Food and Agriculture Organization of the United Nations

SCALA PRIVATE SECTOR ENGAGEMENT FACILITY

VALUE CHAIN ASSESSMENT AND EXPLORATORY MARKET ANALYSIS FOR SUSTAINABLE, MGAP CERTIFIED PAPAYA IN THE MALDIVES

This report presents a comprehensive analysis of the Maldivian papaya value chain, conducted under the Scaling up Climate Ambition on Land Use and Agriculture - Private Sector Engagement Facility (SCALA-PSEF) to explore opportunities for climate-resilient agriculture and private sector investment. The study examines current production practices, market dynamics, and the potential for adopting the Maldives Good Agricultural Practices (MGAP) certification alongside sustainable agricultural practices. Through extensive field research across key production areas including Thoddoo, Laamu Atoll, and Maafahi Island, the analysis identifies pathways for transforming the papaya sector toward more sustainable, profitable, and climate-resilient production systems. The findings provide strategic recommendations for enhancing farmer livelihoods while strengthening the country's agricultural resilience and reducing import dependence.

Key Messages

- Papaya production faces significant challenges from pest and disease pressure affecting 68% of farmers, climate-related stressors including universal exposure to damaging winds and storms, and high input costs that constrain productivity and profitability.
- Market access remains constrained by centralized intermediary systems that dominate marketing channels, leaving 96% of farmers selling to middlemen with limited bargaining power and minimal access to premium market opportunities.
- Strong farmer interest exists for adopting MGAP certification and sustainable agricultural practices, with over 70% expressing willingness to invest in improved practices.
- Premium market opportunities are viable, with tourism sector buyers expressing willingness to pay 15%+ premiums for MGAP-certified, sustainably produced papaya, creating economic incentives for certification adoption.
- Holistic transformation is required across the entire value chain ecosystem, with coordinated interventions needed in farmer training, input quality assurance, transportation infrastructure, and market development to achieve sustainable sector transformation.

ABBREVIATIONS

ADB	Asian Development Bank
AIIB	Asian Infrastructure Investment Bank
BAU	Business-as-usual
BCC	Business Centers Corporation
CSA	Climate-smart agriculture
EbA	Ecosystem-based adaptation
EU	European Union
FAO	Food and Agriculture Organization
GCF	Green Climate Fund
GDP	Gross Domestic Product
GEF	Global Environment Facility
IFAD	International Fund for Agricultural Development
IPM	Integrated pest management
IsDB	Islamic Development Bank
LUPs	Land use plans
MAP	Maldivian Agribusiness Project
MFDA	Maldives Food and Drug Authority
MGAP	Maldives Good Agricultural Practices
MoAAW	Ministry of Agriculture and Animal Welfare
MoTE	Ministry of Tourism and Environment
MTCC	Maldives Transport and Contracting Company
MVR	Maldivian Rufiyaa
NAP	National Adaptation Plan
NbS	Nature-based solutions
NDC	Nationally Determined Contribution
PHI	Pre-harvest intervals
SCALA-PSEF	Scaling up Climate Ambition on Land Use and Agriculture - Private Sector Engagement Facility
SDFC	SME Development Finance Corporation
SIDS	Small Island Developing States
SOPs	Standard Operating Procedures
STO	State Trading Organization
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme

TABLE OF CONTENTS

LIST OF TABLES

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FOREWORD

The Ministry of Agriculture and Animal Welfare and the Ministry of Tourism and Environment are pleased to jointly present this comprehensive analysis of the Maldivian papaya value chain, conducted in partnership with the Food and Agriculture Organization (FAO) and the United Nations Development Programme (UNDP) under the Scaling up Climate Ambition on Land Use and Agriculture - Private Sector Engagement Facility (SCALA-PSEF). This collaborative effort, undertaken with key stakeholders across the government, private sector, and civil society, represents a pivotal step forward in our understanding of agricultural production systems in the Maldives and the transformative opportunities that lie ahead.

This assessment arrives at a particularly timely moment as we advance critical national priorities across multiple fronts. The Ministry of Agriculture and Animal Welfare is developing comprehensive agriculture legislation that will modernize the sector's regulatory framework, while the Ministry of Tourism and Environment is advancing efforts to achieve the country's Nationally Determined Contribution (NDC) targets and driving the development and implementation of the National Adaptation Plan (NAP). The findings and recommendations presented in this report provide crucial evidence and strategic direction that will inform these policy processes and ensure our interventions are grounded in robust field research and stakeholder consultation.

The Maldives' third NDC identifies agriculture and food security as a priority adaptation sector and calls for promoting climate-smart technologies and practices to increase resilience and food security. This effort responds directly to that call. This study examines how MGAP certification integrated with sustainable agricultural practices can be scaled across the papaya value chain, translating national climate commitments into practical strategies. The challenges facing Maldivian agriculture — from climate vulnerability and land constraints to market access barriers — require innovative solutions that bridge public and private sector action. This comprehensive analysis reveals both the significant obstacles our farmers face and the substantial opportunities for transformation through coordinated interventions. The research demonstrates clear pathways for enhancing farmer incomes and agricultural productivity while strengthening climate resilience and market linkages. Importantly, the findings identify promising opportunities for private sector engagement and investment across multiple dimensions of the value chain — from tourism operators and resort partnerships to retailers, transporters, and input suppliers. These collaborations can create meaningful connections between agricultural producers and diverse commercial actors, generating benefits for both farmers and businesses while advancing objectives that align directly with both Ministries' strategic priorities and national development goals.

This study represents more than an analytical exercise. It is a foundation for informed policy development and strategic planning. We look forward to utilizing these findings to strengthen our sector strategies and working with all stakeholders — including farming communities, private sector partners, financial institutions, and development agencies — to realize the vision of a climate-resilient, economically viable, and environmentally sustainable agricultural sector that serves our farmers, our tourism industry, and our nation.

Ministry of Agriculture and Animal Welfare
Republic of Maldives

Ministry of Tourism and Environment
Republic of Maldives

EXECUTIVE SUMMARY

The Maldives faces a critical intersection of climate vulnerability and agricultural sustainability challenges that directly impact farmer livelihoods and local economic development. Agriculture is an important economic sector, providing livelihoods for roughly 7,600 registered farmers (nearly 5% of the workforce) across the archipelago (FAO, 2024). Given the Maldives' limited cultivable land of just 27 km² scattered across the archipelago and mounting climate pressures that threaten agricultural productivity, transforming current farming practices toward sustainable production systems represents both an urgent necessity and a significant opportunity to adapt to climate change, protect ecosystems, and strengthen farmer livelihoods. This report presents a comprehensive assessment of the papaya value chain in the Maldives, with a particular focus on the potential for the adoption of Maldives Good Agricultural Practices (MGAP) certification and sustainable agricultural practices. The MGAP certification scheme encompasses nearly 200 discrete standards covering food safety, environmental management, worker health and welfare, and produce quality. As the Government of Maldives advances MGAP scale-up to strengthen agricultural competitiveness, the Scaling up Climate Ambition on Land Use and Agriculture - Private Sector Engagement Facility (SCALA-PSEF)—a joint initiative of the Food and Agriculture Organization (FAO) and the United Nations Development Programme (UNDP)—commissioned this assessment to identify opportunities for complementing MGAP adoption with nature-based solutions (NbS), ecosystem-based adaptation (EbA), and climate-smart agricultural (CSA) practices. This integrated approach enables quality assurance systems to serve dual functions: protecting consumer safety while building agricultural resilience to the climate shocks that increasingly threaten island food systems.

MGAP encompasses nearly 200 discrete standards covering food safety, environmental management, worker health, and welfare, and produce quality. As the Government of Maldives advances MGAP scale-up to strengthen agricultural competitiveness, the Scaling up Climate Ambition on Land Use and Agriculture - Private Sector Engagement Facility (SCALA-PSEF)—a joint initiative of the Food and Agriculture Organization (FAO) and the United Nations Development Programme (UNDP)—commissioned this assessment to identify opportunities for complementing MGAP adoption with nature-based solutions (NbS), ecosystem-based adaptation (EbA), and climate-smart agricultural (CSA) practices. This integrated approach enables quality assurance systems to serve dual functions: protecting consumer safety while building agricultural resilience to the climate shocks that increasingly threaten island food systems. Given its economic relevance, market demand, and susceptibility to climate stressors, papaya was selected as the focus crop.

Importantly, the challenges and opportunities identified in the papaya value chain reflect broader patterns that are common across other horticultural crops in the Maldives, making this analysis relevant beyond papaya alone. The assessment was carried out across three priority locations—AA. Thoddoo, Laamu Atoll, and HA. Maafahi—to reflect the diversity of production systems present in the country, including smallholder, leased, and commercial farms.

Challenges and Opportunities Across the Papaya Value Chain: The assessment reveals a fragmented and under-optimized value chain characterized by limited market access, agronomic

constraints, and mounting climate risks. Pest and disease pressure is widespread, affecting 68% of surveyed farmers, while 57% cite both high input costs and low prices as major barriers to profitability. Climate impacts are nearly universal: 93% of farmers report damage from strong winds and storms, and 63% report excessive rainfall. These pressures are compounded by limited extension services, inadequate transport logistics, and a highly intermediate marketing system that leaves producers with minimal leverage or visibility into end-market dynamics. Yet, the analysis also identifies significant potential for transformation. The tourism sector—serving nearly 1.9 million annual visitors is a reliable and growing source of demand for premium agricultural products, including papaya. Annual demand for papaya from resorts, guesthouses, and hotels is estimated to exceed 1.9 million kilograms. Based on current productivity levels, farmers in Thoddoo, Laamu, and Maafahi collectively have the potential to meet approximately 76% of this demand. However, the tourism sector shows promising but varied interest in sustainably produced, MGAP-certified papaya. While resort and hotel stakeholders reported significant interest and a willingness to pay at least a 15% premium for certified produce, guesthouses had mixed responses, citing price sensitivity and limited procurement flexibility as constraints to sourcing MGAP-certified papaya. This indicates strong potential for premium market access, though demand cannot yet be considered uniform across all tourism segments. Farmer interest is strong: over 70% of producers surveyed expressed willingness to adopt improved practices if linked to higher farmgate prices.

Status of Sustainable Practice Adoption and MGAP Alignment: Despite this interest, baseline adoption of sustainable, climate-resilient practices is low. For example, just 8.3% of farmers practice composting, despite the availability of organic material, and use of chemical fertilizers and pesticides is near-universal. Key gaps hindering the adoption of MGAP are clear: farmers do not test water quality; workers are not formally trained in chemical handling; and farm-level record keeping is largely absent. These shortcomings not only affect farm productivity and environmental outcomes but also limit market access, particularly to premium buyers in the tourism sector. Low MGAP awareness is a fundamental bottleneck. Only 11.7% of surveyed farmers were aware of the certification prior to the study. However, the majority (88%) cited lack of information—not unwillingness—as the key barrier to adoption. This underscores a significant opportunity: targeted extension services and training could substantially increase the adoption of MGAP-aligned practices, especially when linked to clear economic returns.

Financial Viability and Transition Costs: A detailed analysis demonstrates that MGAP certification is financially accessible for most producers. The average certification cost is estimated at 20,040 Maldivian Rufiyaa (MVR) (approximately USD 1,390), 82% of which are one-time infrastructure investments. During the first crop cycle, only a 6.2% price premium is needed to break even; thereafter, the requirement drops to just 1.1%. This makes MGAP a viable entry point for upgrading farm systems. By contrast, comprehensive adoption of sustainable practices carries higher recurring costs, totaling 58,937 MVR (approximately USD 3,833) per crop cycle. To be viable, this model would require buyers to pay a premium of 18.1% initially and 15.2% in subsequent cropping cycles. While such premiums may be achievable in niche resort markets, broader scaling will require cost reduction strategies, particularly around the affordability of organic fertilizers, which account for the bulk of recurring expenses.

Theory of Change and Systemic Pathways: The pathway to sustainable transformation cannot rely on isolated technical interventions. The proposed theory of change emphasizes the need for a systems-based approach, with concurrent investments across knowledge, finance, infrastructure, and policy. Key enablers include expanded access to credit and agricultural insurance; resolution of land tenure insecurity (particularly on short-term leased plots); improved access to high quality, affordable inputs; and a restructuring of aggregation and distribution systems to strengthen farm-to-market linkages. The central proposition is clear: no single intervention will suffice. Instead, success will depend on aligning incentives and building capabilities across the full value chain—from farmers and input suppliers to policymakers and resort buyers—under a shared vision for climate-resilient, market-driven agriculture.

Strategic Recommendations and Implementation Roadmap: The report presents 21 coordinated recommendations, structured across six strategic domains:

- **Strategy and Planning**: Develop a national horticulture master plan and private sector engagement strategy tailored to sustainable, MGAP-certified production.
- **Governance and Policy**: Contextualize MGAP standards for local farming conditions; develop a national input quality policy; and strengthen land tenure structures to unlock long-term investments.
- **Finance**: Expand access to credit, subsidize key inputs, and promote uptake of climate insurance to mitigate investment risks.
- **Innovation and Development**: Strengthen national agricultural data systems, roll out pest and disease protocols, and support island-level innovation platforms.
- **Training and Awareness**: Launch targeted campaigns and training programs to increase farmer understanding and readiness to pursue MGAP certified and adoption of sustainable agricultural practices.
- **Value Chain Infrastructure**: Improve cold storage, expand inter-island transport networks, and establish pricing mechanisms based on product quality.

Implementation is structured along a five-year roadmap that prioritizes investments—such as regulatory reform and capacity-building in the initial phase, followed by infrastructure upgrades and scaling of market access platforms. Financing will need to be mobilized from domestic resources, including Green Tax allocations, as well as from development partners and private sector actors aligned with national climate and food security priorities.

Conclusion: This assessment demonstrates that, with the right investments and policy frameworks, the papaya sector can serve as a blueprint for transforming Maldivian agriculture into a climate-resilient, commercially viable, and environmentally sustainable system. MGAP certification offers an accessible first step, with significant potential to unlock premium market access. To realize this potential, a coordinated, multi-stakeholder effort is required—one that connects farmers to markets, aligns incentives across institutions, and embeds climate resilience into the fabric of agricultural development in the Maldives. This report outlines 21 actionable recommendations to support that transformation, including the development of a national horticulture master plan, contextualization of MGAP standards for smallholders, scaling of farmer training and outreach, and improvements to input quality control and transport logistics. These interventions, structured within a five-year implementation roadmap, provide a clear and actionable pathway to accelerate nationwide adoption of MGAP and sustainable practices.

INTRODUCTION

SCALA-PSEF

The Scaling up Climate Ambition on Land Use and Agriculture (SCALA) Programme, jointly implemented by FAO and UNDP, supports countries in translating their climate commitments into actionable strategies in the agriculture and land-use sectors. Within this framework, the SCALA Private Sector Engagement Facility (PSEF) was launched at COP26 to strengthen collaboration between governments and private actors in advancing adaptation and mitigation priorities.

Maldives Good Agricultural Practices (MGAP): The MGAP certification scheme is a national quality assurance framework developed collaboratively by the MoAAW and MFDA to enhance the safety, quality, and sustainability of horticultural production in the Maldives.

Scope and Standards: MGAP encompasses nearly 200 discrete requirements organized across multiple domains:

- Food safety and contamination prevention
- Environmental management and resource conservation
- Worker health, safety, and welfare
- Produce quality and traceability

The PSEF responds to the critical need for mobilizing private investment in climate-resilient agriculture, particularly in contexts where public financing and institutional capacity alone are insufficient to drive transformative change. By focusing on targeted value chains and market systems, the Facility provides governments with evidence and tools to align private sector incentives with national climate and development goals. This approach is particularly relevant for Small Island Developing States (SIDS) like the Maldives, where agriculture faces structural constraints, and where the risks of climate change compound food insecurity, dependence on imports, and ecosystem fragility.

In this context, the Government of the Maldives requested support from the SCALA PSEF to explore opportunities for mobilizing private sector engagement in the papaya value chain. Papaya was intentionally selected as the focus crop given its importance as a cash crop for Maldivian farmers and its significant role in the domestic agricultural economy. The geographic focus on HA. Maafahi (uninhabited commercially leased island), AA. Thoddoo (key agricultural production center), and Laamu atoll was strategically chosen by the government to represent the diverse production systems found across the Maldives' agricultural islands, rather than attempting to cover all farming locations. The assignment aims to identify pathways for aligning sustainable production practices with market opportunities, thereby strengthening food system resilience while contributing to the country's nationally determined contribution (NDC) and other strategic frameworks, including the National Adaptation Plan (NAP).

