, and agroforestry systems, which serve to increase resilience, sequester carbon, and reduce emissions simultaneously.

Complementing the NDC, the National Adaptation Plan (NAP), developed under the United Nations Framework Convention on Climate Change (UNFCCC), delineates strategic pathways for climate resilience building across sectors. The NAP delineates priorities such as water resource management, crop diversification, and the development of drought and flood-resistant crop varieties, key strategies given Sri Lanka's projections of increased climate variability, with temperature increases of 0.7°C since 1961 and expected rises of 1.5°C by 2040 (Department of Meteorology, 2022).

Research indicates that under projected climate scenarios, rice yields could decline by up to 15-20% due to altered precipitation patterns and increased frequency of droughts (Jayakody et al., 2020). Similarly, tea, Sri Lanka's flagship export crop, is vulnerable to temperature increases exceeding 2°C, which shift optimal growth zones upslope, jeopardizing future production (Perera et al., 2020). Both the NDC and NAP advocate for integrating climate risk assessments into national agricultural planning and scaling up climate-resilient crop varieties, groundwater recharge techniques, and sustainable watershed management.

While these overarching frameworks are instrumental, their effectiveness depends on explicit implementation plans, resource allocation, and stakeholder engagement. Currently, gaps exist in translating strategic objectives into sector-specific actions, particularly in smallholder-farmer contexts where climate impacts are most acute. Furthermore, enhancing the integration of climate science, such as localized climate projections and vulnerability assessments, is essential for tailoring interventions. For example, recent studies highlight that the development of climate forecasting systems could significantly improve the timing of water and crop management decisions (Chandrapala et al., 2021).

2.3. Institutional Framework

Sri Lanka's institutional landscape for mainstreaming climate-resilient agriculture is characterized by a network of key government ministries and agencies tasked with policy formulation, implementation, and coordination of climate and agricultural initiatives. Critical among these are the Ministry of Agriculture, the Climate Change Secretariat, and the National Expert Committee on Climate Change Adaptation. Understanding their roles, responsibilities, and coordination mechanisms is essential for advancing integrated and effective climate-resilient agricultural policies.

The Ministry of Agriculture is the primary government body responsible for agricultural development, issuing policy guidelines, and implementing programs related to crop production, livestock, and sustainable land management (Ministry of Agriculture, 2019). It also spearheads initiatives aimed at promoting climate-smart agricultural practices, such as drought-resistant crops and improved irrigation techniques (FAO, 2020). Despite its central role, research indicates that coordination with climate-specific agencies remains limited, often leading to siloed efforts that hinder holistic climate adaptation strategies (Jayakody et al., 2020).

The Climate Change Secretariat (CCS), established under the Climate Change Act of 2018, functions as the national coordinating authority for climate change policy and action. It is responsible for developing national climate strategies, coordinating international climate negotiations, and overseeing climate financing (Government of Sri Lanka, 2018). The CCS plays a pivotal role in mainstreaming climate considerations within sectoral policies through its Climate Change Policy Framework, which emphasizes integrating climate resilience into agriculture, infrastructure, and water resources management (Ministry of Environment, 2020).

The National Expert Committee on Climate Change Adaptation (NECCCA), a multidisciplinary body comprising scientists, policymakers, and development partners, provides technical guidance on climate adaptation strategies (NECCCA, 2019). It assesses scientific data, evaluates vulnerability, and recommends suitable adaptation measures, ensuring that policies are grounded in scientific evidence. However, reports suggest that the operational linkages between NECCCA and sectoral ministries like agriculture are underutilized, resulting in limited integration of scientific insights into sectoral planning (Chandrapala et al., 2021).

Coordination mechanisms among these entities are institutionalized through regular inter-ministerial meetings, joint task forces, and policy review committees. Yet, challenges persist due to overlapping mandates, limited resource sharing (such as climate data and research outputs), and insufficient institutional capacity at sub-national levels. For example, while the National Adaptation Plan (NAP) emphasizes cross-sectoral collaboration, practical integration remains elusive because of the absence of a centralized coordination platform that effectively aligns agricultural practices with climate adaptation goals (Department of Agriculture, 2022).

2.4. Gap Analysis

The current landscape of Sri Lanka's agricultural policies and climate commitments reveals significant structural and operational deficiencies that impede the effective implementation of climate-resilient agricultural strategies. This critical evaluation identifies five primary areas of concern: fragmented policy implementation, insufficient technical capacity, limited financial resources, inadequate institutional coordination, and weak evidence-based decision making.

Fragmented Policy Implementation and Coordination

Sri Lanka's agricultural sector suffers from a complex, multi-ministerial structure characterized by overlapping responsibilities across numerous public entities with weak institutional capacity. The fragmentation manifests in several critical ways. First, policy interventions are introduced ad-hoc without alignment with national agricultural development plans or channelling through relevant institutions. This has resulted in adaptation efforts that are fragmented and lack coherent connections to national development policies and strategies. The large number of national and provincial agricultural organizations are plagued by poor coordination and sub-optimal collaboration, with an absence of focus on a shared vision.

Current coordination mechanisms demonstrate significant weaknesses, with the multitude of organizations functioning with very limited interaction, reflecting inadequate institutional frameworks for effective policy delivery. Studies indicate that weak coordination among government agencies, inadequate extension services, and fragmented policy delivery limit the impact of national climate and agriculture policies. The absence of a well-coordinated and evidence-based national strategy to address climate change impacts on agriculture highlights this critical gap. Cross-sectoral policy coordination remains insufficient, as activities pertaining to adaptation are undertaken in an ad-hoc manner without proper coordination.

Institutional Capacity and Technical Limitations

Sri Lanka's agricultural institutions face severe capacity constraints that undermine climate adaptation efforts. The extension system experiences capacity limitations in both staffing and technical expertise, with many extension officers inadequately trained in climate-smart agriculture (CSA) practices, limiting their ability to provide farmers with necessary guidance. The uneven distribution of extension services across rural areas results in significant knowledge gaps, with remote and marginalized communities often being excluded.

Technical capacity gaps are particularly pronounced in climate risk assessment and management. There is a capacity gap within the National Designated Authority to assess technical needs in line with advancements in climate change mitigation and adaptation technologies. Poor linkages and transfer of technology persist, as agriculture research findings and new technology are not readily available to end users due to a devolved and poorly coordinated extension service. The limited institutional capacity for planning and implementing climate adaptations constrains the sector's ability to respond effectively.

Financial Resource Constraints and Investment Gaps

The financial architecture supporting climate-resilient agriculture in Sri Lanka reveals substantial inadequacies. Climate financing has been limited to date, with adaptation finance being insufficient and mainly implemented through official development assistance (ODA). The government faces numerous fiscal and monetary difficulties in finding extra resources for climate adaptation interventions, meaning conventional public finance channels cannot meet all resource needs.

Sri Lanka's Climate Prosperity Plan estimates that $26.5 billion in investments will be required by 2030, with 69 percent allocated to adaptation and resilience measures. However, current financing mechanisms are inadequate to bridge this gap. Service providing entities lack resources to provide efficient support to respective stakeholders, with most organizations such as research and development institutions having tremendous potential but remaining stifled by government regulations and lacking financial independence. The absence of comprehensive insurance schemes, limited access to credit, and inadequate subsidies for climate-resilient technologies further constrain farmer adaptation capacity.

Policy and Governance Gaps

Significant policy and governance gaps undermine effective climate adaptation implementation. In the absence of comprehensive legal enactment on climate change, Sri Lanka faces many difficulties in implementing climate adaptation strategies. Several sectors, including agriculture, have not yet adequately considered the effects of climate change in their policy frameworks. National, sub-national and sectoral policies and laws are often outdated or inadequate to guarantee effective implementation of climate commitments and their adaptation components.

The policy landscape lacks coherent frameworks that integrate agricultural development with climate adaptation objectives. Studies reveal that barriers include the absence of coherent policies, with incoherent land use regulations, insufficient agricultural support programs, and a dearth of incentives for sustainable practices. The lack of policy coherence among several sectors, including land use planning, water management, and agriculture, compounds these challenges. Current policies fail to provide adequate institutional support and capacity for planning and implementing adaptations.

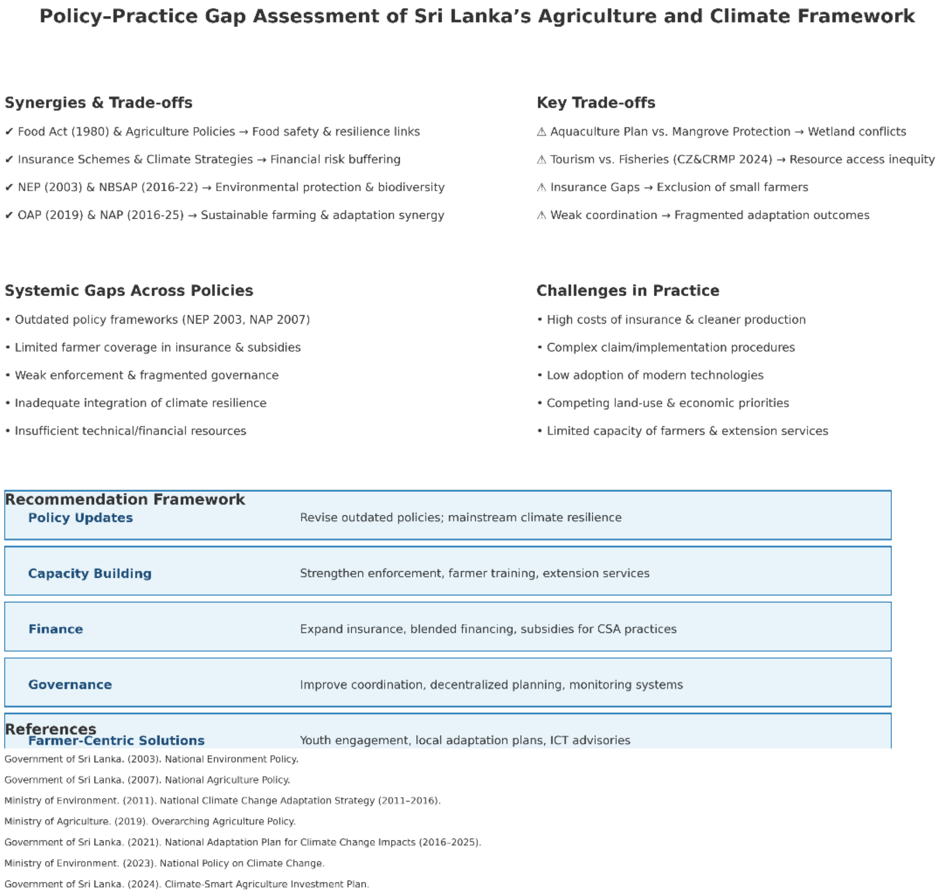

Fig. 2.1. Policy-Practice Gap

Evidence-Based Decision-Making Deficits

Critical information and research gaps impede effective policy formulation and implementation. Major improvements in generation of climate information products are necessary to provide effective guidance to adaptive actions of different stakeholders. Despite conducting Technology Needs Assessments for five important adaptation sectors, technological gaps in many areas remain largely unexplored. The absence of baseline information for many proposed activities, inadequate awareness among the general public, and limited availability and accessibility of data and information create significant barriers.