Objective of the Study

The primary objective of this study is to assess the potential of the papaya value chain as an entry point for advancing climate-resilient agriculture and private sector investment in the Maldives. By examining production systems, market dynamics, and enabling conditions, the study aimed to:

- Understand the constraints and opportunities facing papaya producers in adopting practices outlined in the Maldives Good Agricultural Practices (MGAP) certification, including a comparative cost-benefit analysis of transitioning from conventional to MGAP-certified production systems, and from MGAP to MGAP+ sustainable production approaches.
- Identify existing adaptation practices and explore how the integration of nature-based solutions (NbS) and ecosystem-based adaptation (EbA) practices can address climate risks while improving farm-level productivity and market competitiveness.
- Identify opportunities for stronger private sector engagement and investment to enhance productivity of the papaya value chain, align incentives for MGAP certification, and support adoption of sustainable agricultural practices.
- Develop an actionable roadmap with strategic recommendations that synthesize findings from the value chain assessment, market analysis, and cost-benefit exercise into concrete steps for enhancing the sustainability, resilience, and profitability of the Maldivian papaya sector through MGAP adoption and sustainable production.

Structure of the Report

This report provides a comprehensive analysis of the Maldivian papaya sector and is organized into four main sections that move from context-setting to detailed findings, to market analysis, and finally to actionable recommendations.

- **Overview of the Agriculture Sector and Climate Context:** This section provides a broad overview of the Maldives' agricultural landscape and food systems, outlining the structural characteristics that shape production, including smallholder and commercial farming systems, geographic concentration of cultivation, and the key natural constraints of land, soils, and freshwater. It also examines the climate context, highlighting the Maldives' high vulnerability to climate change and the implications of rising temperatures, sea-level rise, and shifting rainfall patterns for agriculture and food security. Together, this section sets the stage for understanding the opportunities and challenges facing papaya within the wider agricultural and climate framework of the Maldives.
- **Findings:** This section presents the results of the value chain assessment, with a particular emphasis on agricultural production systems. It provides the first comprehensive analysis of papaya production in the Maldives, including farmer demographics, current productivity, and the major production challenges across seeds, soils, water, pests, and labor. It also assesses the adoption of NbS, EbA, and CSA practices, interest in MGAP certification, and barriers to uptake. Beyond farm-level insights, the section examines input and service provisions, aggregation and logistics, and the dynamics of retail and end markets. Together, these findings establish a detailed evidence base to inform investment priorities and policy decisions for strengthening the papaya sector.
- **Exploratory Market Analysis:** This section examines the demand landscape for MGAP-certified and sustainably produced papaya in the Maldives, with specific emphasis on the tourism sector. It segments the resort, guesthouse, and hotel markets, identifying differences in quality requirements, certification interest, pricing sensitivity, and procurement practices.

The analysis also assesses premium pricing potential and the financial viability of different production scenarios, linking cost estimates for MGAP certification, and adoption of sustainable practices to market opportunities.

- **Actionable Roadmap and Recommended Pathways of Action:** This section sets out strategic options for strengthening the papaya value chain as a model for climate-resilient horticulture. Recommendations are structured for farmers, post-production actors, policymakers, and the parliament. Cross-cutting themes include land access, finance, expatriate labor, and data systems. Immediate actions are highlighted alongside medium-term reforms to create enabling conditions for private investment and sustainable production.

Overview: Agricultural Landscape in the Maldives

The Maldives' unique geography – an archipelago of around 1,190 small coral islands – imposes inherent limits on agriculture. Only an estimated 27 km² of land is cultivable, roughly 10% of the total land area (FAO, 2024). This arable land is fragmented across a few dozen larger islands, while most islands (about 90%) are under 0.5 km² and offer little to no farming space (Asian Development Bank, 2014). Consequently, domestic food production is small in scale, and the nation imports about 90% of its food (FAO, 2024). Despite contributing only a few percent of GDP, agriculture is socioeconomically important – providing livelihoods for roughly 7,600 registered farmers (nearly 5% of the workforce) and acting as a food security "safety net" in outer atolls (Asian Development Bank, 2014) (Asian Development Bank, 2014). Notably, much of this farming is at the subsistence or smallholder level and thus underrepresented in formal economic statistics (Mohamed, 2024). Women play a major role, comprising an estimated 53% of smallholders (FAO, 2024).

Institutional and Policy Framework

The Ministry of Agriculture and Animal Welfare (MoAAW) serves as the primary regulatory authority overseeing the agricultural sector in the Maldives. The ministry's mandate centers on transforming the agriculture sector into a sustainably managed and market-oriented system while maintaining animal welfare, contributing to socioeconomic growth, food security, and sustainable management of natural resources. The National Fisheries and Agricultural Policy (NFAP) 2019-2029, published in 2019, provides the overarching strategic framework for the sector, focusing on decreasing dependency on imports, ensuring food security, and developing industrial levels of self-sustainability. The Maldives' Nationally Determined Contribution (NDC) prioritizes reducing the risk of food shortages through green growth and recovery, promoting climate-smart technologies and practices such as Integrated Pest Management. In February 2025, the Maldives submitted its third NDC to the United Nations Framework Convention on Climate Change, becoming among the first 17 countries and the fourth Small Island Developing State to do so, demonstrating the country's leadership in international climate action. These policy instruments collectively guide MoAAW's efforts to strengthen agricultural resilience, enhance productivity, and integrate climate adaptation measures throughout the sector, with specific emphasis on supporting smallholder farmers and enabling private sector engagement in sustainable agricultural development.

Data limitations in agricultural statistics: It should be noted that comprehensive data on crop-specific production and farmer numbers remains limited. Country-wide data on papaya growers, for example, is not available and is not systematically collected by island councils or the MoAAW. To identify or estimate the total number of papaya growers would require a comprehensive survey including all islands growing papaya, as well as commercial leased islands. Even island councils are often uncertain about the exact number of farming plots or farmers operating on their islands. While farmer lists can be obtained from island councils for specific research purposes, these are typically not crop-specific, highlighting the broader challenge of agricultural data collection in the country.

Key Agricultural Production Systems

The agricultural landscape is characterized by several distinct production systems, as well as critical constraints, as detailed below.

Smallholder Farming Systems: Smallholder farming forms the backbone of Maldivian agriculture. On inhabited islands, many families

cultivate small parcels of land or backyard gardens for home consumption and local sale (Mohamed, 2018). These plots are typically intercropped with perennial and annual crops in a mixed system. A coconut grove often provides the overstory – coconut palm is the dominant crop nationwide– while beneath it, farmers grow staples and fruits such as breadfruit, banana, taro, cassava, and sweet potato for household use. In addition, a variety of vegetables (chili peppers, eggplant, gourds, leafy greens) and fruits (papaya, watermelons, melons, mango, etc.) are cultivated on a small scale where feasible (Convention on Biological Diversity, 2013).

Commercial Leased Islands: To augment agricultural production, the Maldivian government had leased 50 uninhabited islands for commercial agriculture, since 2009. These "agricultural islands" are typically larger land masses set aside for farming enterprises. Leaseholders range from private companies to individual entrepreneurs, operating under agreements with the Ministry of Agriculture. Governance of these leases usually involves long-term land use rights (often 20–30-year leases) with provisions to develop the land for agriculture. On commercial islands, farmers can cultivate at a relatively larger scale than on inhabited islands – entire island plots (several tens of hectares) are utilized, allowing more intensive production of specific crops. High-value horticulture is common: for example, watermelons, papaya, cucumbers, melons, pumpkins, chili and other vegetables are grown in quantity to supply urban markets and resorts. Commercial farms often employ hired labor and may use modern inputs such as irrigation pumps, poly-tunnels or simple greenhouses, and imported fertilizers – to overcome environmental constraints on the atolls. Nevertheless, these operations face the same challenges as smallholders, including soil infertility and limited fresh water. The scale of commercial island farming is modest; most are family-run or are small/medium enterprises rather than large agribusinesses. Institutional support and oversight are focused on improving these islands' productivity, for instance through extension services and credit programs. While the leased islands model has increased domestic output of fruits and vegetables, utilization is not yet optimal (only 24 out of 50 leased islands were fully active in 2022), reflecting challenges in investing in, and managing commercial agriculture production systems (IFAD, 2022).

Geographic Distribution of Agricultural Activity

Agriculture in the Maldives is highly concentrated in certain regions. Given the limited suitable land, most farming occurs on a subset of islands scattered across the atolls. According to the national Master Plan, the potential for agriculture is focused on about 36 islands, primarily those with relatively large land area and freshwater availability (Asian Development Bank, 2014). Of these, only 33 islands exceed 1 km² in size and a mere 3 islands have more than 3 km² of land (Asian Development Bank, 2014). These larger islands – for example, Fuvahmulah (Gnaviyani Atoll), Hithadhoo (Addu Atoll), and Gan (Laamu Atoll) in the south, and islands like Hanimaadhoo (Haa Dhaalu) or Kaashidhoo (Kaafu) in the north/central region have historically supported more extensive cultivation.

Constraints Affecting Agriculture

Land Availability and Tenure: Scarcity of arable land is the fundamental constraint on Maldivian agriculture. With most islands being tiny, low-lying sand cays, there is very limited room for field agriculture. Only about 10% of national land area is suitable for farming, and even that is often a thin

coastal strip or small cleared plot (Convention on Biological Diversity, 2013). This scarcity is exacerbated by competing land uses – settlements, infrastructure and tourism claim a large share of usable land on inhabited islands, leaving minimal space for cultivation. Farms are often confined to marginal areas near island interiors or wetlands. Moreover, the available agricultural land is fragmented across many islands due to the country's dispersed geography (Mohamed, 2018). No single island (aside from a few in the far south) has extensive acreage, so production is split into many small parcels separated by sea. This fragmentation makes it hard to achieve economies of scale.

Land tenure issues further complicate the expansion and efficient use of land. On inhabited islands, farmers typically do not hold freehold titles to farmland; instead, they access land through traditional or community arrangements. In many cases, plots are allocated on a temporary or rotating basis – for example, some island councils assign garden plots seasonally or annually to interested households (Mohamed, 2018). Island councils have the formal authority to allocate land to farming based on land use plans (LUPs), which they prepare and submit for approval by the Local Government Authority. On most islands, any commercial farming activities must be conducted within areas specifically designated for agriculture in these approved land use plans. Short-term tenure and restricted designated areas discourage farmers from investing in land improvements (like tree planting, soil enhancement) since they lack long-term security and may be confined to marginal plots. Even when longer land use rights exist (e.g. a family cultivating the same plot for years), formal documentation may be absent or limited to an informal permit. This uncertain tenure regime has been identified as a barrier to agricultural development in the 2009 Ministry of Agriculture Master Plan. By contrast, the uninhabited islands leased for commercial farming come with formal lease contracts (often 21-years or longer). However, leasing costs and conditions can be a constraint for farmers – upfront investments are needed to clear and develop these islands, and lessees must adhere to usage clauses. Some leased islands reportedly remained idle due to lessees lacking capital or finding the logistics unviable. Additionally, the small size of islands means that even if more land is opened up for farming, each individual plot is still small in size. In summary, land scarcity and tenure insecurity limit the scale-up of cultivation. Efforts are underway to improve land tenure for farmers – for instance, by registering farming plots to individuals and introducing nominal rent/lease fees to formalize usage (Mohamed, 2018). Ultimately, the lack of arable land is a structural constraint that forces Maldives to focus on intensive cultivation of available areas rather than expansion.

Soil Quality and Fertility: The natural soil of coral islands is a major challenge for agriculture. Maldivian soils are geologically young, derived from coral limestone and sands, and thus inherently poor in fertility. Typically, the soil profile is very shallow, often only 20–40 cm of sandy or loamy sand topsoil overlying coral rock or hardpan (Ministry of Environment and Energy, 2015). The soil is coarse textured with high porosity, causing rainwater to drain rapidly. Water retention capacity is low, so plants can suffer moisture stress, even shortly after rains. The soils are also alkaline, with pH values around 8.0 to 8.8, due to the calcium carbonate from coral (Ministry of Environment, Energy, and Water, 2014). This high pH and calcareous nature lead to several nutrient availability issues. Critical nutrients like nitrogen and potassium are naturally very low, as organic matter content is minimal (most soil is essentially ground coral sand with little humus) (ibid). Micronutrients such as iron, zinc, and manganese are often deficient or not in plant-available forms (ibid). Phosphorus tends to be present in the soil, but largely in insoluble forms (bound as calcium phosphate in the alkaline

conditions), making it effectively unavailable to crops (ibid). In some island gardens, pockets of slightly better soil (with more organic matter or a clayey layer in wetlands) exist, but overall soil fertility is very low. Farmers historically mitigated this by adding organic matter (composted leaf litter, manure, fish waste) and by shifting cultivation to rested plots. Today, most farmers must rely on substantial fertilizer inputs to achieve reasonable yields (ibid). Chemical fertilizers (urea, NPK blends) are widely used, as are imported growing media for high-value crops. The extensive use of fertilizers is a direct response to the nutrient-poor soils (ibid). This raises costs and, if mismanaged, can cause environmental issues (nutrient runoff to groundwater and lagoons). Soil salinity is another concern – given the proximity to the ocean, salt spray and occasional overwash can accumulate salts in topsoil, further reducing fertility. In some islands, a hard calcium-carbonate pan layer impedes root penetration and exacerbates drainage issues. Overall, poor soil quality severely limits what can be grown. Shallow rooting crops and salt-sensitive plants have difficulty growing in these conditions. This constraint has driven interest in soilless culture (hydroponics) and heavy mulching/composting practices to improve soil structure. The Master Plan emphasizes the need for soil amelioration measures (like green manuring, adding organic matter) to sustain agriculture on these atolls. Without significant soil inputs, many islands can only support coconut, breadfruit, and a few hardy species. Improving soil fertility –within the physical limits of coral sand–is an ongoing struggle for Maldivian farmers.

Freshwater Availability: Reliable freshwater for irrigation is extremely scarce in the Maldives. There are no rivers or streams on the small coral islands; the only natural source of fresh water is the groundwater lens and seasonal rain. Each island has a lens-shaped aquifer of rainwater that floats atop the denser saltwater beneath the ground. These freshwater lenses are typically thin and fragile – on very small islands the lens may be only a meter or two thick or virtually nonexistent (Ministry of Environment, Climate Change, and Technology, 2023). Rainfall recharges the groundwater, but rainfall in Maldives has seasonal variability (a wetter southwest monsoon from May–October and a drier season from January–April), and is becoming increasingly erratic. During dry periods, wells can turn brackish as the freshwater lens shrinks. Irrigation of crops mainly relies on shallow well water or rainwater harvesting, since piped water or large-scale irrigation infrastructure is absent on most islands (IFAD, 2022). Farmers often use buckets to draw water from household wells or use small pumps, but they must be cautious not to over-abstract groundwater. Overuse of the lens can draw in seawater intrusion quickly, negatively affecting the water supply. In fact, saline intrusion is a constant threat – about 80% of islands are less than 1 meter above sea level, so storm surges or high tides can easily contaminate the groundwater with salt (FAO, 2024). Extreme events have demonstrated this vulnerability: for instance, the 2004 Indian Ocean tsunami inundated several agricultural islands with seawater, salinizing up to 60% of cultivated land nationwide and rendering some soils infertile for years (Asian Development Bank, 2014). Even without disasters, gradual sea-level rise is leading to chronic saltwater intrusion into aquifers.

In recent years, some islands have implemented Integrated Water Resource Management systems – combining rainwater harvesting tanks, community desalination plants, and groundwater recharge – to secure water supply (Human Rights Watch, 2025). Desalinated water, while used for drinking on many islands, is generally too expensive for routine farm irrigation. Therefore, maximizing rainwater capture (roof tanks, pond reservoirs) and using water-efficient irrigation (drip irrigation, hydroponics) are key strategies recommended by the Master Plan. Overall, the lack of fresh water

is one of the most acute constraints on Maldivian agriculture, making it heavily dependent on rainfall and vulnerable to climate variability.

Island Dispersion and Fragmentation: The extreme dispersion of islands across the archipelago creates significant logistical and market challenges for agriculture. Farms are spread over hundreds of kilometers and dozens of islands, separated by the sea. According to assessments, the dispersed island geography "impedes the supply of farm inputs to outer islands and the delivery of produce to marketing hubs" (Van Driessche, 2023). This geographic fragmentation means that transporting inputs to farms and outputs to markets is costly and complicated. Farmers on remote islands face difficulty obtaining quality seeds, fertilizers, tools, and machinery – such inputs must be shipped by boat from Malé or a regional center, which is often infrequent and expensive. The limited demand on each small island also means input suppliers are scarce outside the capital. Likewise, moving harvested produce to buyers is a major hurdle. Each island produces relatively small quantities, and without economies of scale, it is inefficient to collect, and ship produce from every island to the main market in Malé (Van Driessche, 2023). Transport by boat is slow; perishables can spoil en route if not handled properly. Cold chain facilities are nearly absent on outer islands. This increases post-harvest losses and reduces the competitiveness of local produce against imports. The scattered production also leads to market irregularities – gluts and shortages – since coordinating supply from many islands is challenging. Additionally, agricultural extension and support services are strained by dispersion: reaching farmers on hundreds of islands for training, veterinary care, or technical advice requires significant resources. The government has tried to improve market linkages by establishing collection centers and cooperative markets in some regions, and by encouraging private sector trading networks that buy in bulk from island farmers. However, high inter-island transport costs are built into the system. Any strategy to strengthen Maldivian agriculture must take this into account, for instance, by using boat networks, improved storage, and digital platforms to link widely scattered producers and consumers. The Master Plan and UN/FAO programs emphasize improving connectivity (both physical and institutional) as critical to overcoming the constraints due to fragmentation (FAO, 2024; (Van Driessche, 2023).