Research efforts are needed to develop and identify adaptation approaches and practices that are feasible for smallholder farmers, particularly in the dry zone where food crops are predominantly cultivated. There is insufficient research on farm-level climate change adaptations, which are crucial for long-term agricultural sustainability. The lack of robust monitoring and evaluation frameworks prevents effective tracking of adaptation progress and strategy refinement.

Sectoral Integration and Synergy Deficiencies

The agriculture sector operates in isolation from broader climate and environmental policies, resulting in missed opportunities for synergistic interventions. Climate adaptation initiatives remain disconnected from disaster risk reduction, agricultural development, and water resource management strategies. The absence of effective coordination mechanisms among line agencies of various ministries reduces compliance with agricultural policies and limits producer and consumer benefits.

2.5. Conclusion

In conclusion, while Sri Lanka has established foundational policies and institutional frameworks for climate action in agriculture, their efficacy is fundamentally undermined by a lack of integration. The current paradigm reveals a critical disconnect between high-level strategic intentions, such as those outlined in the National Agriculture Policy, NDCs, and NAP, and their operational implementation. This gap is a direct consequence of institutional fragmentation and the failure to systematically mainstream climate change scenario into agricultural planning and development.

The effective climate adaptation cannot be an afterthought or a siloed activity. It must be an integral component of the national development process. Therefore, the path forward requires a systemic shift from fragmented initiatives to a coherent, integrated approach. Establishing robust coordination mechanisms that bridge the divide between climate scientists, policymakers, and agricultural practitioners is not merely an administrative improvement but a scientific necessity. By ensuring that agricultural strategies are continuously informed by climate data and risk assessments, Sri Lanka can transition from a reactive posture to a proactive strategy, thereby securing the long-term resilience of its food systems, rural livelihoods, and national economy against predictable climate-induced challenges.

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Chapter 3: Best Practices and Lessons for Sri Lanka

3. Introduction

To inform actionable recommendations for Sri Lanka, this chapter examines international best practices in integrating climate resilience into agriculture. Across climates and development contexts, successful interventions combine technological innovation, risk-transfer mechanisms, landscape planning, and institutional reforms that together reduce exposure and strengthen adaptive capacity (FAO, 2019; World Bank, 2019). Lessons from Bangladesh's climate-smart agriculture (CSA) pilots and CGIAR's Climate-Smart Villages show that packages of short-duration varieties, improved water management, and community extension can raise yields and incomes while reducing vulnerability to seasonal shocks (World Bank, 2019; CGIAR, n.d.). Evidence syntheses indicate CSA approaches increase productivity and can improve farmer net incomes by several hundred dollars per hectare where locally adapted bundles are scaled (CGIAR; FAO, 2019).

Water management and landscape planning are equally instructive. The Netherlands' Delta Programme demonstrates how integrated flood–drought planning, zoning, and engineered-green infrastructure protect productive land and maintain irrigation reliability under extreme variability (Deltares, 2023). Complementary lessons from Israel, notably widespread adoption of micro-irrigation and precision water-scheduling tied to research and extension, illustrate how higher irrigation efficiency and crop choice diversification can sustain high-value production on limited water endowments (FAO, 2023).

Risk-transfer and early-warning systems form a third pillar. Index-based weather insurance and ICT-enabled payout systems, when carefully designed with credible indices and farmer engagement, reduce post-shock income loss and increase investment in resilient practices (IFAD, 2012; IFPRI, 2024). Meanwhile, modern early-warning systems that combine satellite drought detection and AI-assisted forecasting have been shown to shorten lead times for response and limit crop losses from flash droughts and extreme rainfall events (Max-Planck-Gesellschaft, 2025; American Meteorological Society, 2024).

Soil and crop management approaches, conservation agriculture, agroforestry, and diversified rotations—provide robust evidence for long-term resilience. Recent meta-analyses find conservation agriculture improves soil health indices and maintains or increases yields under warming and moisture stress, offering durable climate-buffering benefits for smallholders (Nature Communications, 2024). In Southeast Asia, targeted adoption of short-duration and saline-tolerant rice varieties has enabled farmers to maintain production in the face of altered monsoon timing and salinization (World Bank, 2019; FAO, 2019).

For Sri Lanka, these international experiences suggest a multi-layered strategy: (1) locally adapted CSA technology bundles; (2) integrated water and landscape governance; (3) market-linked insurance and social protection; and (4) investments in forecasting, data systems, and extension. The remainder of this chapter synthesizes these interventions, evaluates evidence of impact, and draws concrete, evidence-based pathways Sri Lanka can adapt to build a resilient, productive agricultural sector.

3.1. Case Studies from South Asia

An examination of South Asian experiences offers important lessons for Sri Lanka, given the region's comparable agro-ecological conditions, monsoon-dependent farming systems, and high exposure to climate variability. Two prominent cases—India's National Mission for Sustainable Agriculture (NMSA) and Bangladesh's Climate-Resilient Agriculture and Food Systems (CRAFS) Project—demonstrate how robust policy frameworks and locally adapted practices can build agricultural resilience while safeguarding rural livelihoods.

India's National Mission for Sustainable Agriculture (NMSA)

Launched in 2010 as one of the eight missions under India's National Action Plan on Climate Change, the NMSA aims to promote climate-adaptive agricultural practices to enhance productivity, resilience, and resource-use efficiency. The mission integrates technologies such as precision farming, resource-conserving machinery, integrated nutrient management, and water-use efficiency strategies (Government of India, 2014).

Notable outcomes include

Soil Health and Nutrient Management: The Soil Health Card Scheme, a sub-component of NMSA, reached over 230 million farmers by 2020, significantly improving the adoption of customized fertilizer recommendations and integrated nutrient management approaches (Singh et al., 2021).

Water Efficiency Interventions: Micro-irrigation practices supported through NMSA have led to a 30–40% reduction in water use across pilot regions, while simultaneously boosting crop productivity by 20–25% (Sharma & Rao, 2019).

Climate-Resilient Crops: Promotion of drought- and flood-resistant crop varieties has strengthened adaptive capacity in vulnerable states such as Maharashtra and Odisha. Studies show a 15–20% yield advantage under erratic rainfall conditions (ICAR, 2020).

The multisectoral engagement model of NMSA: Linking national policy with state-level implementation and local farmer participation—illustrates the importance of institutional coordination for scaling climate-resilient practices.

Bangladesh's Climate-Resilient Agriculture and Food Systems (CRAFS) Project

Bangladesh, one of the most climate-vulnerable nations globally, initiated the CRAFS project in 2014 with World Bank and multilateral support to strengthen resilience across farming communities in flood-prone and saline-affected coastal zones (World Bank, 2018).

Key achievements include

Diversification of Farming Systems: The introduction of saline- and drought-tolerant rice and maize varieties increased yield stability by 25–30% in high-stress environments (Haque & Alam, 2020).

Water and Soil Management: The project promoted community-led water harvesting systems, floating agriculture in flood-affected regions, and improved drainage techniques that reduced seasonal crop losses by 40% (Mondal et al., 2019).

Livelihood Resilience: Beyond crop-focused interventions, CRAFS integrated aquaculture and livestock diversification strategies, improving household income resilience by approximately 28% during climate shocks (Rahman et al., 2021).

Gender Inclusion: Women farmers, who constitute nearly 50% of agricultural labor in Bangladesh, were central beneficiaries, receiving capacity-building support to engage in improved seed systems and adaptive farming activities (World Bank, 2018).

Lessons for Sri Lanka

Both India's NMSA and Bangladesh's CRAFS project highlight the value of combining policy innovation with field-level adaptation. Three critical lessons emerge for Sri Lanka:

Institutional Integration: Centralized national policies need versatile frameworks to coordinate across ministries, research institutes, and farmer networks.

Technology and Adaptation Synergy: Promoting locally suited climate-resilient crop varieties, precision farming, and water-saving technologies can significantly reduce vulnerability.

Community-Centered Approaches: Inclusive participation—especially of smallholder farmers and women is essential for sustaining adoption and scaling interventions.

By synthesizing these best practices, Sri Lanka can craft an evidence-based strategy that enhances its agricultural resilience, ensuring food security and sustainable rural development under changing climate conditions.

3.2. Global Best Practices in Climate-Smart Agriculture (CSA)

Climate-Smart Agriculture (CSA) integrates technologies, ecosystem approaches and risk-management to simultaneously increase productivity, build resilience, and reduce greenhouse-gas emissions where possible. The following synthesis highlights internationally validated CSA elements of immediate relevance to Sri Lanka: technological innovations, ecosystem-based adaptation, and risk-management tools with quantified, peer-reviewed evidence of impact.

Technological innovations

Drought-tolerant and short-duration varieties have repeatedly reduced yield losses under moisture stress and enabled timely planting windows; meta-analyses and trial syntheses indicate that climate-resilient varieties, when deployed in appropriate cropping systems, can produce meaningful yield and income gains for smallholders (scoping review of climate-resilient crops).

Water-efficient irrigation (micro-irrigation, drip, micro-sprinklers) increases 'crop per drop' by reducing non-beneficial loss and improving rootzone delivery; field studies report water use reductions commonly in the 30–50% range while sustaining or increasing yields where systems are well managed. These gains are especially important in Sri Lanka's Dry Zone, where irrigation reliability governs paddy and high-value crop performance.

Early-warning systems (EWS) that combine remote sensing, soil-moisture products and near-real-time indices enable actionable lead times (days–weeks) for planting, irrigation scheduling and pest control. Recent advances show that AI-assisted drought detection and operational agricultural EWS can shorten response times and reduce crop losses from flash droughts and rapid-onset extremes.