Overview: Climate Analysis

Maldives is among the world's most climate-vulnerable nations yet contributes only a negligible share of global emissions (Government of Maldives, 2023). Under the Paris Agreement, it has made bold commitments to both mitigate greenhouse gases and adapt to climate impacts. The Maldives submitted its first Nationally Determined Contribution (NDC) in 2015, pledging a 10% reduction of emissions below business-as-usual (BAU) by 2030, expandable to 24% with international support (Government of Maldives, 2020). This ambition was significantly increased in its 2020 NDC update, which targets a 26% emissions reduction by 2030 and even aspires to achieve net-zero carbon emissions by 2030, conditional on sufficient external assistance (ibid). Notably, a Climate Emergency Act was enacted in 2021 to provide a legal framework for this net-zero 2030 goal (Ministry of Foreign Affairs, 2025). While a 2050 timeline for net-zero is a benchmark for many countries, Maldives' leadership has pledged to reach that outcome far earlier if possible, underscoring the urgency it faces.

Maldives' climate commitments focus on adaptation and resilience alongside mitigation. The updated NDC places "equal importance" on enhancing adaptation capacity to protect communities and livelihoods (Government of Maldives, 2020). For example, it highlights the need to safeguard food and water security through initiatives like the Climate Smart Resilient Islands model launched in 2019 (The President's Office, 2019). In international forums, the government consistently links its net-zero vision with building resilience in critical sectors such as agriculture and fisheries. This is evident through the inclusion of adaptation targets (e.g. improving crop productivity and water access by 2030) in the NDC, and Maldives' advocacy for global funding to address loss and damage in vulnerable sectors (Government of Maldives, 2020). Overall, the Maldives' Paris Agreement commitments – capped by a net-zero pledge by 2050 (with a best-case scenario of 2030) – establish an ambitious policy backdrop that integrates emissions cuts with strengthened resilience for food security and sustainable agriculture.

Key Concepts

Nature-based Solutions (NbS): Actions to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems which address social, economic and environmental challenges effectively and adaptively, while simultaneously providing human wellbeing, ecosystem services, resilience and biodiversity benefits. (United Nations Environment Assembly (UNEA 5.2))

Ecosystem-based Adaptations (EbAs): The use of biodiversity and ecosystem services as part of an overall adaptation strategy to help people adapt to the adverse impacts of climate change. (Convention on Biological Diversity)

Climate-smart Agriculture: An approach to help the people who manage agricultural systems respond effectively to climate change and pursues the triple objectives of sustainably increasing productivity and incomes, adapting to climate change and reducing greenhouse gas emissions where possible (FAO)

National Adaptation Plan

To operationalize its climate goals, Maldives has initiated a comprehensive National Adaptation Plan (NAP) process. The NAP is envisioned as a strategic, medium- to long-term plan to reduce climate vulnerability across all sectors of the economy (NAP Global Network, 2025). This process aims to

integrate climate adaptation into national and sectoral development planning – ensuring it becomes a core component of policies rather than a standalone agenda. Key institutional steps have included establishing a high-level Climate Change Council and developing a NAP Framework to guide sector consultations (ibid). As of 2025, the Maldives had formulated a vertical and horizontal integration model to coordinate adaptation actions across national, atoll, and island levels and across ministries (ibid).

The emerging NAP identifies priority thematic areas that align with Maldives' greatest vulnerabilities. These include coastal zone management and protection, given that 80% of islands are barely one meter above sea level (NASA, 2021). Water resources and freshwater security are another focus, as rainfall patterns change, and groundwater lenses are at risk. Agriculture and food security feature prominently as well – reflecting concerns that climate change could further undermine local crop production and self-sufficiency (NAP Global Network, 2025). Other critical sectors addressed in the NAP process include fisheries, public health, infrastructure, tourism, and biodiversity conservation. For each sector, the NAP will outline adaptation strategies and actions through an evidence-based, consultative approach. Importantly, the NAP emphasizes NbS and EbAs as cross-cutting principles (NAP Global Network, 2025). This means solutions like restoring coastal vegetation, enhancing rainwater harvesting, and climate-proofing agriculture will be prioritized to build resilience. Though Maldives' NAP is still in development (as of 2025), safeguarding agriculture and food security is a core objective within the national adaptation agenda.

Island-level Adaption Plans: Effective adaptation in Maldives must happen not only at the national level but also in its island communities. The country's unique geography – with over 188 inhabited islands spread across atolls – demands localized planning. In recognition of this, Maldives is pursuing Island-level Adaptation Plans, sometimes referred to as tailored climate responses to local needs. As part of the NAP process, a model for "vertical integration" has been developed to link national policies with atoll and island council actions (NAP Global Network, 2025). This enables each island to identify its specific climate risks and adaptation priorities within the broader national framework. The intention is that island councils and local stakeholders will be engaged through consultations and capacity-building so they can formulate and implement adaptation measures on the ground.

Key Climate Risks Affecting Agriculture in Maldives

Maldives is experiencing tangible climate changes that pose escalating risks to its agriculture. Observed climate trends include a steady increase in temperature – about 0.8°C of warming from 1978 to 2018 – leading to more frequent hot days (Only One, 2024; ReliefWeb, 2021). Farmers report shifts in rainfall patterns, with rainfall becoming more erratic and long dry spells more common in some regions. Projections indicate overall rainfall variability will increase, potentially bringing heavier short-term downpours but also longer drought periods (United Nations Maldives, 2024). Such variability directly impacts crop growing cycles, water availability, and pest pressures. Extreme weather events are also a growing threat. Though outside the usual cyclone belt, Maldives has seen stronger windstorms, intense thunderstorms, heavy monsoon rains, and periodic flooding in recent years (Government of Maldives, 2023). Farms are vulnerable to flash floods and saltwater inundation

during storm surges. High winds can physically damage orchard crops like papaya – snapping shallow-rooted trees or stripping off flowers and fruit.

Sea-level rise is an existential issue underpinning many other risks. Over 80% of Maldivian land lies less than 1 meter above sea level, and global seas are rising ~3–4 mm per year (NASA, 2021). Even in a 1.5°C warming scenario, the IPCC projects ~0.5 m of sea-level rise by 2100, and up to 1 m in high-emission scenarios (ibid). This gradual rise, combined with wave-driven flooding, means coastal erosion and saltwater intrusion are already affecting agriculture. High tides and storm surges can lead to saline water seeping into island aquifers and soils, especially on smaller islands (United Nations Maldives, 2024). Farmers in some atolls have reported increasing soil salinization, which stunts or kills salt-sensitive crops like papaya. Once soil is salinated or lost to erosion, it is very difficult to cultivate crops without costly interventions. Similarly, freshwater scarcity is worsening: many islands rely on shallow groundwater lenses recharged by rain, but prolonged droughts and salt intrusion have caused wells to become brackish or dry (ibid). Limited freshwater leads to irrigation shortages during critical growing months, resulting in lower yields and crop failures in extreme dry years.

These climate stressors have numerous impacts on horticulture and papaya production. Higher temperatures and prolonged dry periods have been linked to more frequent pest and disease outbreaks on crops (Van Driessche, 2023). Warmer conditions also alter pest life-cycles – accelerating reproduction and expanding the range of some invasive species – which can lead to persistent infestations. The Maldivian government notes that pest outbreaks during extended dry periods have become a serious issue, with increased temperatures even contributing to pests developing resistance to pesticides (ibid). This in turn forces farmers to apply more chemical controls, raising production costs and food safety concerns. On the other extreme, intense rains and humidity can spur fungal diseases (such as root rot or anthracnose on fruit), further threatening yields. Beyond pests and diseases, climate hazards impact crop productivity and quality. Heat stress and water deficits can reduce papaya flowering and fruit set, leading to smaller harvests (Choudhurry et al., 2022). Salt damage from brackish irrigation water or sea spray causes leaf burn and can kill young papaya plants or render fruit inedible (Álvarez-Méndez et al., 2022). Storms and flooding not only destroy crops but also leach away topsoil and nutrients, degrading the land for subsequent planting (Palanivel & Shah, 2021).

Climate variability also undermines the logistics and economics of agriculture in Maldives. Unpredictable weather and rough seas disrupt inter-island transport, vital for moving agricultural inputs and produce. The government reports that extreme weather events and sea transport challenges make it difficult to ensure a reliable food supply and continuity of local production (Van Driessche, 2023). For example, multiple consecutive stormy days may delay a supply boat, causing harvested papayas to spoil before they reach the market, or prevent farm supplies (seeds, fertilizer) from arriving on time. Such disruptions hit isolated farming communities the hardest and can lead to price volatility or harvested fruits not reaching market. All these factors – yield losses, higher input costs for pest control, infrastructure damage, and transport interruptions – compound to make local farming more costly and less competitive. Maldives' agriculture, which already contributes only ~1% to GDP, struggles to compete with imported produce under these conditions (Van Driessche, 2023). The country is now heavily dependent on food imports, and climate change threatens to deepen this

dependence by impeding efforts to boost domestic production (Van Driessche, 2023). In sum, rising temperatures, shifting rainfall, extreme events, sea-level rise, and freshwater scarcity collectively pose a serious challenge to Maldivian agriculture, increasing risks of crop failure, food insecurity, and livelihood losses in farming communities. Papaya growers are on the frontlines of these risks, given the crop's sensitivity to environmental stress.

Opportunities for Climate-Resilient Agriculture

While the threats are significant, there are many opportunities to build climate resilience and adaptation into Maldives' papaya production and horticulture sectors. The Maldivian government, supported by international partners, is actively promoting NbS that can help farmers adapt and even thrive under new climatic conditions. Key priority measures for climate-resilient papaya and horticulture are outlined below:

Figure 1: Evidence-based Sustainable Practices in Papaya Production

Sustainable Practices	Evidence
Soil Fertility & Carbon Management • Composting and organic amendments • Organic fertilizer • Green manures and cover crops	In one trial, **organic fertilizer combinations** (75% recommended nutrients via farmyard manure + vermicompost + Azospirillum bacteria + mycorrhizal fungi) produced 31.9 kg fruit per plant compared to 18.7 kg per plant with 100% chemical fertilizers—a **70.6% yield increase** over 18 months.[1] **Leguminous cover crops** enhance papaya production through improved soil structure and natural nitrogen fixation. Brazilian studies demonstrate that calopo, sunn hemp, pigeon pea, and jack bean consistently produce higher papaya yields than clean cultivation while improving soil aggregate stability.[2]
Water & Climate Regulation • Enhanced irrigation and sprinkler systems • Mulching • Agroforestry	Compared to traditional flooding, **sprinkler and drip irrigation systems** provide clear benefits for papaya cultivation in terms of yield stability, disease reduction, and water efficiency.[3] In one trial, **mulching** increased papaya yield from 43.02 to 46.20 kg per plant, a 7.4% gain, and improved irrigation water-use efficiency from 47.99 to 51.57 kg m^{-3}, a 7.5% increase.[4] **Tree windbreaks** around papaya blocks cut near-surface wind speeds across a zone extending roughly 10 times the windbreak height, which lowers stem breakage and uprooting, reduces fruit scarring and disease spread, and improves yield.[5]
Pest, Disease, & Biodiversity Management • Integrated pest management (IPM) • Intercropping and habitat creation • Biopesticides	**IPM** centered on biological control (papaya mealybug parasitoids) and area-wide fruit fly suppression (GF-120 + sanitation + trapping) cuts pest pressure sharply and translates into higher production/marketable yield at farm or program scale.[6,7] **Plant essential oils achieve exceptional efficacy** against papaya pests, with neem oil (1.5%) plus isopropyl alcohol delivering 95.5% papaya mealybug mortality after 72 hours. This outperforms chemical controls (91% efficacy) while supporting ecosystem health.[8]

Sources: 1) Reddy et al., 2013; 2) Cruz et al., 2014; 3) Singh & Singh, 2019; 4) Gaat et al., 2023; 5) FAO; 6) CABI, 2024; 7) Vargas et al., 2007; 8) Heliyon, 2023

Approach and Methodology

The methodology was designed to establish a robust evidence base on the papaya value chain in the Maldives, where systematic data on production practices and market dynamics has been limited. The objectives were to document current farm practices, capture perspectives across the value chain, and identify feasible pathways for adoption of MGAP, integration of sustainable, regenerative practices, and private sector engagement. The research team applied a mixed-methods design comprising quantitative farmer surveys, farmer focus group discussions and in-depth interviews, and key informant interviews with market system actors.

Primary Data Collection

Geographic focus: Primary fieldwork was conducted in HA. Maafahi, AA. Thoddoo, and Laamu Atoll to represent the range of production systems present in the Maldives, including commercial production, intensive smallholder systems, and dispersed smallholder farming. This was complemented by secondary analysis in Malé, the central aggregation and distribution hub, and structured consultations with selected resort locations to capture high-end buyer requirements and potential for private sector partnership.

Quantitative surveys with farmers: Primary data were collected from 60 papaya farmers in two main production areas which included 38 farmers from AA. Thoddoo (n = 38; 63.3 percent of total sample) and 22 farmers from Laamu Atoll (n = 22; 36.7 percent**)**, complemented by observations and a key informant interview with the farm manager at HA. Maafahi, a commercial operation managed by Seagull Group. Structured surveys were implemented to generate a reliable baseline on papaya production and adoption of practices relevant to MGAP certification, NbS, EbA, and CSA. Given that the MGAP standard includes nearly 200 discrete requirements, the research team identified and prioritized the most critical and high-risk practices for certification—focusing on those related to soil amendments, water quality and application, pesticide use and storage, post-harvest handling, worker safety, and records management. In addition, the survey instrument investigated the adoption of NbS, EbA, and CSA practices, spanning the following functional areas of soil fertility and carbon management, 2) water and climate regulation, 3) pest, disease, and biodiversity management. These practices were selected and validated by two national agronomists: Mr. Adheel Adam and Ms. Aminath Aroosha. The structure of the survey enabled comparative analysis against MGAP requirements and sustainability benchmarks, allowing the team to quantify current adoption, identify practice gaps, and assess the potential for scaling up under various implementation scenarios.

Farmer focus group discussions and in-depth interviews: To complement the surveys, the team conducted five focus group discussions and five one-on-one in-depth interviews with farmers in each target location. These consultations explored perceived risks, expected costs and benefits, and the enabling support required for adoption of both MGAP critical practices and priority NbS options. Discussions assessed readiness to invest, likely sequencing of improvements, and preferences for extension, finance, and market incentives. Participants were purposively grouped by farm size and production experience to encourage candid exchange, and women farmers were included where possible to incorporate gender perspectives.