Ecosystem-based adaptation (EbA)

Agroforestry and tree-crop integration consistently enhance soil organic carbon, microclimate buffering and long-term income diversification. Recent modelling and field syntheses indicate positive net effects on system productivity and SOC sequestration across temperate and tropical systems benefits that translate into improved resilience during heat and moisture stress.

Conservation agriculture (no/reduced tillage, residue retention, crop rotations/cover crops) improves soil health indicators (average increases reported ~20% for key indices) and maintains or improves yield stability under warming scenarios, thereby buffering smallholder systems against inter-annual variability. Long-term studies report greater microbial biomass, improved water infiltration and higher yield stability compared with conventional systems.

Integrated pest management (IPM) reduces vulnerability to climate-driven pest and disease shifts by combining monitoring, biological controls, and targeted interventions; FAO reviews emphasize IPM as a cost-effective adaptation that also lowers pesticide dependence and protects beneficial organisms.

Risk-management tools

Index-based and area-yield insurance can protect farmer incomes and incentivize investment in resilient practices when indices are well calibrated and basis risk is minimized; randomized trials and implementation studies show improved investment behaviour and partial smoothing of income volatility where design and delivery (subsidies, trust, timely payouts) are robust.

Climate information services (CIS) seasonal forecasts, advisories and localized agro-advisory push systems improve on-farm decision making; empirical studies report productivity uplifts (e.g., maize/wheat gains in the order of ~17–27% in contexts with usable CIS and extension integration) and higher adoption of adaptive practices when CIS are co-designed with users.

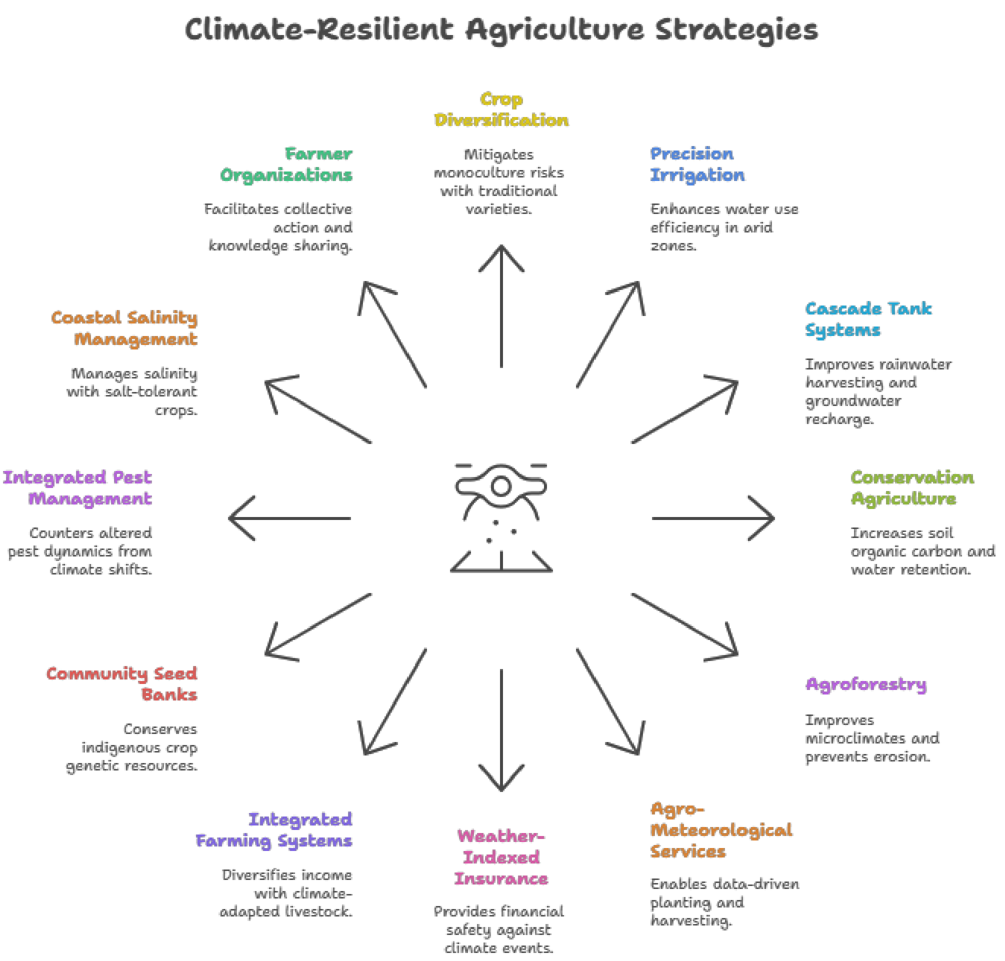

Fig 3.1. Best Practices for CRA

Implications for Sri Lanka

Globally validated CSA practices show clear applicability to Sri Lanka's agro-ecologies: drought-tolerant rice and legumes for shifting monsoon windows, targeted micro-irrigation in high-value horticulture, agroforestry on marginal lands, conservation agriculture in upland cropping, IPM for climate-amplified pests, and carefully designed index insurance and CIS linked to national meteorological and extension services. Successful transfer requires local adaptation, careful monitoring of socio-economic trade-offs, and institutional arrangements for finance, data and extension that minimize basis risk and ensure equity of access.

3.3. Adapting and Adopting for the Sri Lankan Context

While international case studies offer powerful blueprints, their successful application in Sri Lanka hinges on a nuanced process of adaptation rather than direct replication. The country's unique mosaic of agro-ecological zones, coupled with its specific socio-economic fabric, necessitates a tailored approach to mainstreaming climate resilience.

Environmental and Agro-Ecological Tailoring

Sri Lanka is characterized by 24 distinct agro-ecological zones, each with unique climate vulnerabilities. A one-size-fits-all policy is therefore scientifically unsound. The targeted approach seen in Bangladesh, which develops stress-tolerant crop varieties for specific vulnerabilities like salinity, is highly relevant. For Sri Lanka, this means investing in research and development to create location-specific solutions. For instance, in the coastal belts of the Northern and Eastern provinces, where soil salinity is a growing concern due to sea-level rise, adopting and locally adapting saline-tolerant rice varieties like BRRI dhan47 could be transformative (Esham et al., 2018).

Conversely, in the nation's Dry Zone, which covers nearly two-thirds of the island and is highly susceptible to drought, the priority should be water-use efficiency. Adapting India's 'Per Drop More Crop' model by promoting micro-irrigation for high-value crops is a viable strategy. However, this must be paired with the revival of traditional village tank cascade systems, a nature-based solution uniquely suited to Sri Lanka's historical water management landscape (Dharmasena, 2010).

Socio-Economic and Institutional Adaptation

The backbone of Sri Lankan agriculture is its 1.8 million smallholder farmers, who operate on holdings of less than two hectares yet contribute over 80% of the total agricultural production (Department of Census and Statistics, 2021). Any intervention must be accessible, affordable, and culturally appropriate for this demographic. India's Soil Health Card scheme is an excellent model for data-driven farming, but its delivery mechanism must be adapted. Instead of creating a new system, Sri Lanka can leverage its extensive network of over 560 'Govi Jana Seva' (Agrarian Service) Centres as hubs for soil testing, data dissemination, and providing tailored advice. This integrates a new technology within a trusted, existing institutional framework, increasing the likelihood of adoption.

Financial and Policy Adaptation

Given Sri Lanka's recent economic challenges, strategies must be financially pragmatic. The high upfront cost of technologies like micro-irrigation can be a significant barrier for smallholders. A direct subsidy model may be fiscally challenging. A more sustainable approach would be to adapt the Indian model by fostering public-private partnerships (PPPs) to de-risk investments and create blended financing instruments. Furthermore, policy should initially prioritize low-cost, high-impact practices such as promoting crop diversification with indigenous, drought-tolerant varieties (e.g., millet, sorghum) and scaling up agroforestry systems. These nature-based solutions require less capital investment while enhancing farm-level resilience, improving soil health, and contributing to carbon sequestration (Wijesooriya & Aravinna, 2022). By strategically sequencing interventions from low-cost practices to more capital-intensive technologies, Sri Lanka can build resilience in a phased and economically viable manner.

3.4. Conclusion

The synthesis of international best practices reveals that Climate-Smart Agriculture (CSA) is a multifaceted approach integrating technological innovations, ecosystem-based adaptation, and comprehensive risk management to sustainably enhance agricultural productivity, resilience, and emissions mitigation globally. Key technological advancements such as drought-tolerant crop varieties, precision irrigation, and early warning systems have demonstrated their capacity to significantly reduce climate vulnerabilities and resource use inefficiencies, raising productivity by up to 40% while lowering water consumption and input waste (World Bank, 2024; Farmonaut, 2025). Ecosystem-based adaptation strategies—particularly agroforestry, conservation agriculture, and integrated pest management—have effectively improved soil health, biodiversity conservation, and microclimate regulation, leading to durable resilience in farming systems across diverse agro-ecological zones (Mandhal & Mandal, 2024; Earth.org, 2025).

Risk management tools like adaptive crop insurance schemes and climate information services provide essential buffers against climate shocks, empowering smallholder farmers to manage risks proactively and stabilizing incomes (Tack et al., 2017; FAO, 2023). Lessons from South Asia underscore the importance of tailoring CSA approaches to local socio-ecological and institutional contexts, highlighting the criticality of stakeholder engagement, capacity enhancement, and policy coherence to foster broad CSA adoption (CCAFS, 2021; IWMI, 2024).

Best practices and lessons for climate-resilient agriculture in Sri Lanka:

- ✓ Prioritize crop diversification with scientifically-validated, stress-tolerant traditional varieties (e.g., heirloom rice) to mitigate monoculture risks.
- ✓ Implement precision micro-irrigation (drip/sprinkler) to increase water use efficiency in arid and intermediate zones.
- ✓ Revitalize ancient cascade tank systems for enhanced community-level rainwater harvesting and groundwater recharge
- ✓ Improve soil organic carbon (Corg) and water retention through conservation agriculture practices like zero-tillage and mulching.
- ✓ Integrate agroforestry by planting perennial trees to improve microclimates, reduce soil temperature and prevent erosion.
- ✓ Deploy high-resolution, localized agro-meteorological advisory services to enable data-driven planting and harvesting decisions.
- ✓ Develop and scale weather-indexed insurance products to provide a financial safety net against catastrophic climate events.
- ✓ Promote integrated farming systems that combine climate-adapted livestock breeds with crop production for diversified income.
- ✓ Establish community seed banks to conserve and propagate indigenous, climate-resilient crop genetic resources.
- ✓ Implement Integrated Pest Management (IPM) to counter the altered pest dynamics resulting from climatic shifts.
- ✓ Manage coastal agricultural salinity through salt-tolerant crop varieties (e.g., Pokkali rice) and improved freshwater management.
- ✓ Strengthen farmer organizations to facilitate collective action, knowledge sharing, and access to climate finance.