Key informant interviews with value chain actors: Key informant interviews mapped services, markets, and institutions that shape farmer decisions and influence demand for quality and certification. Interviews were conducted with input suppliers, aggregators, distributors, buyers in tourism and retail, regulators, and financial institutions to identify systemic constraints and investment opportunities. A two-phase structure was used: an initial round during the farmer survey period to complete the value chain map, followed by a second round during market analysis to test buyer specifications, assess certification credibility and willingness to source MGAP-compliant produce, and explore financing mechanisms relevant to farm-level upgrades and NbS adoption. Key informant interviews were conducted with the following actors:

- Input and service providers (three key informant interviews)
- Transporters, wholesalers, and Malé "cubicle"/small vendors in Malé markets Local governance institutions, namely the AA. Thoddoo Island Council and two councils in Laamu
- Five guesthouses sourcing papaya in local markets (five)
- One resort
- Government institutions: former AgroNat Distribution Center in Laamu; Ministry of Agriculture and Animal Welfare (MoAAW); Ministry of Agriculture's Agricultural Research Center; Ministry of Agriculture's Maldivian Agribusiness Project (MAP); Maldives Food and Drug Authority (MFDA); Ministry of Tourism and Environment (MoTE)
- Financial institutions: SME Development Finance Corporation (SDFC); Allied Insurance
- A technical expert on MGAP certification

Findings

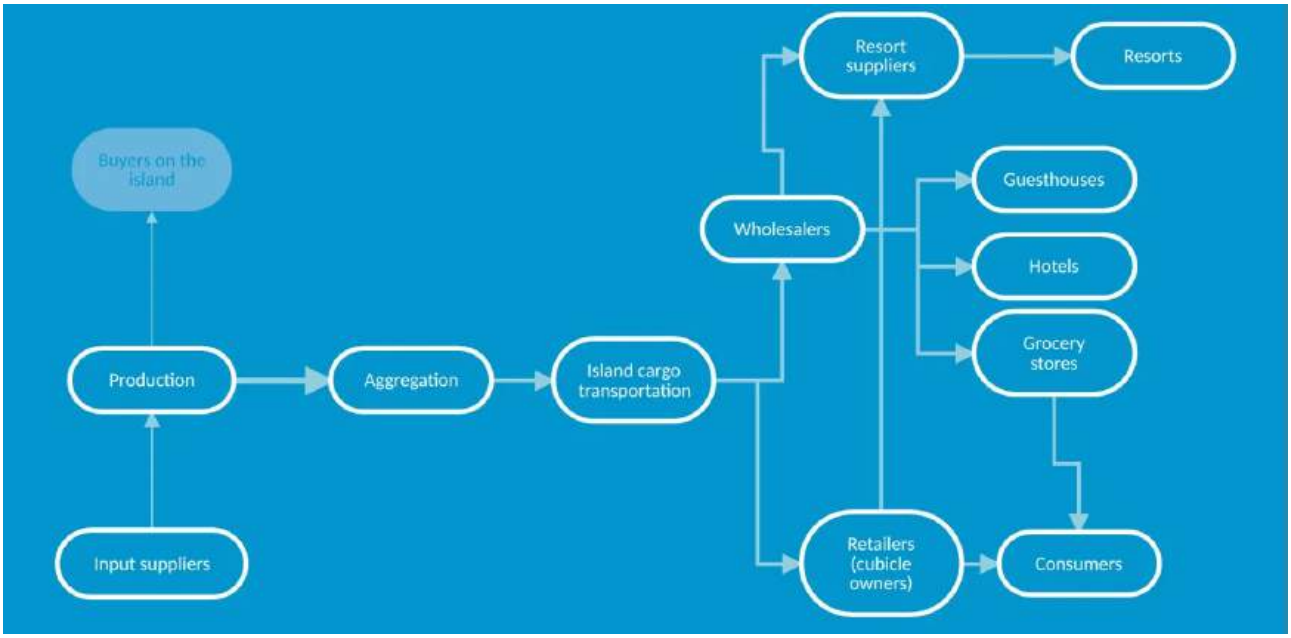
In the following sections, we articulate the results from the papaya value chain analysis and exploratory end market assessment. The findings present an exhaustive analysis of the production sector, adopting a production-centered analytical framework that reflects critical data gaps in systematic agricultural information and the fundamental importance of establishing baseline conditions before designing interventions to promote MGAP certification and sustainable agricultural practices. Findings are based on interviews with other value chain actors, describing opportunities and challenges across each segment from production to end markets, as well as the broader enabling environment. This integrated approach provides a foundation for understanding current value chain dynamics and identifying strategic intervention points for enhancing sustainability, climate resilience, and market integration within the Maldivian papaya sector.

Papaya Value Chain

The research informed the value chain map pictured below, which traces the flow from production to end markets across key farming islands, particularly AA. Thoddoo and islands in Laamu Atoll, along with commercial operations like HA. Maafahi. The value chain structure reveals a system that is largely not interconnected until produce reaches Malé-based wholesalers, who serve as the central distribution hub. From this point, papaya flows through multiple channels to diverse end markets including resort suppliers, guesthouses, hotels, grocery stores, and retailers serving local consumers. These downstream actors maintain numerous interconnected relationships with each

other, but this network of market connections is largely held by the wholesalers in Malé. This structure clearly depicts how farmers are largely isolated from the rest of the value chain. Producers have limited connectivity beyond selling to local aggregators or middlemen and are disconnected from the diverse array of end markets and buyers that exist downstream. The concentration of market relationships in Malé-based intermediaries limits farmers' ability to access information about end market demand, negotiate prices, or capture value from premium market segments. This overview provides a general framework for understanding the papaya value chain, though it should be noted that connectivity patterns may vary among individual farmers and production systems. The dynamics and implications of this structure are covered more thoroughly throughout the rest of this report.

Figure 2: Papaya Value Chain



Production

1. Demographics and Farm Profile

The survey results indicate that papaya farmers in the Maldives constitute a relatively mature and experienced population. The average age of farmers was 46.7 years, with an average of 10.8 years of papaya cultivation experience. Production is highly male dominated, with 84.7 percent of respondents identifying as male, reflecting broader gender imbalances observed across the agricultural sector. Focus group discussions further confirmed that women's roles are largely indirect, often linked to family guesthouses or marketing, with limited involvement in production or certification decision-making.

A critical structural divide in the papaya sector relates to land tenure, which strongly shapes production strategies and investment behavior. Overall, 42.4 percent of farmers both own and directly manage their farms. However, notable differences exist between locations. In Laamu Atoll, 66.7 percent of farmers own their land, while in Thoddoo the vast majority (94.7 percent) lease land from the government. This divergence in tenure arrangements has direct implications for investment horizons and willingness to adopt certification standards. Farmers in Laamu emphasized that secure tenure makes them more willing to invest in irrigation, greenhouses, and even agroforestry buffers. By contrast, Thoddoo lessee farmers consistently reported withholding investments in permanent infrastructure or natural windbreaks due to the current lease tenure structure, which is 3-5 years but had been extended by one year at the time of the August 2025 scoping exercise. One farmer in Thoddoo described investing only in short-term inputs, noting that decisions about long-term improvements would not be viable without more secure leases.

Farm scale also differs significantly across the two production systems. The average farm size in Laamu was 19,700 square feet, compared to just 8,012 square feet in Thoddoo. Despite this gap, planting densities are similar, indicating that Thoddoo farmers rely on more intensive spacing strategies. Focus group participants explained that small, leased plots are deliberately crowded to maximize returns in the short lease period. While economically rational, this intensification raises pest and disease pressure—particularly the yellow crinkle virus—and drives higher reliance on chemical controls.

Management patterns further highlight these structural differences. In Laamu, 61.9 percent of farms were directly managed by their owners, compared to only 31.6 percent in Thoddoo. Direct management is often associated with faster uptake of certification requirements, as owner-managers are better positioned to implement and monitor compliance measures without relying on intermediaries or delegated labor. In Thoddoo, focus group and interview data revealed a different management structure where foreign workers lease and independently operate farms, with landowners limiting their involvement primarily to input supply and rent collection. This arrangement reinforces reliance on informal peer-to-peer knowledge and reduces exposure to formal extension or training, contributing to the limited MGAP awareness observed in survey data. The case of Maafahi Island, which is leased to the commercial agricultural entity Seagull Group, spans 140,000 square feet, making it 7.4 times larger than the average Laamu farm and nearly 20 times larger than

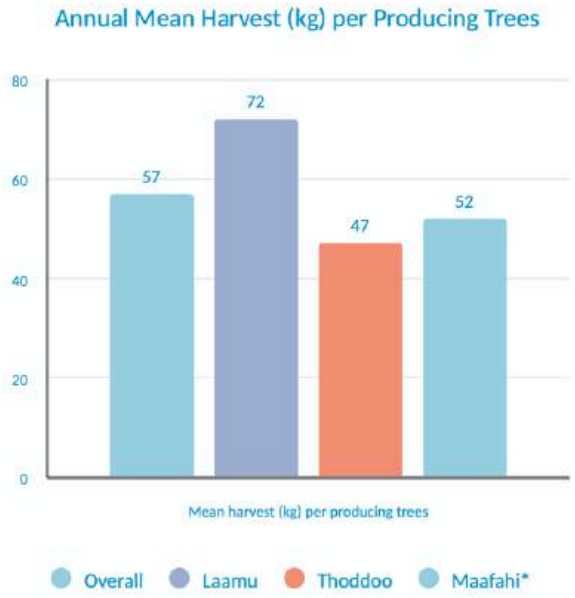
the typical Thoddoo plot. With over 25 years of cultivation experience, Maafahi illustrates the potential scale and sophistication of commercial horticulture in the Maldives.

Table 1: Demographics

Indicator	Overall	Laamu	Thoddoo	Maafahi*
Mean age (years)	46.7	44.7	47.8	NA
Mean farming experience	10.8	6.3	13.3	NA
Own and directly manage (%)	42.4	61.9	31.6	No
Lease from government (%)	67.8	19.0	94.7	Yes
Own land (%)	23.7	66.7	2.6	No
Average farm area (sq ft)	13,206	19,700	8,012	140,000

*Maafahi represents a single commercial operation (Seagull Group) and is not included in overall averages

2. Productivity and Economic Outcomes



Productivity: Average papaya production across surveyed farms was 11,586 kilograms per year, with 92.8 percent of output sold in commercial markets. Farm-level outcomes show a sharp productivity divide. Yields in Laamu were 164 percent higher than in Thoddoo despite comparable tree counts, pointing to differences not only in agronomic practices and management incentives but also in biotic stress factors. Field observations confirmed that all surveyed Thoddoo farms showed signs of papaya yellow crinkle disease, a major viral disease that reduces yields and shortens the productive lifespan of trees. This heightened disease pressure compounds the effects of more intensive planting densities in Thoddoo, which increase pest susceptibility and require more rigorous nutrient and canopy management.

Per-tree productivity reveals the magnitude of regional production challenges. Laamu farmers achieve 72 kilograms per producing tree annually compared to only 47 kilograms in Thoddoo—a 53 percent difference that translates directly into farm profitability. This productivity gap is particularly concerning given that Thoddoo farms maintain both higher numbers of producing trees (186 versus 178) and significantly higher planting densities (27 trees per 1,000 square feet compared to 11 in Laamu), suggesting that intensification efforts cannot compensate for underlying biotic stress and

management constraints. While the study did not capture variety-specific yield data, both regions primarily cultivate Holland/Israel hybrid, though Thoddoo farmers increasingly report transitioning to Red Lady variety due to its perceived superior disease resistance—a shift discussed in detail in Section 5 on genetic material management.

Table 2: Productivity and Economic Outcomes of Papaya Farms

Indicator	Overall	Laamu	Thoddoo	Maafahi*
Mean harvest (kg)	11,586	13,187	8,400	62,400
Mean harvest (kg) per producing trees	57	72	47	52
Total trees per farm	217	219	215	1,200
Producing trees per farm	192	178	186	1,750
Price per kg (MVR / USD)	14.1 ($0.92)	20.2 ($1.32)	10.6 ($0.69)	18.0 ($1.18)
Annual papaya income (MVR / USD)	151,017 ($9,870)	321,182 ($20,992)	52,500 ($3,431)	200,000 ($13,072)
Percentage sold	92.8	93.2	92.5	78

*Maafahi represents a single commercial operation (Seagull Group) and is not included in overall averages

Price and Income: Seasonal price fluctuations were reported by 98.3 percent of farmers. Price differentials further amplify disparities between study locations. Laamu farmers received an average of 20.2 MVR per kilogram ($1.32/kg) compared to only 10.6 MVR per kilogram ($0.69/kg) in Thoddoo—a 90 percent price premium that defies conventional expectations given Thoddoo's geographic proximity to Malé markets. The factors driving these counterintuitive price patterns, including market structure and aggregation dynamics, are examined in detail in Section 11 on Farmer Marketing. Given productivity and price advantages, the income gap is substantial. Laamu farmers earned an average of 321,182 MVR (20,992 USD) annually from papaya, more than six times the income reported in Thoddoo (52,500 MVR (3,431 USD)). *It should be noted that income figures are self-reported and given that most farmers do not maintain formal records; estimates are subject to recall bias and should be interpreted as indicative rather than precise.*

Production costs also shape these disparities: On average, farmers in Thoddoo spend roughly 45,000 MVR (2,941 USD) more per year than their counterparts in Laamu, despite achieving lower yields and prices. Annual labor expenses are the main driver, averaging 75,263 MVR (4,919 USD) in Thoddoo compared to 30,000 MVR (1,961 USD) in Laamu. This reflects structural differences in management: many Thoddoo farms are leased and operated by hired foreign workers, while Laamu farms are more often directly managed by owners. Other production costs were broadly similar across locations. Fertilizer expenditures ranged from 10,000–12,000 MVR (654-784 USD) per farm annually, pesticide expenditures from 1,900–2,200 MVR (124-144 USD), and seedling costs from 600–1,500 MVR (39-98 USD). Transport costs, however, diverge sharply. Laamu farmers reported average annual transport costs of 6,614 MVR (432 USD), nearly three times higher than Thoddoo farmers (2,382 MVR (156 USD)), reflecting both longer distances to Malé and higher on-island logistics costs. Thoddoo farmers, by contrast, benefit from shorter vessel routes and aggregation practices that reduce individual transport outlays. These cost structures help explain why Laamu farmers—despite paying more for transport—achieve stronger net returns, while Thoddoo's reliance on hired labor erodes profitability and widens the income gap. *It should be noted that cost figures are self-reported and given that most farmers do not maintain formal records; estimates are subject to recall bias and should be interpreted as indicative rather than precise.*

Price Disparities Between Thoddoo and Laamu

At first glance, this differential is puzzling. Laamu farmers face longer transport times—up to two days by vessel to Malé—while Thoddoo farmers can deliver to the same market within two to four hours. With broadly similar product quality and both groups relying on Malé cubicles as the ultimate marketing channel, one would expect Thoddoo farmers to capture equal or higher prices. The fact that the reverse is true suggests that factors beyond distance and perishability are shaping farm-gate prices.

One potential explanation raised in interviews is the degree of market integration and control within Thoddoo. Production there is dominated by Bangladeshi lessees, many of whom depend on Malé-based cubicle owners—also frequently Bangladeshi—for both transport and downstream sales. This vertically integrated system appears to reduce farmers' price bargaining power, functioning almost as a monopsony or cartel. Laamu farmers, by contrast, sell through more fragmented channels, which may prevent price suppression and allow them to capture a greater share of end-market value.

While further research is needed to confirm these dynamics, the fact remains that Thoddoo's geographic advantage has not translated into price premiums. Instead, structural market arrangements may be reinforcing income disparities. This underscores the importance of analyzing transport and marketing systems in greater detail (see section Aggregation & Distribution).

Commercial operations: The Maafahi farm illustrates a distinct commercial-scale model. With 1,750 trees—over seven times more than the average Laamu farm—and infrastructure including chillers and professional management, the farm produced 62,400 kilograms annually. Yet total income from papaya was only 200,000 MVR, or 38 percent less than the Laamu average, despite producing 3.6 times more volume.

3. Main Challenges Faced by Farmers

Understanding the challenges currently constraining papaya farmers is essential for designing effective interventions that promote the adoption of MGAP certification and integration of NbS. Before introducing new standards or promoting NbS, EbA, or CSA practices, policymakers and development practitioners must consider the fundamental production and market constraints that farmers are currently facing. The survey results reveal that farmers face a complex set of interconnected challenges, with pests and diseases emerging as the most widespread concern, affecting 68 percent of respondents overall. High input costs and low market prices constrain 57 percent of farmers, while competition from imports affects 38 percent. Notably, these challenges manifest differently across production systems: Thoddoo farmers are disproportionately affected by pest and disease pressure (79 percent) and low market prices (76 percent), while Laamu farmers face greater constraints from weather and climate issues (64 percent) and high input costs (64 percent). These geographic variations in severity of challenges have direct implications for the design and sequencing of MGAP and NbS interventions, as detailed in Table 3 below. Other key challenges that came up during qualitative interviews include wind damage, land tenure, infrequent transportation (particularly in Laamu), and marketing challenges. This section is meant to provide a high-level overview of the main challenges faced by farmers. The subsequent sections will provide greater detail on the identified challenges.

Table 3: Main Challenges Faced by Farmers

Challenge	Overall	Laamu	Thoddoo	Maafahi*
Pests and diseases	68%	50%	79%	Yes
High input costs	57%	64%	53%	Yes
Low market prices	57%	23%	76%	Yes
Competition from imports	38%	5%	58%	No
Weather/climate issues	37%	64%	21%	Yes
Lack of technical knowledge	25%	14%	32%	No
Access to credit/financing	23%	36%	16%	Yes
Transportation/logistics	13%	36%	0%	Yes
Lack of storage	5%	5%	5%	No
Labor shortage	0%	0%	0%	Yes

*Maafahi represents a single commercial operation (Seagull Group) rather than multiple farmers, so responses are indicated as “Yes/No” rather than percentages and are not included in overall averages

4. Climate Challenges and Environmental Pressures

Papaya production in the Maldives is increasingly shaped by climate variability and environmental stressors that affect every stage of the value chain—from seed selection and field preparation to harvesting and market access. These challenges are central to how farmers make production decisions and prioritize resources. This section provides an overview of how farmers perceive and experience climate change, highlighting regional differences in vulnerability and impact, as well as the environmental pressures they most frequently report. Section 12. Nature-based Solutions, Ecosystem-based Adaptations, and Climate-smart Agricultural Practices provide greater insight on farmers' adoption of various NbS and CSA practices.

Climate Change Perceptions and Regional Variations

A large majority of farmers (86.7 percent) report observing changes in weather patterns and growing conditions due to climate change. However, the intensity and types of changes perceived vary significantly between production areas. Thoddoo farmers report universal climate change impacts (100 percent), while 27.3 percent of Laamu farmers observe no changes, suggesting different exposure levels, adaptive capacity, or baseline vulnerability conditions. The commercial Maafahi operation reports exclusively "significant" rather than moderate changes, suggesting that commercial-scale operations may be more acutely aware of climate impacts. This heightened awareness may reflect professional management systems that systematically track production variations and weather patterns, allowing for more precise assessment of climate-related disruptions to agricultural operations.

Table 4: Climate Change Perceptions

Challenge	Overall	Laamu	Thoddoo	Maafahi*
Some changes (%)	56.7	45.5	63.2	No
Significant changes (%)	30	18.2	36.8	Yes
No changes (%)	10	27.3	0	No

*Maafahi represents a single commercial operation (Seagull Group) rather than multiple farmers, so responses are indicated as "Yes/No" rather than percentages and are not included in overall averages

Specific Climate Impacts and Vulnerabilities

Climate impacts show both universal challenges and location-specific vulnerabilities that require tailored adaptation strategies. Strong winds and storms affect virtually all farmers (93 percent overall), making wind protection a universal adaptation priority. However, other climate stressors vary considerably across production systems.

Table 5: Self-reported Climate Impacts

Climate Impact	Overall	Laamu	Thoddoo	Maafahi*
Strong winds/storms (%)	93	86	97	Yes
Too much rain (%)	63	59	66	Yes
Increased pest/disease pressure (%)	60	32	76	Yes
Extreme heat (%)	23	14	29	Yes
Irregular rainfall patterns (%)	10	18	5	Yes
Drought/dry periods (%)	10	0	16	Yes
Saltwater intrusion (%)	7	0	11	0

*Maafahi represents a single commercial operation (Seagull Group) rather than multiple farmers, so responses are indicated as “Yes/No” rather than percentages and are not included in overall averages

Photo: Wind damage to papaya trees, July 2025. Source: Adam Adheel

Excessive rainfall is a major concern, affecting 63 percent of farmers overall and creating conditions that favor fungal diseases, root rot, and post-harvest quality problems. The intensity of rainfall, combined with limited drainage infrastructure, creates challenges for maintaining product quality and managing disease pressure during wet seasons. Increased pest and disease pressure linked to climate change affects 60 percent of farmers overall but shows dramatic regional variation. Thoddoo farmers report much higher rates (76 percent) compared to Laamu (32 percent), aligning with the intensive pest and disease challenges documented throughout Thoddoo production systems. This climate-pest interaction appears compounded by Thoddoo's significantly higher planting densities (27 trees per 1,000 square feet versus 11 in Laamu), which reduce air circulation, increase canopy humidity, and facilitate pest movement between plants—creating conditions where a combination of climate stressors and intensive cultivation practices increase disease vulnerability. This climate-pest interaction suggests that climate adaptation strategies must integrate pest management approaches rather than treating them as separate challenges.

5. Seeds, Varieties, and Genetic Material Management

Papaya seed use in the Maldives is highly standardized and overwhelmingly reliant on imported varieties. Approximately 98 percent of farmers use imported seed, typically sourced through local agro-input retailers. On-farm seed propagation is uncommon, with only about one-quarter of Thoddoo farmers and fewer than one-fifth in Laamu saving seed from existing orchards. This limited use of saved seed reflects broad awareness that such practices tend to result in lower performance and higher disease risk. Two varieties dominate the market: the Holland/Israel hybrid and the Red Lady. In Laamu, the Holland/Israel hybrid is the predominant choice, planted by 95 percent of surveyed farmers. In contrast, Thoddoo farmers are increasingly shifting toward Red Lady, with 76 percent reporting its use. This shift appears to be driven by differences in perceived market demand, disease resistance, and suitability to local growing conditions. Although many farmers in Thoddoo still have Holland/Israel trees in production due to the two-year cropping cycle, in-depth interviews confirmed that future planting plans are almost exclusively focused on Red Lady. Farmers in Thoddoo consistently reported that Red Lady performs better against yellow crinkle disease.

Photo: Seed packets sold from a Malé input provider, August 2025. Source: Alysa Grude

The commercial Maafahi operation also uses Red Lady exclusively and is actively trialing additional varietals to support future diversification. While the widespread use of imported seed helps to limit the spread of disease through informal seed-saving, the current seed system lacks regulatory oversight. Imports are not subject to any quality-declaration or inspection standards, creating risks around seed purity and performance.

Table 6: Genetic Material – Varietal Uses

Variety	Overall	Laamu	Thoddoo	Maafahi*
Import seeds (%)	98	100	97	Yes
Holland/Israel variety (%)	85	95	79	No
Red Lady variety (%)	60	32	76	Yes
Propagate from existing trees (%)	23	18	26	No

*Maafahi represents a single commercial operation (Seagull Group) rather than multiple farmers, so responses are indicated as “Yes/No” rather than percentages and are not included in overall averages

When asked what factors inform their varietal decision-making, farmers gave responses that highlight clear differences between locations. In Laamu, varietal choice is almost entirely market-driven, with 100 percent of surveyed farmers citing demand and price as their primary consideration. By contrast, only 58 percent of Thoddoo farmers identified market demand as a key factor, while much larger shares pointed to disease resistance (39 percent) and climate suitability (37 percent), compared to Laamu, reflecting the higher disease prevalence observed in Thoddoo. Taste and fruit quality were also mentioned more often in Thoddoo (50 percent) than in Laamu (14 percent). Overall, 73 percent of farmers across both locations cited market demand, 27 percent mentioned disease resistance, 27 percent highlighted climate suitability, and 37 percent emphasized taste or quality.

Enabling Environment – Regulatory Challenges in Seed Quality and Plant Health Management
According to the Agricultural Research Center, under the MoAAW, it is critical that farmers change the seed variety to control diseases affecting papaya. A key recommendation was to have stronger regulation on the seeds being imported, which goes beyond papaya and was noted to be important for all crops that are having disease issues, including cucumbers, gourds, and pumpkins. According to the MoAAW, there are currently no regulations in place to ensure that imported seeds are quality-declared. While the Ministry does endorse certain seed varieties that have been tested at the Agricultural Research Center in Hanimaadhoo, there are no national standards governing seed quality. Ministry officials also acknowledged that broader phytosanitary concerns remain unaddressed and may require more immediate attention. Among these, the lack of implementation of the existing Plant Protection Policy was identified as a key priority.

6. Soil Management and Fertilizer Practices

Soil Preparation

Farmers across both regions commonly apply organic soil amendments prior to planting, although the type of amendment varies by location. In Thoddoo, 63 percent of farmers reported using cow dung, while in Laamu, 59 percent use general “manure,” which aligns with recommendations from the MoAAW. However, locally produced compost use is extremely limited, reported by only 5 percent of farmers overall. Most soil amendments used in the Maldives are imported and are not subject to any form of quality control or inspection. The Seagull Group farm manager shared that a recent shipment of imported cow dung contained substantial filler material, prompting the company to change its procurement approach. Previously, Seagull Group paid suppliers in full prior to delivery. Following this incident, they adopted a two-stage payment model: a partial advance, with final payment issued only after the input was received and its quality verified. While this adjustment created a feedback loop to improve input quality, such negotiating power is not available to smallholder farmers, who typically lack the scale or leverage to influence supplier behavior. The MoAAW confirmed that there are currently no national quality standards or inspection systems in place for imported organic amendments.

Table 7: Soil Preparation Practices

Method	Overall	Laamu	Thoddoo	Maafahi*
Cow dung (%)	45	13	63	No
Manure (%)	30	59	13	No
Compost (%)	5	14	0	Yes

*Maafahi represents a single commercial operation (Seagull Group) rather than multiple farmers, so responses are indicated as "Yes/No" rather than percentages and are not included in overall averages

Importantly for MGAP record keeping, soil sterilization is rare, reported by only 7 percent of farmers. While not common, this practice is relevant for MGAP compliance since any sterilization undertaken must be documented.

Fertilizer Application

Key informants from the Agricultural Research Center expressed concern that farmers have become overly reliant on chemical fertilizers, rather than investing in practices that build long-term soil fertility. Survey data reflect this trend: despite high costs, farmers rely predominantly on imported synthetic fertilizers, which receive no government subsidies. Survey data reflect this trend: 57 percent of farmers reported using only synthetic fertilizers for ongoing crop nutrition, while 43 percent combine chemical and organic inputs. This pattern reflects fertilization practices during the growing season; as detailed above, many farmers do apply organic amendments such as cow dung (45 percent) or manure (30 percent) during initial soil preparation but then rely exclusively on chemical fertilizers for subsequent crop nutrition throughout the production cycle. Fertilizer is typically applied on a fixed schedule. Around one-third of farmers reported applying fertilizer every 14 days, with an additional 15 percent applying every 15 days. Application frequency varies by region. In Laamu, 52 percent of farmers follow a 14-day cycle, compared to only 19 percent in Thoddoo. However, input availability frequently disrupts these routines. In Laamu, farmers reported that some fertilizers are unavailable for periods ranging from one to three months, requiring adjustments to their schedules. Field visits to agro-input shops confirmed low stock levels for soluble fertilizers and manures.

Research Trials: Fertilizer Use Increasing, Yields Still Declining: Key informants from the Agricultural Research Center reported that ongoing fertilizer trials have shown a decline in productivity, even when higher quantities of fertilizer are applied. This pattern of reduced yields despite increased input use is believed to reflect what many farmers are currently experiencing in the field.

Table 8: Fertilizer Use

Practice	Overall	Laamu	Thoddoo	Maafahi*
Chemical fertilizers only (%)	57	36	68	No
Mixed chemical/organic (%)	43	64	32	Yes

*Maafahi represents a single commercial operation (Seagull Group) rather than multiple farmers, so responses are indicated as “Yes/No” rather than percentages and are not included in overall averages

Decisions regarding fertilizer quantities are primarily experience-based. Overall, 73 percent of farmers rely on personal judgment when determining application rates. This is particularly pronounced in Thoddoo (84 percent), where farmers often work independently. In Laamu, farmers are more likely to consult peers (27 percent) or extension officers (14 percent), indicating stronger knowledge-sharing networks.

Table 9: Decision-Making for Fertilizer Amount Use

Approach	Overall	Laamu	Thoddoo	Maafahi*
Based on experience (%)	73	55	84	No
Advice from other farmers (%)	15	27	8	No
Advice from extension officer (%)	7	14	3	Yes
Follow package instructions (%)	5	5	5	Yes

*Maafahi represents a single commercial operation (Seagull Group) rather than multiple farmers, so responses are indicated as “Yes/No” rather than percentages and are not included in overall averages

Other Soil Health Practices

Soil health depends not only on external amendments but also on management of cropping cycles. Two practices—discontinuation and intercropping—are especially relevant for nutrient cycling, pest and disease management, and long-term soil resilience.

Discontinuation: Leaving fields fallow, or rotating crops away from papaya is widely recognized as a key practice for breaking disease cycles and restoring soil fertility. Yet discontinuation is rarely practiced in either Laamu or Thoddoo. Farmers in both locations keep their land continuously under production, often replanting papaya, or short-cycle vegetables immediately after harvesting. In Thoddoo, short-term lease arrangements reinforce this extractive approach, as tenants seek to maximize output within limited time horizons rather than invest in long-term soil recovery. By contrast, Maafahi has experimented with one-year rotations using sunn hemp as a green manure before re-establishing papaya. This practice allows the soil to rest while also fixing nitrogen and improving organic matter, demonstrating the potential for rotation to contribute to soil recovery even in intensive systems.

Intercropping: Intercropping is widely practiced in Thoddoo but is uncommon in Laamu. Sixty percent of farmers in Thoddoo reported using intercropping, compared to only 20 percent in Laamu. Farmers noted that intercrops can only be established during the early months of the papaya cycle before the canopy closes and limits light availability. Crop selection is primarily driven by short-term income considerations. Common intercrops include gourds, spinach, Chinese cabbage, and watermelon—vegetables grown either for sale or household consumption. None of the crops mentioned are nitrogen-fixing or selected for soil health benefits. Follow-up survey data supports this: only 2 percent of farmers reported choosing intercrops based on their potential to improve soil

fertility. Moreover, the vegetable intercrops commonly planted (gourds, spinach, Chinese cabbage, watermelon) do not create physical barriers between papaya plants or diversify the farm ecosystem in ways that would disrupt pest and disease cycles—meaning current intercropping patterns provide income diversification but offer limited agronomic benefits for addressing the pest and disease pressures that constrain papaya productivity, particularly in Thoddoo's intensive production system.

Enabling Environment – Land Tenure Uncertainty and Its Impact on Farm Investment in Thoddoo
In-depth interviews and focus group discussions with farmers and the Island Council in Thoddoo revealed a shared concern regarding short-term land leases. Farmers reported being reluctant to make long-term investments in their fields—such as soil improvement, infrastructure, or sustainable practices—due to uncertainty about whether they would retain access to the same plots beyond their current lease term. Most leases are issued for a period of three to five years, after which the land is often rotated to another farmer. According to representatives from the Thoddoo Island Council, there is recognition that short lease durations discourage long-term planning and sustainable land management. As a result, the Council has extended the current leasing period by one year to allow time to formalize a new framework for longer-term leases, which they intend to introduce in the next leasing cycle.

Fertilizer risks, storage, and record keeping

Safe management of fertilizers and soil additives is a core requirement of MGAP, which calls for risk assessment, mitigation, and documentation. Current farmer practices show low awareness of contamination risks from fertilizers. When asked whether they had identified risks, only 16.7 percent of farmers said yes, while more than half (56.7 percent) were uncertain. This lack of clarity was particularly acute in Thoddoo, where two-thirds of farmers reported being unsure, compared to 41 percent in Laamu. A further 26.7 percent said no outright. The data suggest that most farmers either do not recognize contamination pathways or are unsure how to evaluate them, underscoring the need for awareness generation. Storage practices, by contrast, are somewhat better. Nearly 70 percent of farmers reported storing fertilizers in separate buildings, while the rest kept them outdoors under cover (17 percent) or in their home (9 percent). A major gap in compliance is record keeping. Just over half the farmers reported keeping written fertilizer records, while 19 percent kept none at all. This problem is concentrated in Thoddoo, where nearly one-third reported no records. Many farmers rely on memory, which undermines traceability and the ability to demonstrate safe use. In contrast, Maafahi maintains systematic written records and batch tracking, demonstrating what compliance can look like at scale.

Maafahi demonstrates commercial-scale best practices with 100% composting using coconut waste, crop residues, and animal manure—far exceeding smallholder adoption rates. The operation uses exclusively mixed chemical-organic approaches and maintains record-keeping of their systematic 21-day application schedules based on extension advice rather than experience.

7. Pest and Disease Management

Pest and disease pressure represents one of the most severe constraints facing papaya farmers in the Maldives, affecting 68 percent of surveyed farmers, and driving both yield losses and increased chemical dependency. The survey results reveal a production system under intense biological stress, with 82 percent of farmers reporting papaya yellow crinkle disease—a devastating viral condition that severely impacts yield and fruit quality. This near-universal prevalence indicates systemic problems requiring urgent intervention.

Photo: Papaya tree with yellow crinkle disease, August 2025. Source: Alysa Grude

Pest Prevalence and Control

Pest pressure varies significantly between production systems, reflecting different ecological conditions and cultivation intensities. Thoddoo faces particularly intense pressure from bats (79 percent), mealybugs (82 percent), and rodents (63 percent), suggesting problems associated with intensive cultivation in a confined area. By contrast, Laamu struggles more with birds (82 percent) and snails/slugs (45 percent), indicating different environmental conditions that require distinct management approaches. It should be noted that white flies were not included in the pre-coded options for the quantitative surveys and therefore do not show up in the table below but emerged as a significant issue for farmers during qualitative interviews and farm observations.

Table 10: Farmers Self-reported Presence of Pests on their Farms

Pest Type	Overall	Laamu	Thoddoo	Maafahi*
Mealybugs (%)	75	64	82	Yes
Bats (%)	62	32	79	Yes
Birds (%)	53	82	37	No
Rodents (%)	43	9	63	Yes
Snails/slugs (%)	17	45	0	No

*Maafahi represents a single commercial operation (Seagull Group) rather than multiple farmers, so responses are indicated as “Yes/No” rather than percentages and are not included in overall averages

Pest Control methods: Current pest management practices demonstrate heavy reliance on synthetic pesticides (93 percent of farmers), with minimal adoption of integrated pest management (IPM) approaches that combine biological, cultural, and chemical controls. This chemical-intensive

system creates several interconnected risks: accelerated development of pest resistance, suppression of beneficial arthropod populations, potential pesticide residue issues affecting MGAP compliance, and increased input costs that reduce farm profitability.