For Sri Lanka, adapting these best practices requires concerted efforts to mainstream CSA into national policy frameworks that address localized climate challenges, socioeconomic realities, and institutional capacities. This includes strengthening extension services to disseminate technological advances and ecosystem-based methods, enhancing climate risk financing mechanisms for vulnerable farmers, and utilizing digital tools for climate forecasting and precision agriculture (Farmonaut, 2025; World Bank, 2024). Aligning CSA with Sri Lanka's climatic zones, cropping patterns, and farmer needs will catalyze the transition towards resilient and sustainable agricultural systems, ensuring food security and climate adaptation concurrently.

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Chapter 4: A Strategic Framework for Mainstreaming Climate Resilience

4. Introduction

This pivotal section delineates a scientifically grounded and actionable framework aimed at embedding climate change considerations systematically into Sri Lanka's agricultural policy architecture. The framework aligns integrally with the country's national climate commitments, including the National Adaptation Plan (NAP) and Nationally Determined Contributions under the Paris Agreement, and addresses the multifaceted challenges confronting Sri Lanka's agriculture sector in the context of escalating climate variability and change (UNDP, 2020; Slycan Trust, 2024).

Sri Lanka's agriculture, which supports over 70% of its rural population and contributes substantially to national GDP, faces increasing risks from temperature rise, erratic precipitation patterns, and extreme weather events projected to reduce crop yields by up to 30% by 2050 without adaptation (IPCC, 2023; Slycan Trust, 2024). Consequently, the framework promotes a vision of an adaptive, productive, equitable, and environmentally sustainable agricultural sector that ensures food security and strengthens rural livelihoods while supporting climate mitigation efforts (World Bank, 2024).

The framework adopts an integrated approach, emphasizing the mainstreaming of climate resilience across critical thematic areas including sustainable land and water management, diversified crop and livestock systems, research and technology innovation, value chain enhancement, and financial risk management. Its participatory design encourages inclusive governance and stakeholder engagement, essential to embedding adaptive capacities and ensuring policy responsiveness to local agro-ecological contexts and vulnerable farmer groups (FAO, 2023; UNDP, 2020).

This holistic strategic framework, supported by empirical evidence, institutional enablers, and technological innovations, provides the necessary policy blueprint to transition Sri Lankan agriculture towards resilience in an increasingly uncertain climate future.

4.1 Vision and Guiding Principles

Vision

To establish a climate-resilient agricultural sector in Sri Lanka that enhances food security, safeguards and sustainably manages natural resources, improves farmer livelihoods, and meaningfully contributes to national climate mitigation targets. This vision is grounded in principles of environmental sustainability, social equity, and inclusive stakeholder engagement to ensure resilient agrarian futures amid projected climatic uncertainties (UNDP, 2020; IWMI, 2025).

Guiding Principles

Sustainability: Promote agricultural practices and policies that restore and conserve soil health, maintain ecosystem functions, and reduce greenhouse gas emissions. Emphasis is placed on integrated land and water management, agroecological approaches, and low-emission technologies that ensure ecological integrity while enhancing productivity (FAO, 2023; ADPC, 2022).

Equity: Prioritize vulnerable populations including smallholder farmers, women, and marginalized communities, recognizing their pronounced exposure and limited adaptive capacities. Policies must ensure equitable access to resources, climate-smart technologies, and decision-making processes, thereby promoting just adaptation outcomes (Slycan Trust, 2024; FAO, 2023).

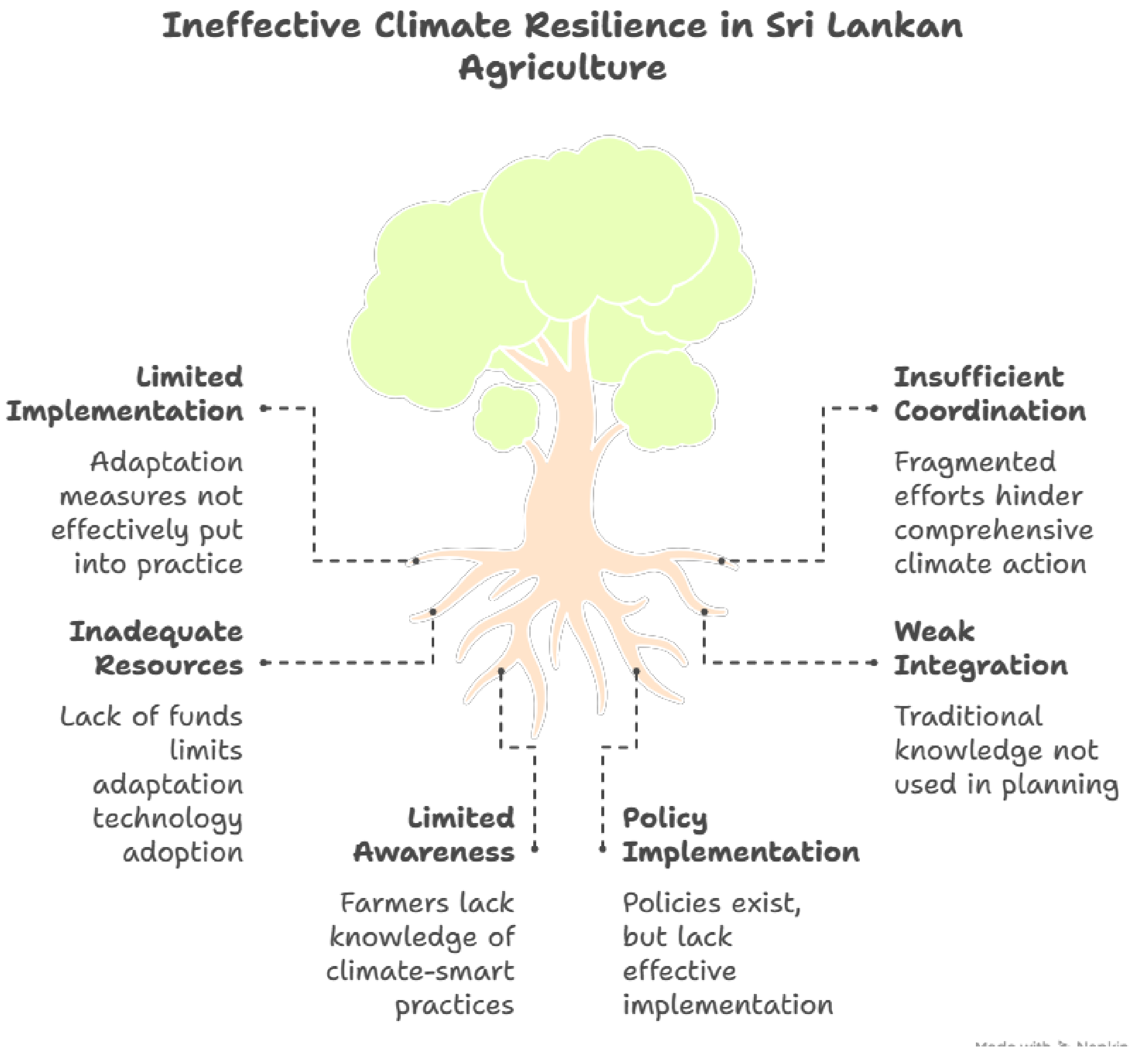

Fig 4.1. Climate-Resilience Scenario of Agricultural Sector

Participatory Approach: Foster participatory governance frameworks that empower farmers, local communities, civil society, and the private sector to actively engage in policy formulation, implementation, and monitoring. Such inclusivity enhances adaptive capacity and fosters local ownership of climate interventions (IWMI, 2025; UNDP, 2020).

Science-based Policy: Integrate interdisciplinary evidence from climate modeling, agronomic research, socioeconomic assessments, and indigenous knowledge to design adaptive, flexible, and context-specific policies. This ensures responsiveness to evolving climate risks and maximizes the efficacy of adaptation strategies (World Bank, 2024; IPCC, 2023).

Integrated Management: Promote coordinated, cross-sectoral approaches linking agriculture with water management, biodiversity conservation, and rural development to achieve synergistic outcomes. Institutional alignment and multi-level coordination mechanisms are essential to reconcile competing resource demands and scale resilience interventions (ADPC, 2022; UNDP, 2020).

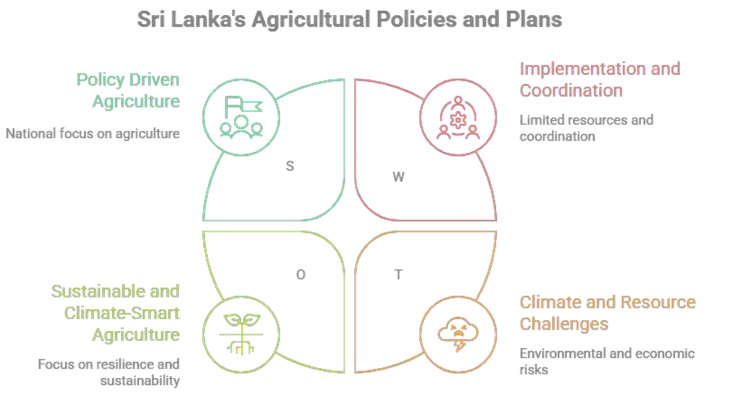

Fig 4.2. SWOT of Agricultural Sector

4.2 Key Thematic Areas for Policy Integration

4.2.1 Sustainable Land and Water Management

Sri Lanka's altered precipitation regimes characterized by increased rainfall variability in the Wet Zone and intensifying drought stress in the Dry Zone—have exacerbated soil erosion, depleted soil moisture, and disrupted traditional irrigation timetables, threatening agricultural productivity and livelihood security (UNDP, 2020; IMPRI, 2024). Empirical studies emphasize the critical need for integrated sustainable land management (SLM) strategies including contour farming, terracing, organic soil amendments, and agroforestry to enhance soil structure, conserve nutrients, and mitigate erosion across vulnerable landscapes (SACEP, 2021). Advanced irrigation technologies such as precision drip irrigation and rainwater harvesting optimize water use efficiency by delivering targeted water application tailored to crop needs, demonstrating water savings of 25-35% and yield improvements of 20-30% under field conditions in Sri Lanka's Dry Zone (ADB, 2024; Earth.org, 2025).