The complete absence of biological pest control across smallholder systems indicates gaps in both IPM knowledge transfer and access to biological inputs. IPM approaches offer multiple advantages for tropical fruit production systems: enhanced pest resistance management through diversified control mechanisms, conservation of natural enemy populations that provide long-term pest regulation, reduced pesticide residue risks that support market access, and improved economic sustainability through reduced input dependence. The commercial Seagull Group operation demonstrates IPM feasibility through successful deployment of biological agents against whitefly populations, providing a local proof-of-concept for smallholder adoption.

Intensive chemical applications have created ecosystem disruption that compounds management challenges. Thoddoo farmers observed that "we haven't seen some beneficial insects like ladybugs in the fields for quite some time," indicating suppression of natural enemy populations that normally provide biological pest control services. This ecological disruption suggests that successful IPM adoption will require not only input substitution, but active restoration of beneficial arthropod habitat and populations—a process that may take multiple cropping cycles to achieve functional biodiversity recovery.

Despite minimal current adoption, survey data reveals latent interest in ecological pest management approaches. Recognition of intercropping benefits for pest reduction (reported by 38% of Laamu farmers and 9% in Thoddoo) demonstrates some foundational awareness of habitat manipulation strategies. Furthermore, nearly 50% of non-adopters expressed interest in creating beneficial insect habitats. However, adoption barriers extend beyond awareness to include critical supply chain and demonstration gaps. Farmers cite product reliability and storage challenges, with one Laamu farmer noting that pheromone traps had "low shelf life and needed proper storage"—highlighting infrastructure requirements for biological input distribution. Foreign workers managing leased farms expressed reluctance to adopt unfamiliar methods without proof of effectiveness. This emphasizes the importance of demonstration-based extension approaches that allow farmers to evaluate IPM performance under their specific production conditions before committing to adoption of investments.

Table 11: Pest Control Methods by Location

Control Method	Overall	Laamu	Thoddoo	Maafahi*
Chemical pesticides (%)	93	100	89	Yes
Manual removal (%)	30	32	29	Yes
Organic/natural methods (%)	5	9	3	Yes
Biological control (%)	0	0	0	Yes

*Maafahi represents a single commercial operation (Seagull Group) rather than multiple farmers, so responses are indicated as "Yes/No" rather than percentages and are not included in overall averages

Disease Prevalence and Control

Disease pressure represents a critical constraint across papaya production systems, with papaya yellow crinkle virus affecting 82 percent of farms and serving as a key driver of production decisions. This viral disease has reached endemic levels that alter varietal selection, management practices, and economic outcomes. Fungal disease pressure shows pronounced regional variation (79 percent in Thoddoo versus 32 percent in Laamu), likely reflecting differences in planting density, air circulation, and humidity management between production systems.

Table 12: Self-reported Disease Presence

Disease Type	Overall	Laamu	Thoddoo	Maafahi*
Papaya yellow crinkle (%)	82	77	84	Yes
Fungal diseases (%)	62	32	79	Yes
Root rot (%)	15	23	11	Yes
Other diseases (%)	15	0	24	Yes

*Maafahi represents a single commercial operation (Seagull Group) rather than multiple farmers, so responses are indicated as “Yes/No” rather than percentages and are not included in overall averages

Disease Control methods: Current disease management practices lack systematic integration of prevention, monitoring, and control strategies essential for effective pathogen management in tropical fruit systems. For fungal pathogens and root rot, farmers rely primarily on reactive fungicide applications instead of traditional practices that address predisposing factors such as excessive soil moisture, poor drainage, or inadequate plant spacing that create favorable disease environments. This shows that there is a critical gap in teaching farmers how to manage viral diseases. Despite the widespread prevalence of papaya yellow crinkle virus across production areas, farmers report receiving no systematic recommendations from the MoAAW for comprehensive management approaches. While an FAO-supported diagnostic study was conducted to better understand the disease, the absence of follow-up training has created a knowledge void. Farmers lack access to evidence-based protocols for vector management, infected plant removal procedures, or guidance on deploying resistant varieties effectively.

In the absence of formal disease management protocols, farmers have developed diverse coping strategies with varying degrees of effectiveness. Some farmers have responded to yellow crinkle disease by simply increasing fertilizer applications, hoping that better-nourished plants might withstand infection—though this approach lacks a scientific basis and can sometimes exacerbate disease problems. A portion of farmers have also made the difficult decision to shift from higher-value Holland/Israel hybrid varieties to the Red Lady variety, which they perceive as more disease-resilient. As one Laamu farmer explained: *"I get 50 MVR/kg ($3.27/kg) for Holland variety and 20 MVR/kg ($1.31/kg) for Red Lady but am switching to Red Lady due to the disease."* This is a significant economic sacrifice, but not all farmers have made this transition, with many still attempting to maintain production of premium varieties despite disease challenges. Agricultural Research Center staff have emphasized that basic prevention and sanitation measures—which form the

foundation of integrated disease management (IVM)—are not being systematically promoted or practiced. Practices for controlling disease vectors such as whiteflies and mealybugs, like implementing simple tool-cleaning protocols to prevent pathogen spread, and maintaining proper orchard sanitation are largely absent from routine farming practices.

Without clear institutional guidance, farmer training programs, and demonstration of integrated control methods, producers are left to navigate escalating disease pressures through trial-and-error approaches that often prove ineffective. While this presents a significant constraint on production, it creates a substantial opportunity to intensify sustainably by implementing evidence-based disease management systems.

Chemical Application Practices, Management, and Compliance with MGAP

Legal pesticide use: MGAP certification requires that all crop protection products be legally registered, applied according to label specifications, and managed to ensure consumer and environmental safety. While the majority of surveyed farmers report using only legal pesticides, significant knowledge gaps remain that could undermine compliance efforts. Nearly one in four farmers express uncertainty about what constitutes a "legal" product, and a small portion acknowledge using products they know to be banned. This uncertainty appears to stem primarily from information access challenges rather than intentional non-compliance. Focus group discussions revealed that foreign workers—who operate many farms particularly in Thoddoo, often cannot read product labels and packaging, highlighting the need for multilingual guidance materials and improved point-of-sale advisory services.

Pre-harvest Intervals: The most significant compliance challenge involves pre-harvest interval (PHI) adherence. There are substantial regional differences in PHI compliance, with 90.5 percent of Laamu farmers reporting 90.5 percent adherence to recommended waiting periods (seven days) compared to only 27.3 percent in Thoddoo. Specifically, Thoddoo farmers wait an average of 6.2 days between pesticide application and harvest, while Laamu farmers maintain longer intervals averaging 7.5 days. However, focus group participants in Laamu acknowledged that enforcement is inconsistent, noting that "there are farmers selling within 48 hours of pesticide application." The findings imply that actual compliance may be lower than reported, underscoring the need to strengthen verification mechanisms. The three-fold difference in PHI compliance between regions represents one of the clearest indicators of varying MGAP readiness and directly affects farmers' ability to access premium markets that prioritize food safety standards. Addressing these compliance gaps through improved extension support and strengthened verification systems will be essential for expanding market opportunities and ensuring consumer safety. These PHI violations, combined with other pesticide management gaps documented in this section, constitute serious food safety risks requiring urgent regulatory attention—concerns that are synthesized and addressed in the comprehensive food safety analysis presented in Section 13 on MGAP Adoption.

Information on pesticide application: How farmers select crop protection products appears to significantly influence their compliance with safety protocols. Laamu farmers demonstrate a more advice-seeking approach, with two-thirds relying primarily on shop and supplier recommendations. In contrast, Thoddoo farmers rely more heavily on personal experience when making pesticide selection and application decisions. This experience-driven approach, while reflecting accumulated local knowledge, may contribute to greater variation in safety protocol adherence and potentially higher risks of non-compliance with MGAP standards.

Table 13: Chemical Source and Training

Compliance Indicator	Overall	Laamu	Thoddoo	Maafahi*
Permitted Chemicals				
Uses only legal pesticides (%)	71.4	81.8	64.7	Yes
Don't know what's legal (%)	23.2	18.2	26.5	No
Admits using banned products (%)	5.4	0	8.8	No
Chemical Safety Training				
Received pesticide training (%)	12.7	23.8	5.9	Yes

*Maafahi represents a single commercial operation (Seagull Group) rather than multiple farmers, so responses are indicated as "Yes/No" rather than percentages and are not included in overall averages

Chemical storage: Proper storage of crop protection products is a key safety requirement under MGAP certification, both for worker protection and to maintain product efficacy. Storage practices show notable variation, with Thoddoo farmers demonstrating higher compliance rates for secure storage infrastructure. Nearly 80 percent of Thoddoo farmers maintain separate, locked storage facilities compared to 59 percent in Laamu, suggesting better awareness or implementation of basic safety protocols.

Record keeping: Record keeping practices reveal a contrasting trend: Laamu farmers demonstrate better documentation habits despite weaker storage infrastructure. While 45.5 percent of Laamu farmers maintain written application records compared to 34.4 percent in Thoddoo, the overall reliance on memory-based tracking is problematic across both regions. More than half of all surveyed farmers rely exclusively on memory to track pesticide applications, with no written documentation whatsoever. This heavy dependence on informal record keeping creates significant challenges for MGAP compliance and traceability requirements. Memory-based systems make it nearly impossible to demonstrate compliance during certification audits, limit farmers' ability to analyze application patterns for optimization, and provide no backup if primary operators are unavailable. The situation is particularly concerning in Thoddoo, where 12.5 percent of farmers maintain no records at all, compared to zero farmers in this category in Laamu.

Table 14: Storage and Record Keeping Practices

Compliance Indicator	Overall	Laamu	Thoddoo	Maafahi*
Proper Storage				
Separate locked storage (%)	71.4	59.1	79.4	Yes
Record Keeping				
Written application records (%)	38.9	45.5	34.4	Yes
Rely on memory only (%)	53.7	54.5	53.1	No
No records at all (%)	7.4	0	12.5	No

*Maafahi represents a single commercial operation (Seagull Group) rather than multiple farmers, so responses are indicated as "Yes/No" rather than percentages and are not included in overall averages

Chemical disposal: Management of end-of-life pesticide containers and unused products is the most significant systemic weakness in current MGAP compliance. The disposal practices reveal concerning gaps in both infrastructure and farmer awareness. Official collection systems are utilized by only 9.1 percent of farmers across both regions, indicating inadequate institutional support for proper disposal. The prevalence of inappropriate disposal methods poses both environmental and health risks. Burning pesticide containers, practiced by 18.2 percent of farmers overall—and by over one-third of Laamu farmers—can release toxic compounds and create air quality hazards. Even more concerning is that 41.8 percent of farmers report using "other methods" for disposal without specification, suggesting potentially problematic practices that require investigation and intervention.

Table 15: Chemical Disposal Practices

Disposal Method	Overall	Laamu	Thoddoo	Maafahi*
"Other methods" (undefined) (%)	41.8	4.5	66.7	No
Haven't disposed yet (%)	20.0	27.3	15.2	Yes
Burning (%)	18.2	36.4	6.1	No
Official collection (%)	9.1	9.1	9.1	No

*Maafahi represents a single commercial operation (Seagull Group) rather than multiple farmers, so responses are indicated as "Yes/No" rather than percentages and are not included in overall averages

8. Water Management

Water management represents a critical intersection of MGAP compliance, climate adaptation, and production efficiency in papaya farming. MGAP standards require documented use of safe water sources for irrigation and post-harvest washing, while climate-smart water practices enable farmers

to manage increasing variability in rainfall patterns and reduce disease pressure through more precise application methods. In the Maldives context, where freshwater resources exist as fragile lenses above saltwater and face ongoing threats from sea-level rise and extreme weather events, effective water management is essential for both immediate productivity and long-term agricultural sustainability.

Water sources: Farmers have developed diversified water sourcing and scheduling strategies to adapt to the archipelago's water security challenges. Nearly all farmers rely on well water as their primary source, with 62 percent of respondents also depending on natural rainfall to supplement their irrigation practices, particularly in Laamu (73 percent) compared to Thoddoo (55 percent). This dual-source approach indicates farmers' reliance on both groundwater and rain-fed agriculture, though no farmers depend solely on rainfall for their irrigation needs.

Watering practices: Current irrigation practices center on pump-and-hose systems, used by 75 percent of farmers, reflecting both technological availability and practical preferences for flexible water application. However, farmers show strong interest in efficient irrigation technology, particularly solar-powered systems that align with both economic and environmental sustainability goals.

The economic case for improved irrigation technology is compelling from both labor efficiency and climate adaptation perspectives. A Laamu farmer who had researched solar irrigation options provided specific cost estimates: "irrigation would cost 85,000 MVR (5,555 USD) for the equipment with solar," while another estimated "100,000-150,000 MVR (6,536-9,804 USD) for solar with battery backup." These systems offer significant labor savings, as a Thoddoo farmer explained that manual watering "takes 2 hours to water by hand versus 20-30 minutes with irrigation." Solar-powered irrigation systems represent a particularly sustainable solution given that electricity remains unavailable on most farms. These systems eliminate diesel fuel dependency, reduce operational costs over time, and enable more precise water application that can reduce both water consumption and disease pressure. Irrigation systems, when combined with solar power, can deliver water directly to root zones while minimizing leaf wetness that promotes fungal diseases—addressing both resource efficiency and integrated disease management objectives. Currently, farmers who prefer pump-and-hose methods, including operators of the commercial Maafahi farm, cite practical advantages including immediate responsiveness to plant needs, flexibility for variable field conditions, and lower maintenance requirements.

Table 16: Water Sources and Application Method

	Overall	Laamu	Thoddoo	Maafahi*
Water Source				
Well water (%)	95	95	95	No
Rainfed (%)	62	73	55	Yes
Municipal piped water (%)	3	5	3	Yes

Application Method				
Pump and hose (%)	75	68.2	78.9	Yes
Sprinkler systems (%)	11.7	22.7	5.3	No
Drip irrigation (%)	1.7	0	2.6	No

*Maafahi represents a single commercial operation (Seagull Group) rather than multiple farmers, so responses are indicated as "Yes/No" rather than percentages and are not included in overall averages

Water Conservation Through Mulching: Mulching practices show moderate adoption across the surveyed farms, with notable regional variation that shows different approaches to resource management and agroecological knowledge. Thoddoo farmers are more consistent, with 36.8 percent always employing mulching techniques compared to 13.6 percent in Laamu. This practice delivers multiple ecosystem services that are particularly valuable for climate adaptation: water conservation through reduced evaporation, soil temperature moderation during heat stress periods, and weed suppression that reduces competition for limited water resources. Seagull Group practices full coverage mulching on their papaya plots, covering 100% of the ground with leaves from coconut palms.

Harvesting the Rain: Responsible Water Usage on Maafahi Island

Maafahi farm has established one of the most ambitious rainwater harvesting systems in the Maldives. Each storage tank holds 100 tons of water, and together they collect nearly 1 million liters during the rainy season. Remarkably, the tanks can fill within just one to two days of heavy rainfall, providing enough water to meet most irrigation needs for the year. This system allows the farm to remain largely self-sufficient, facing only about four months of water shortage when rains are scarce. By investing in large-scale catchment and storage, Seagull Group demonstrates how rainwater harvesting can underpin commercial horticulture while reducing vulnerability to dry periods and aligning with climate-smart practices.

Irrigation Scheduling and Decision-Making: Irrigation scheduling practices show that farms use varying levels of sophistication in water management decision-making across farms. The majority of farmers (73.3 percent) base irrigation timing on weather and rainfall patterns—a responsive approach that demonstrates good water conservation instincts but may not fully optimize plant physiological needs or efficient use of resources. Growth stage-based irrigation, practiced more commonly in Laamu (27.3 percent versus zero percent in Thoddoo), indicates more advanced technical knowledge and precision agriculture approaches. This scheduling method aligns with CSA principles by matching water inputs to plant demand, potentially reducing water waste while optimizing yield outcomes. The regional difference may contribute to the yield advantages observed in Laamu and suggests opportunities for knowledge transfer and extension programming focused on precision water management.

Water Quality and MGAP Compliance Challenges: A critical compliance gap exists in water quality monitoring, as currently, zero percent of farmers test their irrigation water sources. This represents an immediate barrier to MGAP certification and food safety assurance, as certification standards require documented evidence that irrigation water meets safety standards for agricultural

use. However, the institutional context offers important insights into implementing sustainable certification. Farmers consistently frame water quality testing as a governmental or council responsibility rather than an individual farm-level expense. Relevant for the next section (Harvest and Post-harvest Handling and Food Safety), focus group participants in Laamu proposed institutional solutions, suggesting that "the island council can prepare a fruit wash area at the harbor so that it can be washed before being loaded to the vessel with clean good quality water." This perspective reflects both economic constraints of farmers and expectations for public infrastructure support.