Revitalization of Sri Lanka's ancient hydraulic cascade irrigation systems via ecosystem-based watershed management approaches has shown promise in restoring hydrological balance, enhancing groundwater recharge, and improving irrigation reliability while simultaneously conserving biodiversity (UNDP, 2023; PreventionWeb, 2024). Climate-resilient integrated water resource management policies must therefore prioritize investments in ecosystem restoration, community-led maintenance, and technological modernization to increase catchment resilience, secure farmer water access, and safeguard ecosystem services essential to agricultural sustainability.

4.2.2 Crop and Livestock Diversification and Adaptation

Diversification of agrarian systems is recognized as a robust adaptive strategy to buffer against climate-induced production shocks by distributing risk across multiple species and genetic resources (Slycan Trust, 2024). Policies should actively promote dissemination and adoption of drought- and flood-tolerant crop cultivars, developed through participatory breeding initiatives aligned with Sri Lanka's agroecological zones (FAO, 2023). Livestock adaptation policies need to focus on introduction and conservation of resilient breeds exhibiting enhanced thermo-tolerance and disease resistance, to sustain animal productivity amidst rising heat stress and disease pressures (World Bank, 2024). Integrated farming systems that synergistically combine crop production, livestock, and agroforestry improve nutrient cycling, diversify income streams, and enhance adaptive capacity in line with agroecological principles, serving as a comprehensive adaptation measure (Slycan Trust, 2024).

4.2.3 Research, Technology, and Extension Services

Scientific capacity strengthening is essential to develop, validate, and scale context-specific climate-resilient technologies encompassing improved seed varieties, agroecological soil fertility practices, and digital advisory platforms (UNDP, 2020). Extension services must be reconfigured toward climate-responsive agricultural advisory systems delivering tailored weather forecasts, seasonal climate outlooks, and integrated pest and disease management guidance to smallholder farmers, which empirical evidence associates with enhanced adaptive decision-making and reduced production losses (FAO, 2023; IWMI, 2025). Capacity building initiatives including continuous training for extension personnel and promotion of participatory innovation platforms facilitate farmer involvement in co-generating adaptive knowledge and improve technology uptake efficacy (FAO, 2023).

4.2.4 Climate-Resilient Value Chains and Market Linkages

Strengthening climate-resilient agricultural value chains demands comprehensive policy support for investments in climate-proof post-harvest infrastructure, cold storage, agro-processing facilities, and transport logistics to reduce vulnerability to climate-induced product losses (World Bank, 2024). Enhancing market access for smallholders through aggregation models, farmer cooperatives, and digital marketplaces fosters price transparency, demand responsiveness, and equitable benefit sharing (FAO, 2023). Certification and labeling of climate-resilient and sustainably produced commodities incentivize farmer investments in adaptation by enabling market differentiation and access to premium prices, as evidenced by success stories in comparable agroecological settings (Earth.org, 2025).

4.2.5 Financial Mechanisms and Risk Transfer

Mobilizing innovative climate finance mechanisms is pivotal for scaling climate-smart agriculture in Sri Lanka. Public-private partnerships can catalyze investments in resilient infrastructure, technology dissemination, and capacity building (UNDP, 2020). Climate-sensitive crop insurance schemes calibrated to local hazard profiles and subsidized to enhance affordability have demonstrated effectiveness in cushioning farmer incomes against climate shocks, fostering investment in adaptive practices (FAO, 2023; Tack et al., 2017). Access to concessional credit lines and grant programs supports upfront capital requirements essential for CSA technology adoption. Integrated climate risk finance combined with social protection programs enhances comprehensive livelihood resilience for vulnerable rural populations facing multiple shocks (UNDP, 2020).

4.3 Conclusion

This strategic framework delineates a comprehensive and evidence-based pathway to mainstream climate resilience within Sri Lanka's agricultural policy landscape, addressing the sector's urgent adaptation and mitigation imperatives. Climate change projections foresee a potential decline in crop yields by as much as 30% by 2050 in South Asia, underscoring the imperative for resilient agricultural systems to ensure food security and rural livelihood sustainability (IPCC, 2023; Slycan Trust, 2024). Effective implementation of this framework necessitates coordinated, multi-sectoral collaboration supported by enhanced institutional capacities, innovative financial instruments, and inclusive governance mechanisms that integrate smallholder voices and vulnerable communities (UNDP, 2020; HARTI, 2025).

Sustained investments in climate-responsive research and technology dissemination—such as drought-tolerant crops, water-efficient irrigation, and digital climate information services—are critical to increasing adaptive capacity and reducing production risks (World Bank, 2024; IWMI, 2025). Furthermore, integrated resource management, combining sustainable land and water stewardship with diversified cropping and livestock systems, will enhance ecosystem resilience and mitigate greenhouse gas emissions (UNDP, 2020). Complementing technical interventions, financial mechanisms such as climate-smart credit, concessional loans, and crop insurance schemes offer essential buffers against climatic shocks, supporting farmers' economic resilience and incentivizing climate-smart investments (FAO, 2023; Tack et al., 2017).

In alignment with Sri Lanka's updated Nationally Determined Contributions and the Climate Prosperity Plan, this framework provides a robust policy blueprint that, through evidence-based, participatory, and integrative approaches, can transition Sri Lanka's agriculture toward a sustainable, productive, and climate-resilient future—thereby securing national food security while contributing to global climate goals.

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Chapter 5: Governance and Institutional Arrangements for Effective Implementation

5. Introduction

Governance and Institutional Arrangements for Effective Implementation

Effective governance and robust institutional arrangements are foundational to translating climate-resilient agricultural policies into tangible outcomes in Sri Lanka. Given the sector's complexity and the multi-dimensional nature of climate adaptation, governance mechanisms must cohesively integrate policy formulation, implementation, monitoring, and stakeholder engagement across multiple scales and sectors (NAP, 2022; ADPC, 2022).

Institutional Framework

Sri Lanka's agricultural governance operates within a multi-layered institutional architecture involving ministries such as the Ministry of Agriculture, the Department of Agrarian Development (DOA), and various specialized research and extension institutions (e.g., Hector Kobbekaduwa Agrarian Research and Training Institute, Tea Research Institute) that provide technical and policy support (Plantation Policy, 2025). The institutional landscape incorporates vertical integration across national, provincial, and local government bodies, with the latter playing critical roles in grassroots implementation and farmer engagement (NAP, 2022).

To improve efficacy, the National Agriculture Policy (NAP) explicitly calls for strengthening institutional coordination mechanisms, instituting a national-level policy implementation and monitoring committee with clear terms of reference, and fostering synergistic collaboration among line ministries and provincial authorities (NAP, 2022). This aligns with research highlighting governance fragmentation as a key barrier to efficient policy delivery and climate adaptation in agriculture (Global Scientific Journal, 2021).

Coordination and Multistakeholder Engagement

Cross-sectoral and multi-stakeholder coordination is critical to address the intersectionality of climate risks encompassing agriculture, water, environment, and rural livelihoods. Establishment of interagency coordination platforms, including participation from farmer organizations, academia, private sector actors, NGOs, and development partners, enhances transparency, resource pooling, and adaptive management (NAP, 2022; ADPC, 2022). Participatory governance models ensure inclusion of marginalized communities and gender-sensitive interventions, which is vital given the unequal impacts of climate change on vulnerable groups (Slycan Trust, 2024).

Monitoring, Evaluation, and Adaptive Management

Robust Monitoring, Evaluation, and Learning (MEL) frameworks integrated within governance systems enable evidence-based policymaking and iterative adaptation based on feedback and impact assessments. The National Agriculture Policy recommends establishing comprehensive MEL systems, including key performance indicators linked to climate resilience objectives, supported by real-time data collection using emerging ICT tools and mobile platforms (NAP, 2022); (GSJ, 2021). Adaptive management facilitated by performance-based evaluations and reforms ensures policy relevance amid evolving climatic and socioeconomic contexts.

Capacity Building and Institutional Strengthening

Sustained capacity development at all governance levels, from policy planners to extension agents, is essential for operationalizing climate-resilient agriculture. Institutional strengthening measures encompass recruitment of technically qualified personnel, continuous professional development, and enhancing digital literacy for climate information services delivery (NAP, 2022). The alignment of education and research institutions with policy needs creates a feedback loop for innovation and knowledge transfer (Plantation Policy, 2025).

Legal and Regulatory Instruments

Effective governance is underpinned by a coherent legal and regulatory framework that empowers institutions and enforces compliance. Sri Lanka's policies call for updating agriculture-related Acts and Ordinances, empowering regulatory agencies to enforce standards for inputs, sustainable practices, and climate-smart technologies, thereby creating enabling conditions for policy adherence and impact scaling (NAP, 2022).

5.1. Strengthening Inter-Agency Coordination

Effective collaboration among governmental ministries, research institutions, civil society, and the private sector is imperative for operationalizing climate-resilient agricultural policies in Sri Lanka. The inherent cross-sectoral nature of climate adaptation demands an institutional governance platform that fosters integrated planning, resource sharing, and synergistic action across agriculture, environment, water management, and rural development sectors (World Bank, 2019).

Proposal for a Multi-Stakeholder Platform or Task Force

To overcome existing institutional fragmentation and improve coordination, it is proposed to establish a high-level Multi-Stakeholder Coordination Platform (MSCP) or Task Force. Chaired by a senior official within the Ministry of Agriculture or the Ministry of Environment, this platform would incorporate representatives from:

Key Government Ministries: Ministry of Agriculture, Ministry of Environment, Ministry of Irrigation and Water Resource Management, Ministry of Plantation Industries, and provincial agricultural departments.

Research and Academic Institutions: Hector Kobbekaduwa Agrarian Research and Training Institute, Tea Research Institute, Coconut Research Institute, Sri Lankan universities, and technical colleges.

Civil Society Organizations: Farmer cooperatives, community-based organizations, environmental NGOs, and advocacy groups.