9. Harvesting and Post-harvest Handling and Food Safety

Post-harvest practices determine product quality, shelf life, and food safety—key requirements for MGAP certification and tourism market access. While poor practices may not result in immediate buyer rejections in current markets, they create potential food safety risks and barriers to accessing premium buyers who require MGAP certification or equivalent standards. The survey results reveal dramatically different approaches between regions, ranging from minimal intervention to comprehensive quality management systems.

Harvest Timing Decisions: Harvest timing decisions demonstrate consistent adoption of quality-focused practices across production systems, with 92 percent of farmers relying on color change as their primary ripeness indicator. This physiological approach to harvest timing aligns with sustainable agriculture principles by ensuring optimal fruit quality and nutritional content while maximizing shelf life and market value.

The coordination of harvest timing with transportation schedules is an adaptive strategy for managing post-harvest losses in the archipelago context. Farmers consistently "harvest when they know the vessel is coming," which minimizes storage requirements and reduces quality deterioration during extended holding periods. The market-responsive approach demands immediate processing, creating operational pressure. However, it is an efficient strategy that demonstrates farmer adaptation by preserving fruit quality in the absence of cold storage infrastructure. While the current just-in-time harvest approach embodies elements of sustainable value chain management by reducing waste and optimizing resource use, it also highlights the vulnerability of current systems to transportation disruptions. Improving post-harvest infrastructure is necessary to provide greater operational flexibility.

Harvest Methods and Quality Preservation: Harvest methods that may influence fruit quality outcomes and post-harvest performance, show notable regional variation. Hand harvesting dominates in Thoddoo (73.7 percent), while Laamu farmers demonstrate greater

Buyer Perspectives on Farm Handling:

Guesthouse interviews revealed buyer skepticism about current handling practices that reflects inconsistent post-harvest quality. One operator explained: "we wash it very well, because we don't trust the farmer," while noting that "there are some people who follow the good manners, sometimes we are happy with the farmer and sometimes we are not." This buyer wariness indicates that inconsistent post-harvest practices affect confidence throughout the value chain and may limit market access opportunities for all farmers, regardless of their individual practices. The variation in buyer satisfaction suggests that systematic improvements in post-harvest handling could enhance trust and potentially open access to premium markets that currently rely on imported alternatives.

adoption of tool-assisted harvesting, including knives (36.4 percent) and pruning shears (22.7 percent). The regional difference in harvesting methods indicates varying levels of technical knowledge, labor availability, or market quality requirements. Tool-assisted harvesting, when properly implemented, supports both immediate fruit quality and storage life—critical factors for accessing premium markets and reducing post-harvest losses that undermine economic and environmental sustainability. Nearly all farmers (97 percent) report using plastic crates or boxes for initial collection, which provides appropriate protection during harvest. However, field observations revealed gaps between reported and actual practices. In Thoddoo, farmers explained that they "recently lost the baskets to the cubicle owners in Malé who sent them to the resorts/other markets." So, in the meantime, farmers are using plastic bags." This shift to plastic bags creates multiple problems: increased fruit damage during transportation, humidity buildup at the bottom of bags, and accelerated ripening that reduces shelf life and market quality.

Post-harvest Handling and Food Safety Systems: Post-harvest handling practices reveal fundamentally different approaches to quality management and food safety protocols across regions. Laamu demonstrates a quality-oriented system with systematic attention to food safety requirements: 82 percent of farmers wash their fruit (at their farm or at home), 68 percent keep fruit away from soil contact, and 41 percent use clean storage containers. These practices provide a strong foundation for MGAP compliance and show systematic attention to reducing contamination risks throughout the handling process. In contrast, Thoddoo's post-harvest system shows limited adoption of quality control measures, with 71 percent of farmers implementing no specific post-harvest practices. This rapid turnover approach may reflect cash flow pressures, limited storage facilities, or market relationships that do not currently reward quality investments. Focus groups revealed that infrastructure constraints contribute to these patterns, with farmers explaining that "produce goes directly from the farm to the vessels" because "clean water other than the ground water is not available on the farm."

Table 17: Post-harvest Food Safety Practice

	Overall	Laamu	Thoddoo	Maafahi*
Practice				
Wash with clean water (%)	50	82	32	Yes
No specific practices (%)	45	0	71	No
Keep away from soil/dirt (%)	37	68	18	No
Store in clean containers (%)	23	41	13	Yes
Clean harvesting tools (%)	5	14	0	Yes

*Maafahi represents a single commercial operation (Seagull Group) rather than multiple farmers, so responses are indicated as "Yes/No" rather than percentages and are not included in overall averages

Farmers have proposed innovative community-level solutions to address infrastructure constraints around washing and cleaning. Laamu focus group participants suggested that "the island council

can prepare a fruit wash area at the harbor so that it can be washed before being loaded to the vessel with clean good quality water." This approach could address both water access and quality concerns while spreading infrastructure costs across the farming community and ensuring consistent food safety practices.

10. Labor, Worker Safety, and Farm Management

Labor arrangements, safety protocols, and management systems determine operational consistency and MGAP compliance capability. MGAP requires comprehensive worker safety provisions, chemical handling protocols, and management documentation that extend beyond basic agricultural practices to encompass workplace safety and human resource management. The survey results reveal extensive reliance on foreign workers combined with significant gaps in safety training and infrastructure that create immediate barriers to certification and raise concerns about worker welfare and operational sustainability.

Labor Sourcing and Management Structures

Labor arrangements show overwhelming dependence on foreign workers, who constitute the primary workforce on 83 percent of farms with minimal variation between regions (77 percent Laamu, 87 percent Thoddoo). Notably, zero percent of farms report hiring local workers, indicating either significant wage disparities, skill gaps, or regulatory barriers that merit policy attention. Family labor is important on 30 percent of farms, suggesting mixed management approaches that combine household and hired labor.

Table 18: Labor Sources by Location

	Overall	Laamu	Thoddoo	Maafahi*
Labor Type				
Foreign workers (%)	83	77	87	100
Family members (%)	30	27	32	0
Hired local workers (%)	0	0	0	0

*Maafahi represents a single commercial operation (Seagull Group) rather than multiple farmers, so responses are indicated as "Yes/No" rather than percentages and are not included in overall averages

These labor patterns reflect the broader structural arrangements observed throughout the value chain. As documented in the demographics section, foreign workers often serve not just as employees but as farm operators, with some leasing land directly from local farmers and making independent production decisions of the local farmer. One Thoddoo leaseholder noted that production decisions are made by "the [Bangladeshi] farmer who decides what is produced" rather than him, as the leaseholder. The commercial Maafahi operation demonstrates a different model, employing foreign workers within structured management systems that include defined working hours, comprehensive training programs, and systematic supervision.

Chemical Handling and Safety Protocols

Workers are heavily involved in chemical handling, with 70.2 percent of farms reporting that workers are responsible for applying pesticides and fertilizers. However, this practice varies significantly by region. In Thoddoo, 88.9 percent of farms involve workers in chemical application, compared to just 38.1 percent in Laamu. This disparity likely reflects differences in farm management structures: Laamu has a higher proportion of owner-operated farms, where farmers themselves are more directly involved in daily operations. The complete absence of chemical handling training across smallholder farms represents a critical safety gap that affects both worker welfare and MGAP compliance. Focus group discussions revealed language barriers that compound these safety risks, with foreign workers reporting being "unable to read the labels on the bottles and packets." Focus groups indicated that farmers do not have the knowledge of chemical handling, and that farmers would be "happy to be trained by an expert." The willingness to participate in training suggests that capacity building programs could address these gaps if delivered appropriately.

Table 19: Chemical Handling by Workers

	Overall	Laamu	Thoddoo	Maafahi*
Practice				
Workers handle chemicals (%)	70.2	38.1	88.9	Yes
Workers trained for chemicals (%)	0	0	0	Yes

*Maafahi represents a single commercial operation (Seagull Group) rather than multiple farmers, so responses are indicated as "Yes/No" rather than percentages and are not included in overall averages

Record-Keeping and Management Systems

Farmers have basic record-keeping and business tracking capabilities that could support MGAP traceability requirements, though these may not be complete or accurate. While survey responses suggest reasonable adoption of documentation practices, qualitative data from focus groups, interviews, and field observations indicate that self-reported figures may overstate actual practice. This gap likely reflects social desirability bias, where farmers overstate their systematic record keeping to appear compliant.

Table 20: Record-Keeping Practices

	Overall	Laamu	Thoddoo	Maafahi*
Practice				
Sales records (%)	78	73	82	Yes
Harvest amounts (%)	77	68	82	Yes
Fertilizer applications (%)	58	64	55	Yes
Pesticide applications (%)	57	64	53	Yes

Input purchases (%)	55	32	68	Yes
Planting dates (%)	45	23	58	Yes

*Maafahi represents a single commercial operation (Seagull Group) rather than multiple farmers, so responses are indicated as "Yes/No" rather than percentages and are not included in overall averages

Financial and production records are a top priority among farmers, with sales records maintained by 78 percent and harvest tracking by 77 percent of respondents. This suggests that farmers recognize the importance of tracking income and production volumes for basic business management. These records help track farm profitability and production trends over time. Input application records—which are important for MGAP compliance and food safety protocols—show more variable adoption. Approximately half of farmers report maintaining these records, though the actual completeness and details of documentation likely vary considerably. For MGAP certification, detailed input records must include product names, application dates, rates used, and pre-harvest intervals—a level of documentation that may exceed current farmer practices.

Implication for MGAP Compliance: Record-keeping practices are currently uneven, which complicates meeting MGAP traceability requirements. While farmers have basic business record keeping skills, they are unlikely to meet the level of detail and systematic documentation required for certification. Farmers will need to maintain more comprehensive, standardized records that can withstand third-party audit processes for MGAP compliance. The gap between reported and actual record-keeping practices also suggests that successful MGAP implementation will need to address both technical training needs and the practical challenges that prevent farmers from maintaining systematic documentation. This may include developing simple record-keeping templates, providing training on documentation requirements, and integrating record-keeping support into extension services.

11. Farmer Marketing

Marketing represents a fundamental constraint for papaya farmers that directly shapes income stability, investment capacity, and overall agricultural productivity. Effective market linkages allow farmers to capture returns from production improvements and quality investments. Conversely, marketing bottlenecks can limit incentives for yield optimization and farm modernization. The survey results reveal heavy dependence on intermediary systems and significant barriers to accessing premium tourism markets, which have implications for MGAP adoption and private sector engagement strategies. Moreover, there are striking regional price differentials that challenge conventional assumptions about market access and geography.

Regional Price Disparities

The most striking finding in papaya marketing relates to significant price differentials between production regions that contradict expected geographic advantages. Laamu farmers receive an average of 20.2 MVR per kilogram for their papaya ($1.32/kg), compared to only 10.6 MVR per kilogram for Thoddoo farmers ($0.69/kg)—a 90 percent price premium. This price differential points to a market access paradox: Thoddoo farmers, despite being significantly closer to Malé (the primary

market destination), receive substantially lower prices than their Laamu counterparts. Conventional market theory would predict the opposite outcome, with transportation cost advantages translating into higher farmgate prices for Thoddoo producers. The lower prices in Thoddoo may be partly explained by concentrated market control, where an aggregation network operated primarily by migrant traders has created substantial barriers for alternative buyers and limited farmer bargaining power (discussed in detail in the Aggregation and Transportation section). This concentrated control may constrain farmers' access to competitive pricing despite their geographic advantages.

Current Sales Channel Patterns

Farmer overwhelmingly rely on intermediaries for marketing, with middlemen and traders serving as a buyer for 96 percent of farmers across both regions. This dependence is driven by practical operational considerations that extend well beyond simple price negotiations. Intermediaries provide essential services including volume aggregation, transportation logistics, and buyer relationship management that individual farmers would struggle to manage independently. However, this convenience comes at the cost of reduced profit margins, limited direct market feedback about quality preferences, and pricing opportunities. Farmers operating within intermediary-dominated systems often have limited visibility into end-market demand patterns and consumer preferences that could inform production decisions and quality improvements.

Regional differences in direct sales highlight location-specific constraints that may partly explain price differentials. Thoddoo farmers capitalize on the island's emerging tourism sector, through modest direct sales to guesthouses (35 percent participation). However, this direct market access has not been translated into higher overall prices, suggesting that direct tourism sales may represent small volumes or lower-value transactions. Laamu farmers report zero direct tourism sales, reflecting limited tourism infrastructure development in their region.

Table 21: Primary Sales Channels by Location

	Overall	Laamu	Thoddoo	Maafahi*
Channel				
Middlemen/traders (%)	96	95	96	Yes
Local shops/markets (%)	43	30	54	Yes
Guest houses (directly) (%)	20	0	35	No
Directly to consumers (%)	2	0	4	Yes
Resorts (directly) (%)	2	0	4	Yes

*Maafahi represents a single commercial operation (Seagull Group) rather than multiple farmers, so responses are indicated as "Yes/No" rather than percentages and are not included in overall averages

Tourism Market Access Barriers

Survey results show that 74.6 percent of farmers consider selling to the tourism sector difficult, with higher barriers reported in Laamu (90.5 percent) than Thoddoo (65.8 percent). Only 6.8 percent find

tourism sales easy, concentrated entirely on Thoddoo (10.5 percent). Most farmers (70 percent) cited that the main problem is that resorts don't directly source from farmers. This is due to the structural buying arrangements of the tourism industry, rather than simple farmer limitations. Focus group discussions revealed that this barrier stems from volume and logistics constraints rather than farmer capabilities.

Table 22: Tourism Market Barriers

	Overall	Laamu	Thoddoo
Barrier			
Buyers don't purchase directly from farmers (%)	70	84	60
Demand inconsistent/seasonal (%)	50	58	44
Don't know (%)	27	16	36
Low prices offered (%)	11	5	16
Distribution system doesn't favor farm (%)	7	0	12
Production practices raise safety concerns (%)	5	11	0
Lack of MGAP/certifications (%)	2	5	0

*Maafahi represents a single commercial operation (Seagull Group) rather than multiple farmers, so responses are indicated as "Yes/No" rather than percentages and are not included in overall averages

Volume and Logistics Constraints: Qualitative insights highlight that the main reason intermediaries dominate the market is a fundamental mismatch between the scale of farmer production and the needs of the buyers. Thoddoo farmers explained a critical volume challenge: "The produced volume is quite high per farm per week. Only a guest house may not be able to buy the entire product. They prefer to sell the entire produce to the Malé market as they can take the entire produce." This indicates that farmers often produce more than individual tourism buyers can absorb, making middlemen attractive for their ability to handle entire harvests. Transportation logistics compound these volume challenges. A Laamu farmer emphasized that "the transportation charges are a lot and make it difficult to efficiently market their products," while noting that vessels "all seemingly come at the same time, typically just coming twice a month, rather than spreading out throughout the month." These transportation constraints make it difficult for farmers to maintain the supply consistency that tourism buyers require. A Thoddoo farmer who supplies a nearby resort noted that they provide the transportation services to the resort, rather than relying on other transport providers saying, "it's more profitable this way". However, such arrangements remain limited to farmers with existing connections and cannot easily scale to include additional producers.

Relationship-Based Direct Sales: Where direct tourism sales do occur, they operate through personal relationships rather than formal market channels. Guesthouse operators confirmed this pattern, with one explaining: "It's a very small community; we know which farms are ready for delivering different fruits and vegetables at that time." Another noted sourcing "from friends during the high season," indicating that direct sales depend on social networks rather than systematic market mechanisms. These relationship-based sales can provide benefits for farmers who can access them.

Historical Institutional Support: Multiple farmers in Laamu highlighted the important role of the Agro National Corporation Ltd (AgroNat) in providing guaranteed market access through contract farming arrangements. Established in April 2020 as a state-owned enterprise with the objective of revitalizing the agricultural sector, AgroNat operated across several islands in the Maldives, including in Laamu, where it had entered into contract farming agreements that provided farmers with stable market outlets. AgroNat's marketing approach primarily focused on selling into the Malé wholesale market, with one resort market contract, rather than developing specialized or innovative marketing mechanisms. AgroNat was abruptly discontinued in December 2024. While reports emerged in spring 2025 suggesting that operations would resume under the oversight of the MoAAW, as of September 2025, AgroNat's operational status remained unclear, and the organization was not functional.

PROOF OF CONCEPT: DIRECT FARM-TO-RESORT SUPPLY IN THODDOO: A Thoddoo farming family has maintained direct supply relationships with a nearby resort since the 1980s, demonstrating that direct farm-to-resort sales are operationally feasible and economically advantageous when key enabling conditions are present.