Private Sector: Agribusiness firms, input suppliers, financial institutions providing climate-smart credit and insurance products, and technology providers.

Development Partners: UN agencies (e.g., FAO, UNDP), development banks, and climate finance entities.

This inclusive task force would guide the development, coordination, and monitoring of climate-smart agriculture (CSA) initiatives, ensuring alignment with national climate commitments such as Sri Lanka's Nationally Determined Contributions (NDCs) and National Adaptation Plan (NAP) (Slycan Trust, 2024; UNFCCC, 2022).

Functions and Objectives

Strategic Planning and Policy Integration: Harmonize CSA-related policy development across ministries to avoid duplication and maximize resource efficiency (ADPC, 2022).

Information Sharing and Capacity Building: Facilitate data exchange on climate risk, research findings, technological innovations, and extension service delivery to optimize adaptive interventions at grassroots levels (FAO, 2016).

Resource Mobilization and Funding Coordination: Align multi-source financing from government budgets, international climate funds, and private investments, streamlining fund flows towards priority CSA actions (World Bank, 2019).

Monitoring, Evaluation, and Adaptive Learning: Develop a unified Monitoring, Evaluation, and Learning (MEL) framework leveraging ICT tools to track progress on CSA indicators, inform policy adjustments, and promote best practice dissemination (ADPC, 2022; GSJ, 2021).

Stakeholder Engagement and Knowledge Exchange: Create inclusive platforms for participatory dialogue involving farmers, experts, and policymakers to co-create locally relevant CSA solutions (Slycan Trust, 2024).

Strategic Importance and Impact

Evidence from Sri Lanka and comparable contexts underscores that well-structured inter-agency coordination accelerates the scaling of CSA technologies and enhances adaptive capacity. For example, the Sri Lanka E-Agriculture Strategy 2016 established an E-Agriculture Steering Committee and Task Force integrating diverse stakeholders, leading to improved ICT service delivery for farming communities and enhanced climate information dissemination (FAO, 2016). Similar multi-stakeholder models have facilitated cohesive climate risk management and policy coherence in national contexts across Southeast Asia (ADPC, 2022).

Through institutionalized collaboration across ministries, research institutions, civil society, and private stakeholders, Sri Lanka can achieve integrated climate governance that translates policy commitments into ground-level impact, fostering resilient, productive, and equitable agricultural systems.

5.2. Capacity Building and Knowledge Management

Building the technical capacity of policymakers, extension officers, and farmers is fundamental to the effective understanding and implementation of climate-resilient agricultural practices in Sri Lanka. Given the intensifying impacts of climate variability—erratic rainfall, droughts, floods, and temperature extremes—robust capacity development strategies enable stakeholders at all levels to anticipate, adapt, and innovate effectively (UNDP, 2020; IWMI, 2024).

Targeted Capacity Building for Policymakers and Extension Officers

Policymakers require enhanced competencies in integrating climate science, socio-economic assessments, and participatory governance frameworks into agricultural policy formulation and evaluation. Training programs focused on climate risk analysis, climate-smart agriculture (CSA) frameworks, and multisectoral coordination have demonstrated efficacy in improving policymaking inclusivity and responsiveness in Sri Lanka (Slycan Trust, 2024).

Extension officers, who serve as critical conduits of technical knowledge to farmers, have benefited from upskilling in climate information interpretation, digital advisory platforms, and climate-resilient agronomic practices. Integrating technological tools such as mobile-based agro-meteorological advisories and climate-resilient seed protocols into extension curricula has enhanced outreach and adaptive capacities on the ground (IWMI, 2024; FAO, 2023).

Empowering Farmers through Participatory Knowledge Exchange

Smallholder farmers in Sri Lanka's dry and intermediate zones confront persistent water scarcity and land degradation, heightening vulnerability to climate extremes (UNCCD, 2023). Participatory training focusing on CSA techniques—including soil conservation, drought-tolerant crop varieties, agroforestry, and integrated pest management—has proven effective in enhancing farmer resilience and productivity (CRIWMP Project, 2017-2024).

Digital tools paired with locally tailored climate forecast dissemination increase farmer agency in decision-making. The successful Bundled Solutions with Climate Information and Seed Systems (BICSA) initiative in the north-central plains demonstrated how weather-index insurance combined with SMS-based agro-advisories reduced economic losses and incentivized risk-mitigating behaviors (IWMI, 2024).

Particularly significant is the integration of gender-responsive approaches; women farmers, historically marginalized but pivotal in agricultural productivity, have gained leadership roles in climate adaptation through skill-building, cooperative formation, and participation in governance, leading to improved water and land management outcomes (UNDP, 2020).

Knowledge Management Systems for Climate Resilience

Institutionalized knowledge management platforms facilitate the synthesis, storage, and dissemination of climate adaptation knowledge, best practices, and innovations. Sri Lanka's development of e-agriculture strategies and climate information services aims to centralize climate data and deliver timely, context-specific advisories to stakeholders, enhancing adaptive capacity at scale (FAO, 2016).

Synergizing indigenous knowledge and scientific research further generates location-specific innovative solutions that are culturally acceptable and environmentally sustainable (Slycan Trust, 2024).

Outcomes and Impact

Investments in capacity building have yielded measurable improvements in adaptive behavior adoption, productivity resilience, and community empowerment. Projects like the Climate Resilient Integrated Water Management Project (CRIWMP) have enhanced climate-smart farming adoption, increased small-scale water storage capacity, and strengthened social capital in farming communities, particularly among women-led groups, thereby reducing vulnerability and promoting sustainable livelihoods (UNDP, 2020).

5.3. The Role of the Private Sector: Strategies to Incentivize Investment in Climate-Smart Agriculture

The private sector's role in advancing climate-smart agriculture (CSA) in Sri Lanka is vital for scaling technologies, enhancing value chain efficiency, and catalyzing innovation required to build agricultural resilience against climate change. As the agriculture sector encounters mounting risks from rising temperatures, erratic monsoons, and extreme weather events—with projected yield declines of 10-12% in vulnerable dry and intermediate zones by 2050 without interventions—the mobilization of private capital and expertise is imperative to meet adaptation and mitigation goals (FAO, 2024; World Bank, 2019).

Technology Provision and Innovation

Private enterprises, including agri-tech firms, input suppliers, and irrigation technology providers, are key agents for delivering climate-resilient innovations such as drought-tolerant seeds, precision irrigation systems, and digital advisory platforms. These entities foster adoption of site-specific practices aligned with Sri Lanka's agroecological diversity. The emerging Climate-Smart Agriculture Investment Plan initiative, funded by the Green Climate Fund and facilitated by FAO in partnership with the Ministries of Environment and Agriculture, explicitly aims to engage private sector stakeholders for technology dissemination and co-development (FAO, 2024).

Digital technologies such as mobile-based agro-meteorological advisories, supply chain traceability platforms, and climate risk analytics developed by private firms enhance timely decision-making and market transparency, improving farmer access to climate information and resilient inputs (Slycan Trust, 2024). Encouraging public-private partnerships for research and development accelerates locally adapted technology solutions.

Value Chain Development

Private sector investment can significantly strengthen value chains for climate-resilient crops by financing climate-proof infrastructure like cold storage, processing units, and efficient logistics, thereby reducing post-harvest losses caused by climate shocks (World Bank, 2019). Aggregation services, farmer producer organizations (FPOs), and digital marketplaces supported by private entities enhance smallholder farmer bargaining power and market access, creating incentives for climate-smart investments (FAO, 2016; ADPC, 2022).

Certification and eco-labeling initiatives guided by private actors open premium markets for sustainably produced climate-resilient commodities, promoting a virtuous cycle of investment and adoption. Private finance also supports supply chain resilience through climate risk insurance products tailored for agribusinesses and cooperatives.

Financial Incentives and Investment Mechanisms

Innovative financing instruments are crucial to attract private capital into climate-smart agriculture. The CSA Investment Plan proposes mechanisms such as blended finance models, green bonds, and impact investment funds that de-risk private sector participation while ensuring alignment with national climate objectives (FAO, 2024; World Bank, 2019). Fiscal incentives including tax rebates, subsidized credit lines, and grants catalyze private investments in climate adaptation technologies and infrastructure.

Additionally, fostering private engagement in climate finance requires streamlined regulatory frameworks and transparent contract mechanisms supported by digital financial services, enabling efficient fund flows from domestic and international sources to ground-level climate-smart interventions (Slycan Trust, 2024).

Enhancing Private Sector Engagement: Policy and Institutional Support

To unlock the private sector's potential, policy reforms are necessary to reduce entry barriers, clarify land and resource tenure, and simplify compliance with climate and agricultural standards. The establishment of a Private Sector Working Group—recommended by recent public-private-people forums in Sri Lanka—facilitates continuous dialogue, joint planning, and policy feedback between government, private actors, and civil society (FAO, 2025). This platform supports alignment of private investment with national CSA targets and international climate finance priorities.

5.4. Monitoring, Evaluation, and Learning Framework

A robust Monitoring, Evaluation, and Learning (MEL) framework is essential to systematically track the progress, outcomes, and impacts of mainstreamed climate-resilient agricultural policies in Sri Lanka. Given the dynamic nature of climate change and its multifaceted impacts on agriculture, the framework must facilitate adaptive management through continuous feedback loops, evidence-based adjustments, and knowledge dissemination.

Framework Design and Key Indicators

The MEL framework integrates quantitative and qualitative indicators covering key domains:

Adaptation Effectiveness: Metrics such as area (ha) under climate-resilient crops, number of farmers adopting climate-smart agriculture (CSA) practices, and yield stability under climate stress are pivotal. Baseline assessment in Sri Lanka's dry and intermediate zones reports adoption rates of key CSA practices (e.g., dry sowing, water-saving irrigation) below 30% with productivity gains estimated between 15-25% upon adoption (World Bank, 2019; FAO, 2020).

Mitigation Impact: Indicators include reductions in greenhouse gas emissions per unit of agricultural output, soil organic carbon content improvements, and decreased methane emissions from paddy cultivation via alternate wetting and drying (AWD) techniques. Studies quantify AWD reducing methane emissions by up to 48% in Sri Lankan rice systems while maintaining yields (HARTI, 2025).

Resource Use Efficiency: Water productivity (kg/m³) improvements, energy savings, and fertilizer use efficiencies act as proxies for sustainable land and water management (CSIAP Annual Report, 2022).

Institutional and Capacity Outcomes: Coverage and effectiveness of extension services, number of trained extension officers and farmers, stakeholder engagement levels, and the establishment of coordination bodies are crucial governance indicators (UNDP, 2020).

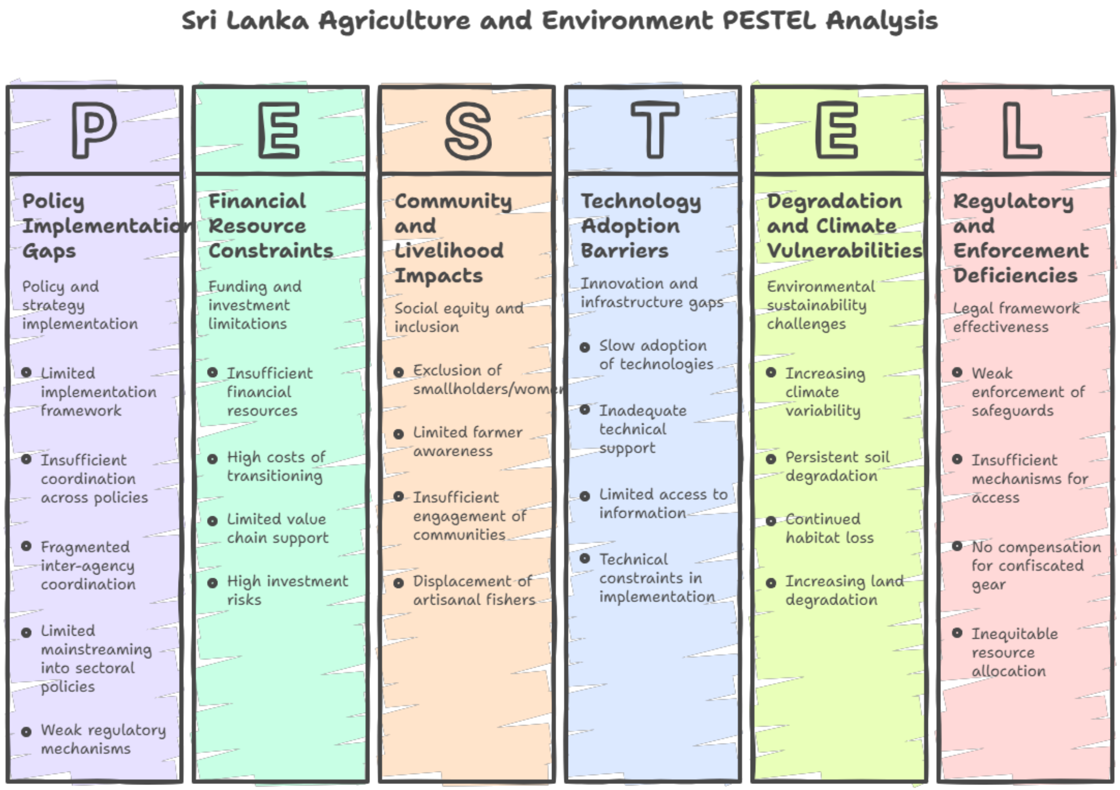

Fig 5.1. PESTEL framework: The Political, Economic, Social, Technological, Environmental, and Legal factors affecting Sri Lankan Agricultural Sector

Real-Time Data Integration and Digital Platforms

Sri Lanka's GeoGoviya Smart Farming Platform exemplifies integration of advanced climate services with geospatial analytics, providing real-time data on weather patterns, land use, soil conditions, and water availability to inform decision-making at farm and policy levels (IWMI, 2025). Such digital platforms enable ongoing data collection, visualization, and analysis for MEL, reducing reporting lags and facilitating timely course corrections.

Adaptive Management and Learning

The MEL system must be embedded in a culture of adaptive management wherein periodic evaluations inform policy refinements. Structured learning sessions and knowledge-sharing networks involving policymakers, scientists, extension personnel, and farmers enhance collective understanding of emerging challenges and effective strategies (Slycan Trust, 2024). The National Guidelines for Climate Smart Agricultural Technologies and Practices underscore this iterative learning approach as central to building resilience in the Dry and Intermediate zones (UNDP, 2020).

Multi-Level and Participatory Monitoring

Inclusion of participatory monitoring at community and farmer levels empowers stakeholders, ensures data relevance, and enhances ownership of outcomes. Combining community-based monitoring with technological tools such as mobile data collection and remote sensing augments accuracy and spatial coverage (CRIWMP, 2017-2024).

5.5 Conclusion

The mainstreaming of climate resilience into Sri Lanka's agricultural policy framework is an essential and urgent endeavor to safeguard national food security, bolster rural livelihoods, and meet international climate commitments. Empirical evidence indicates that Sri Lanka's agriculture, particularly in vulnerable dry and intermediate zones, faces projected yield declines ranging from 10% to 30% by mid-century due to increasing temperature extremes, erratic precipitation, and growing incidence of pests and diseases (Samarasinghe et al., 2025; UNDP, 2020). This necessitates transformative policy interventions grounded in climate-smart agriculture (CSA) principles that enhance adaptive capacity, mitigate emissions, and foster sustainable resource management.

A strategic framework integrating technological innovation, sustainable land and water management, diversified cropping systems, value chain development, and financial risk transfer mechanisms is paramount. Such a holistic approach is supported by recent national initiatives, including Sri Lanka's first Climate-Smart Agriculture Investment Plan funded by Green Climate Fund and coordinated by FAO, which seeks to mobilize public and private investments towards resilient agricultural transformation (FAO, 2024).

Effective governance, robust inter-agency coordination, and multi-stakeholder engagement underpin the operationalization of climate-resilient policies. Integrated Monitoring, Evaluation, and Learning systems employing real-time digital data enhance adaptive management and evidence-based policy adjustments (IWMI, 2025; Slycan Trust, 2024). Capacity building across policymakers, extension services, and farming communities accelerates technology uptake and fosters participatory adaptation, ensuring context-specific and inclusive resilience (UNDP, 2020).

Private sector participation is equally vital, with opportunities spanning technology provision, climate finance, and value chain strengthening serving as critical levers for scaling CSA innovations and unlocking sustainable growth pathways (FAO, 2024; World Bank, 2019).

Finally, the scientific, institutional, and financial pillars outlined in this white paper constitute a comprehensive blueprint for resilient agricultural development in Sri Lanka. Persistent commitment, multi-sectoral collaboration, and evidence-driven implementation will transform climate risks into opportunities for sustainable agricultural prosperity, nourishing Sri Lanka's people and contributing to global climate resilience.

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Chapter 6: Conclusion and Recommendations

6. Introduction

Sri Lanka's agricultural sector, the backbone of its rural economy and a cornerstone of national food security, is facing an existential threat from climate change. The nation's high dependency on climate-sensitive livelihoods makes it exceptionally vulnerable to shifts in weather patterns. Projections indicate that by 2050, Sri Lanka could experience a GDP loss of up to 1.2% annually due to climate impacts (World Bank, 2021). While Sri Lanka has formulated a suite of policies aimed at addressing these challenges, a significant policy-practice gap undermines their effectiveness. Numerous strategies, including the National Adaptation Plan for Climate Change Impacts (2016-2025) and the National Agriculture Policy (2021), exist on paper but struggle with implementation due to systemic barriers. This paper analyzes the scientific basis of the climate threat, diagnoses the implementation gap using evidence from the existing policy framework, and proposes a strategic, multi-pronged approach to effectively mainstream climate resilience into Sri Lanka's national agricultural framework.

6.1 The Climate-Agriculture Nexus in Sri Lanka: A Scientific Overview

The impacts of climate change on Sri Lankan agriculture are not abstract future threats; they are observable, measurable, and escalating phenomena.

Temperature and Precipitation Anomalies: Scientific models project a mean temperature increase of 1.0°C to 1.5°C by 2050 across Sri Lanka (Esham & Garforth, 2013). This seemingly small increase has profound implications, particularly for paddy cultivation, where night temperature increases can significantly reduce grain fill and yield. Furthermore, rainfall patterns are becoming increasingly erratic. The bimodal monsoon system is being disrupted, leading to intense rainfall events that cause flooding and soil erosion, interspersed with prolonged droughts that deplete reservoirs and groundwater, severely impacting both the Yala and Maha cultivation seasons (IPCC, 2022). For instance, increasing climate variability is cited as a primary challenge to the successful implementation of the National Climate Change Adaptation Strategy.

Impact on Crop Yields and Food Security: Research indicates that without adaptation, rice yields in Sri Lanka could decline by up to 20-30% in the dry zone by 2050 (World Bank, 2021). Increasing soil salinity from sea-level rise and saltwater intrusion, particularly in coastal farming areas, further threatens productivity. The Coastal Zone and Coastal Resource Management Plan notes saltwater intrusion has already destroyed 620 hectares of mango farms in Kalpitiya. These yield declines pose a direct threat to the nation's goal of food self-sufficiency and exacerbate rural poverty.

Fisheries and Livestock Vulnerability: Ocean warming and acidification are altering the distribution and abundance of marine fish stocks, threatening coastal fishing communities. Concurrently, heat stress on livestock reduces milk yields and reproductive capacity, while fodder shortages during droughts impact the entire sector. The Livestock Development Policy (2022) identifies climate threats and a lack of superior breeding animals as acute challenges to achieving self-sufficiency in milk and poultry.

6.2 Diagnosis of the Policy-Practice Gap

A comprehensive review of Sri Lanka's policy landscape reveals that the primary failure is not in the formulation of goals but in their operationalization. The gap is driven by three interconnected deficits:

Institutional and Governance Deficits: There is fragmented inter-agency coordination and a lack of integration across policies. For example, the Nationally Determined Contribution (NDC) Implementation Plan suffers from limited coordination between climate and agricultural policies, while the National Action Programme for Combating Land Degradation is hampered by insufficient coordination across sectoral institutions. Many policies are also outdated and do not reflect the latest climate science, and weak enforcement of environmental regulations allow for continued degradation, such as the salinization of wells from poorly managed aquaculture.

Resource and Capacity Constraints: A chronic lack of financial resources and insufficient resource allocation are cited as impediments across nearly every major policy, from the National Environment Policy to the recent National Agriculture Policy (2021). This is compounded by a limited technical capacity for climate modelling, risk assessment, and food safety testing, as well as weak and under-resourced agricultural extension services that fail to transfer climate-smart technologies to farmers effectively.

Socio-Economic and Adoption Barriers: The adoption of climate-resilient practices at the farm level remains low. This is due to the high costs of transitioning to cleaner production, a lack of awareness among small-scale farmers, complex procedures for accessing support like insurance, and the exclusion of smallholders and women from planning processes. Market preferences that favor conventionally produced goods also disincentivize the adoption of sustainable practices.

6.3. A Strategic Framework for Mainstreaming Climate Resilience

Bridging the policy-practice gap requires moving beyond siloed policy creation towards an integrated, actionable framework. We propose a three-pillar strategy:

Pillar 1: Strengthen Integrated Governance and Policy Cohesion

Establish a National Steering Committee for Climate-Resilient Agriculture: This high-level body, with representation from the Ministries of Agriculture, Environment, Irrigation, and Finance, should be mandated to harmonize policies, eliminate redundancies, and oversee the implementation of a unified national strategy. This directly addresses the fragmented coordination identified as a core weakness.

Mandate Dynamic Policy Review: Implement a mandatory five-year review cycle for all key

Key Challenges

Fragmented Governance: Policies often suffer from insufficient coordination between ministries, across different levels of government, and with other related policies. Many initiatives lack detailed implementation frameworks.

Inadequate Resources & Capacity: Initiatives are plagued by chronic underfunding, insufficient resource allocation, and a lack of technical capacity for implementation, testing, and monitoring. Advisory and extension services are often weak.

Weak Enforcement & Outdated Frameworks: Many key policies, such as the National Environment Policy (2003) and National Agriculture Policy (2007), are outdated and need revision. The enforcement of existing regulations, like environmental safeguards, is frequently weak.

Limited Community Engagement: There is often inadequate awareness among farmers, and planning processes can exclude smallholders, women, and indigenous communities. High costs and complex procedures also create significant barriers to adoption.

Impacts on the Ground

Environmental Degradation: Salinization of 380 village wells in Puttalam has been linked to aquaculture practices.

Livelihood Loss: 8,000 hectares of traditional Tamil and Muslim fishing grounds have been lost to tourism resorts.

Economic Damage: Disease outbreaks in aquaculture, such as White Spot Virus, have led to significant crop losses, sometimes as high as 40%.

Social Conflict: Conflicts persist over coastal access between hotels and fishing communities. Militarized enforcement of fishing regulations has displaced small-scale fishers.

agricultural and environmental policies to ensure they align with the latest IPCC findings and national climate targets. This prevents policies from becoming outdated.

Key Findings

This white paper has critically examined the multifaceted challenges and emerging opportunities for mainstreaming climate resilience within Sri Lanka's agricultural sector. Climate vulnerability remains acute due to increasing temperature extremes, rainfall variability, droughts, and floods, posing significant threats to crop yields, rural livelihoods, and national food security. Empirical projections suggest yield declines of up to 30% by 2050 in key agricultural zones without effective adaptation (Samarasinghe et al., 2025; IPCC, 2023). Soil degradation, water scarcity, and pest and disease pressures compound the risks, especially for smallholder farming systems that dominate Sri Lanka's agrarian landscape (UNDP, 2020; Slycan Trust, 2024).

Despite progress, policy fragmentation, insufficient technical and financial capacities, and weak inter-agency coordination obstruct the effective scaling of climate-smart agriculture (CSA) practices (HARTI, 2025). Critical institutional gaps persist in extension services, research linkage, and capacity-building mechanisms. Nevertheless, technological innovations such as drought-tolerant crop varieties, precision irrigation, digital climate advisory platforms, and ecosystem-based adaptation practices provide tangible pathways to reduce vulnerability and enhance productivity (World Bank, 2019; IWMI, 2025).

Private sector engagement remains nascent but essential, offering significant opportunities for driving innovation, financing, and value chain development (FAO, 2024). A robust Monitoring, Evaluation, and Learning framework is critical for adaptive management and informed policy evolution (Slycan Trust, 2024). Strategic, multi-stakeholder governance models integrating government agencies, researchers, civil society, and private actors underscore an effective implementation approach conducive to durable

Pillar 2: Mobilize Blended Finance and Build Human Capacity

Develop a National Climate Finance Mechanism: Establish a dedicated fund, as recommended in the National Policy on Climate Change 2023, that utilizes blended financing—combining public funds, international climate funds (e.g., GCF), and private sector investment—to support climate-smart agriculture.

Invest in Farmer-Centric Agro-Meteorological Services: Scale up investment in localized climate advisories and ICT-enabled extension services to provide farmers with actionable, real-time information on weather patterns, water management, and pest outbreaks, a key recommendation from the National Adaptation Plan.

Pillar 3: Foster Inclusive, Community-Led Adaptation

Prioritize Community-Based Adaptation (CBA) Planning: Empower local authorities and farmer organizations to develop and implement localized adaptation plans. This ensures that interventions are context-specific and addresses the exclusion of smallholders and women from top-down planning.

Integrate Traditional Knowledge with Modern Science: Create formal mechanisms, as suggested in the National Biodiversity Strategic Action Plan, to document and integrate traditional ecological knowledge (e.g., drought-resistant crop varieties, water harvesting techniques) with modern scientific approaches to enhance resilience.

6.3 Consolidated Policy Recommendations

For Policymakers

- ✓ Institutionalize cross-sectoral coordination platforms with clear mandates for climate-resilient agriculture governance and resource allocation (NAP, 2022).
- ✓ Align agricultural, water, and environmental policies to create enabling conditions for CSA integration and climate risk financing (World Bank, 2019).

- ✓ Encourage climate-resilient crop and livestock diversification via subsidy reforms, quality seed certification, and varietal release processes (FAO, 2023).
- ✓ Expand and institutionalize Monitoring, Evaluation, and Learning systems leveraging digital tools for real-time impact tracking and adaptive policy adjustment (IWMI, 2025).

For Government Agencies and Extension Services:

- ✓ Strengthen technical capacity-building programs focused on climate risk assessment, CSA technologies, and farmer participatory approaches (UNDP, 2020).
- ✓ Enhance climate information service delivery through integration of geospatial and meteorological data in extension advisories (CSIAP, 2022).
- ✓ Develop gender-responsive extension and training programs to ensure inclusion of marginalized groups (Slycan Trust, 2024).

For Research Institutions:

- ✓ Prioritize participatory research on climate-resilient crop varieties, integrated pest management, and agroecological water conservation suited to Sri Lanka's microclimatic zones (HARTI, 2025).
- ✓ Strengthen research-to-practice linkages through collaborative innovation platforms and farmer field schools (FAO, 2023).

For Development Partners and Private Sector:

- ✓ Mobilize blended finance mechanisms, including public-private partnerships, to scale CSA investments in technology and infrastructure development (FAO, 2024).
- ✓ Support digital agriculture platforms that integrate climate risk data with market and advisory services for enhanced farmer decision-making (IWMI, 2025).
- ✓ Facilitate premium market development for sustainably produced climate-resilient agricultural commodities through certification schemes and value chain upgrading (World Bank, 2019).

6.4 A Call to Action

The accelerating pace and magnitude of climate change pose existential threats to Sri Lanka's agricultural sustainability, rural livelihoods, and food security. Mainstreaming climate-resilient agricultural policies is no longer optional but an imperative to safeguard the nation's socio-economic and environmental future. It demands urgent, coordinated action that embeds climate resilience at the heart of agricultural development. Through integrated policy reforms, scientific innovation, inclusive governance, robust financing, and participatory capacity-building, Sri Lanka can transform its agriculture into a climate-smart, sustainable, and equitable system. The time for decisive, science-driven, and collaborative action is now—to build resilience, ensure prosperity, and contribute meaningfully to global climate goals.

6.5 Conclusion

The challenge for Sri Lanka is not the absence of policies but the absence of a cohesive, well-funded, and inclusive implementation architecture. Mainstreaming climate resilience requires a fundamental shift from creating isolated policy documents to building a dynamic, integrated system of governance. By strengthening institutional cohesion, mobilizing innovative financing, and empowering local communities, Sri Lanka can bridge the critical gap between policy and practice, securing a sustainable and resilient future for its agricultural sector.

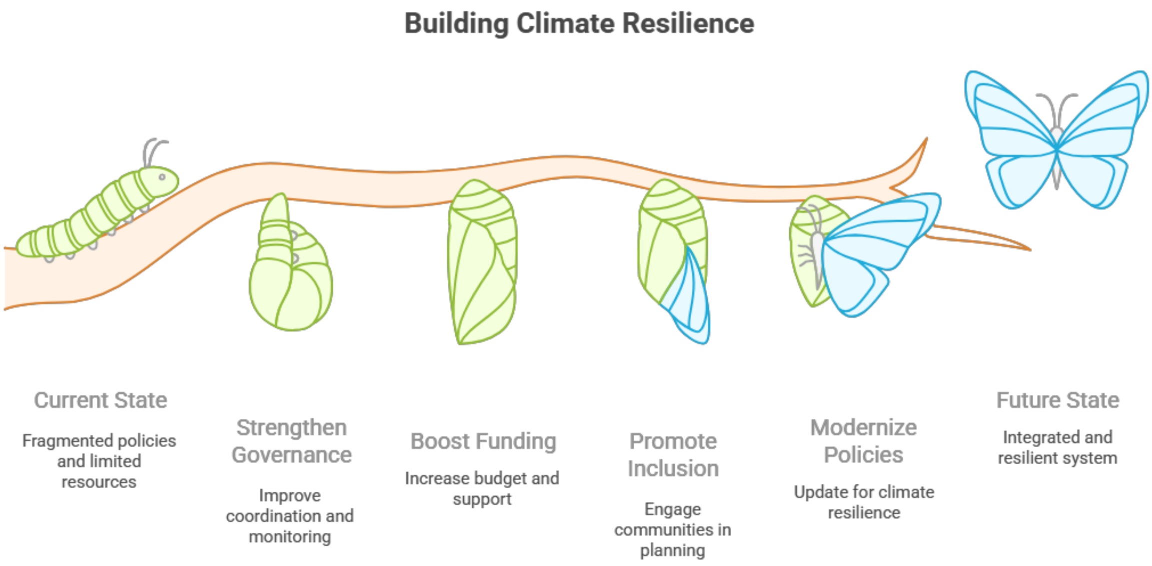

Fig 6.1. The Path Forward

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