The model:

- Multi-generational supply relationship (30+ years)
- Farmer coordinates transportation directly to resort
- Aggregates from neighboring farmers when own production is insufficient
- Bypasses Malé intermediaries entirely

Why it works:

- Long-established trust relationship with buyer
- Geographic proximity reduces logistics complexity
- Farmer capacity to manage transportation and aggregation

Implications: While currently dependent on pre-existing relationships and farmer coordination capacity, this case proves direct farm-to-resort supply is viable in the Maldivian context. Facilitated market-making programs could enable similar coordinating farmers to replicate this model more broadly, creating systematic pathways for premium market access that benefit multiple producers beyond those with historical resort connections. Photo: *Thoddoo farmer selling direct to a nearby resort, August 2025 Source: Alysa Grude*

A Laamu farmer recalled: "it was working well with AgroNat, they helped in data management and an employee would come straight to the farms to provide guidance." Another noted that AgroNat "used to provide clean containers, and boxes to carry goods." Now it's no longer available since them shutting down." This institutional withdrawal has left farmers more dependent on informal marketing arrangements and individual relationship-building rather than systematic market development. Several farmers expressed hope that AgroNat could resume operations, indicating continued interest in institutional marketing support.

Enabling Environment – Government Plan for App-based Marketing
The MoAAW has recognized the critical need to address market coordination failures that constrain farmer income and agricultural productivity. Ministry officials emphasize the importance of developing markets and connecting farmers directly with buyers, moving beyond the concentrated intermediary systems that currently dominate papaya marketing. To address these structural constraints, the Ministry is developing the Dhanduveriya app, a digital marketplace platform that will enable farmers to upload their production information and allow buyers to purchase directly through the application.

12. Nature-based Solutions, Ecosystem-based Adaptations and Climate-Smart Agricultural Practices

Papaya farmers face a convergence of climate impacts that create urgent adaptation needs and opportunities for sustainable agricultural practices. With universal exposure to strong winds and storms (experienced by 93 percent of respondents), widespread excessive rainfall events (63 percent), and significant increases in pest and disease pressure (60 percent) linked to changing weather patterns, farmers require adaptation strategies that address multiple stressors simultaneously while building long-term agricultural resilience. NbS, EbA, and CSA solutions offer promising approaches that harness ecological processes to enhance climate resilience while reducing dependency on external inputs and improving productivity. Practices such as composting, agroforestry, strategic intercropping, and integrated pest management can simultaneously address soil health, water conservation, pest regulation, and carbon sequestration while reducing farmers' vulnerability to climate shocks and input price volatility. However, survey results reveal generally low adoption of these sustainable practices among smallholder farmers, with significant gaps between farmer interest in sustainable approaches and current implementation.

Organic Matter Management and Soil Health

Soil health represents the foundation of climate-resilient agriculture, determining farms' ability to withstand drought, excessive rainfall, and other climate stressors while maintaining productivity. In small island environments like the Maldives, where soils are naturally low in organic matter and vulnerable to saltwater intrusion, building soil organic carbon and improving soil structure are crucial climate adaptation strategies. Healthy soils with adequate organic matter retain more water during dry periods, drain better during floods, support beneficial microbial communities that enhance plant resilience, and sequester atmospheric carbon. For papaya production specifically, improved soil health can reduce dependence on external inputs, enhance disease resistance, and provide the deep, well-structured root zone that papaya trees require for optimal growth under variable climate conditions.

Soil Amendments: Farmers currently rely heavily on external inputs to maintain soil fertility, with 57 percent using exclusively synthetic fertilizers while 43 percent combine chemical and organic approaches. This mixed approach provides a foundation for expanding organic matter management, as nearly half of farmers already recognize the value of organic inputs. However, the types of organic materials

Using Seagrass for soil health

While many farmers face barriers to composting adoption, successful local innovations demonstrate the potential for community-based solutions using readily available materials. A particularly compelling example emerged from L. Dhanbidhoo island, where a farmer participating in an extension training program successfully used seagrass collected from the beach for his banana crop. According to the extension agent who conducted the training, this approach "yielded good results and reduced input cost for the farmer," demonstrating both the effectiveness of locally available organic materials and the importance of technical guidance for successful implementation. This success story illustrates how traditional materials can be systematically integrated into modern composting practices when farmers receive appropriate training and support, suggesting potential for scaling similar approaches to other islands with abundant coastal organic matter resources.

used vary considerably and often depend on imported sources that create supply chain vulnerabilities or quality control challenges. Current soil preparation practices for planting include cow dung application (45 percent of farmers), general manure use (30 percent), and limited compost use (5 percent). Interviews with input suppliers and farmers indicate that most cow dung and other manure products are imported and currently lack any quality control. As noted, Seagull Group detected quality issues in imported cow dung, including added fillers. To mitigate this, the company notified the supplier and revised payment terms: a partial advance only, with final payment contingent on verified quality. Smallholder farmers generally do not have comparable leverage.

Composting: Composting adoption remains extremely low, despite its potential for reducing fertilizer dependence and improving soil health by using locally available organic materials. Only 8.3 percent of farmers currently make or use compost, with slightly higher adoption in Thoddoo (10.5 percent) compared to Laamu (4.5 percent). This low adoption is a major opportunity for CSA programming that could simultaneously address soil health, waste management, and input cost challenges. Labor time is, rather than material availability or technical knowledge, the main barrier to composting. Focus groups revealed that farmers understand the benefits of composting but face practical time limitations. Thoddoo foreign farm laborers felt like it would take extra labor time, which they do not currently have and acknowledged they'd be happy to buy finished compost if it was affordable. This suggests an opportunity for enterprise development or community-level composting to address individual labor constraints while providing quality-assured organic matter for soil building.

Intercropping and Crop Diversification: Intercropping is the most widely adopted sustainable practice, with 62 percent of farmers practicing intercropping, though its adoption varies dramatically between regions. This practice provides important soil health benefits through nutrient cycling, reduced erosion, and improved soil structure, while also supporting biodiversity and natural pest management when appropriate crop combinations are selected. Additional benefits include enhanced resilience to extreme weather events and diversified income streams that reduce economic risk.

Table 23: Intercropping Adoption

Practice	Overall	Laamu	Thoddoo	Maafahi*
Yes (%)	62	35	76	Yes
No (%)	38	65	24	NA

*Maafahi represents a single commercial operation (Seagull Group) rather than multiple farmers, so responses are indicated as "Yes/No" rather than percentages and are not included in overall averages

Thoddoo's much higher intercropping rate (76 percent versus 35 percent in Laamu) likely reflects smaller plot sizes that require maximum productivity per unit area. Farmers typically establish intercrops during the early months of the papaya cycle before canopy closure limits light availability, growing vegetables such as spinach, Chinese cabbage, watermelon, and moringa for both sale and household consumption.

However, focus groups revealed limited understanding of intercropping's ecological benefits despite widespread adoption. Economic benefits dominate farmer perceptions , with 82 percent citing additional income or food as the primary advantage. However, Laamu farmers who practice intercropping show greater awareness of ecological benefits, with 38 percent recognizing pest reduction potential compared to only 9 percent in Thoddoo, and 12 percent acknowledging soil fertility improvements versus zero percent in Thoddoo. This difference in knowledge suggests opportunities for extension programs to highlight the climate adaptation and soil health benefits of strategic intercrop selection. Laamu farmers noted that "the concept of soil regeneration is not understood" and that they "lack knowledge" about beneficial crop combinations. When researchers explained the roles of legumes, marigold" and other beneficial plants, farmers did not highlight any specific barrier to do it, suggesting high receptivity to improved practices once benefits are understood. Foreign workers in Thoddoo similarly reported growing "only pumpkin or watermelon" and showed little understanding of the benefits of intercropping. This indicates that that current intercropping practices are largely driven by economic benefits, rather than ecological motivation.

FARMER-LED DISCOVERY OF NITROGEN-FIXING BENEFITS

A Thoddoo farmer discovered the soil-building potential of leguminous intercrops through his own field observations. During one papaya cycle, he planted bush beans as an intercrop during the early months before canopy closure and observed notably stronger papaya growth compared to previous seasons. In his next cycle, he planted watermelon instead of bush beans in the same field area and noticed that the papaya plants did not perform as well, showing less vigorous growth overall.

Through this informal comparison, the farmer concluded that bush beans provided superior support for papaya growth compared to watermelon, though he was unaware of the scientific explanation. His observation reflects the nitrogen-fixing capacity of bush beans, which adds atmospheric nitrogen to the soil through root nodules and benefits companion crops. While this conclusion was not verified through extension advice or controlled trials, his experiential learning demonstrates how farmers are adapting their practices through their own experiences.

Table 24: Perceived Benefits of Intercropping

Practice	Overall	Laamu	Thoddoo	Maafahi*
Extra income/food (%)	82	88	81	Yes
Shade for seedlings (%)	40	38	41	Yes
Reduces pest/diseases (%)	15	38	41	Yes
Improves soil fertility (%)	2	12	0	Yes

*Maafahi represents a single commercial operation (Seagull Group) rather than multiple farmers, so responses are indicated as "Yes/No" rather than percentages and are not included in overall averages

Integrated Soil Health Strategies at Maafahi: The commercial Maafahi operation demonstrates how comprehensive soil health management can integrate multiple approaches for maximum climate resilience benefits. The operation employs systematic composting, strategic intercropping, and rotational practices including sunn hemp as green manure. This integrated approach provides a model for scaling soil health improvements that combine traditional practices with systematic

organic matter management. The rotational use of sunn hemp at Maafahi illustrates particular potential for climate adaptation. Sunn hemp fixes atmospheric nitrogen, builds soil organic matter through deep root systems, and breaks pest and disease cycles that can intensify under climate stress. After one year, the sunn hemp is "plowed into the field and then coco husk is added," creating a systematic approach to soil building that reduces external input dependence while improving climate resilience.

Water Conservation and Climate Adaptation

Water management is a critical climate adaptation challenge for papaya farmers in the Maldives, where freshwater resources are naturally limited and climate impacts are intensifying water stress. Farmers report experiencing periods of drought (affecting 10 percent overall), irregular rainfall patterns (10 percent), and excessive rainfall events (63 percent) that create both scarcity and management challenges. In small island environments, effective water conservation becomes essential not only for maintaining productivity during dry periods but also for managing excess water during flood events while protecting the limited freshwater lens from saltwater intrusion.

Current Water Sourcing and Conservation Strategies: Farmers have developed diversified water sourcing strategies that provide reasonable security against seasonal variations, with 95 percent relying on well water supplemented by dependence on natural rainfall practiced by 62 percent of respondents. This dual-source approach indicates sound risk management, combining groundwater irrigation with rain-fed agricultural practices, and can form the basis for expanding water conservation practices. Laamu relies more heavily on natural rainfall (73%) than Thoddoo (55%), which may be due to different cropping patterns, farm management approaches, or rainfall reliability in the respective areas.

Table 25: Water Sources and Application Method

	Overall	Laamu	Thoddoo	Maafahi*
Water Source				
Well water (%)	95	95	95	No
Rainfed (%)	62	73	55	Yes
Municipal piped water (%)	3	5	3	Yes
Application Method				
Pump and hose (%)	75	68.2	78.9	Yes
Sprinkler systems (%)	11.7	22.7	5.3	No
Drip irrigation (%)	1.7	0	2.6	No

*Maafahi represents a single commercial operation (Seagull Group) rather than multiple farmers, so responses are indicated as "Yes/No" rather than percentages and are not included in overall averages

Current irrigation practices show preferences for flexible systems and opportunities for water use efficiency improvements. 75 percent of farmers use pump-and-hose systems in response to plant needs and variable field conditions. However, this manual application method can result in uneven water distribution and less efficient water use compared to precision irrigation systems, as water hoses tend to create localized water saturation rather than consistent soil moisture across the root zone. Sprinkler systems are used by 11.7 percent of farmers overall, with notably higher adoption in Laamu (22.7 percent) compared to Thoddoo (5.3 percent), though effectiveness can be limited unless sprinklers are positioned near individual trees, which increases infrastructure costs significantly. Only 1.7 percent use drip irrigation, despite its potential water conservation benefits. Focus group discussions revealed that farmers have specific concerns about drip irrigation effectiveness for tree crops, noting that systems can get clogged easily when used with papaya production. Given the Maldives' shallow freshwater lenses and constant risk of saltwater intrusion, sprinkler systems may be more appropriate than drip irrigation for tree crops, as they allow for periodic leaching of salts from the root zone while still improving water use efficiency compared to manual application. The commercial Maafahi operation, despite its advanced infrastructure and professional management, continues to use pump-and-hose methods exclusively, suggesting that even well-resourced operations prioritize flexibility and reliability over theoretical efficiency gains when practical challenges with alternative systems are considered.

During focus group discussions, farmers expressed strong interest in efficiency improvements, particularly solar-powered systems that could conserve water. Farmers provided specific cost estimates for solar irrigation systems ranging from 85,000 to 150,000 MVR (6,536-9,804 USD), with a clear understanding of labor-saving benefits. A Thoddoo farmer explained that manual watering "takes 2 hours to water by hand versus 20-30 minutes with irrigation," demonstrating that efficiency gains and time savings motivate investment interest in water-conserving technologies. However, in the Maldives' context of shallow freshwater lenses vulnerable to saltwater intrusion, solar-powered pumping systems require careful management to avoid over-extraction that could accelerate salinization. Further technical assessment is needed to determine optimal pumping rates and monitoring systems that balance operational efficiency with aquifer protection. The challenge lies in developing irrigation approaches that balance water use efficiency with the practical requirements of tree crop production and the maintenance capabilities of smallholder farming systems.

Mulching for Water Conservation: Mulching is moderately adopted with notable regional differences. This practice conserves water by reducing evaporation, moderating soil temperature, and suppressing weeds, which is particularly useful, given the widespread experience of extreme heat and irregular rainfall patterns. Overall, 28.3 percent of farmers always practice mulching while 41.7 percent use it sometimes, indicating substantial awareness of the practice and varying degrees of usage.

Table 26: Mulching Adoption Patterns

Practice	Overall	Laamu	Thoddoo	Maafahi*
Mulch always (%)	28	14	37	Yes
Mulch sometimes (%)	42	32	47	NA
Never mulch (%)	12	23	5	NA

*Maafahi represents a single commercial operation (Seagull Group) rather than multiple farmers, so responses are indicated as "Yes/No" rather than percentages and are not included in overall averages

Field observations revealed that some farmers use papaya crop residues as mulching material, though this practice can perpetuate pest and disease problems by providing habitat for pathogens near growing plants. Extension programs should promote use of non-host materials such as coconut leaves or other organic matter that provide water conservation benefits without disease risks.

Sustainable Pest and Disease Management

Sustainable pest and disease management are perhaps the most critical challenges for scaling sustainable solutions and climate adaptation in papaya production. Climate change is intensifying pest and disease pressure, with 60 percent of farmers reporting increased pest and diseases linked to changing weather patterns, which affects 76 percent in Thoddoo where intensive cultivation compounds climate stress. As documented in Section 4, these climate-driven pressures operate through dual mechanisms: prolonged dry periods and extreme heat accelerate pest reproduction cycles and expand pest ranges, while excessive rainfall (reported by 63 percent of farmers) and increased humidity create favorable conditions for fungal diseases including root rot and anthracnose. As pest and disease pressure affects 68 percent of farmers and ranks as the primary challenge facing papaya production, developing resilient management approaches becomes essential for climate adaptation. However, current management approaches rely almost exclusively on chemical control methods, creating environmental risks, farmer dependency on external inputs, and potential ecosystem disruption that may reduce long-term resilience to climate-related pest and disease challenges.

Table 27: Pest Control Methods by Location

Control Method	Overall	Laamu	Thoddoo	Maafahi*
Chemical pesticides (%)	93	100	89	Yes
Manual removal (%)	30	32	29	Yes
Organic/natural methods (%)	5	9	3	Yes
Biological control (%)	0	0	0	Yes

*Maafahi represents a single commercial operation (Seagull Group) rather than multiple farmers, so responses are indicated as "Yes/No" rather than percentages and are not included in overall averages

Despite low overall adoption, organic and natural farming methods show promise where they are practiced. The 5 percent of farmers using organic approaches primarily rely on neem oil applications, which provides pest control with lower environmental impact than synthetic alternatives. Farmers using neem oil report satisfaction with effectiveness against common pests like mealybugs and aphids, though more frequent application is required compared to synthetic pesticides. Manual removal practices, used by 30 percent of farmers, represent another method for sustainable management. This includes removing infested plant parts, clearing crop residues that harbor pests, and maintaining field sanitation that reduces disease pressure. However, manual methods are labor-intensive and often viewed as supplementary rather than primary control approaches.

The complete absence of biological pest and disease control across smallholder systems indicates fundamental gaps in both knowledge and confidence about alternative approaches. Focus group discussions revealed that farmers have observed ecosystem disruption from heavy chemical use, with Thoddoo farmers noting they "haven't seen some beneficial insects like lady bugs in their fields for quite some time." suggesting this could be largely due to the broad-spectrum insecticides being used. This awareness of beneficial insect loss suggests potential receptivity to restoration approaches, yet farmers remain reluctant to experiment with unfamiliar methods. Despite zero current adoption of biological control among smallholder farmers, substantial farmer interest exists in beneficial insect management approaches. Survey data shows 51.7 percent of farmers interested in growing crops to attract beneficial insects for pest control and pollination, indicating recognition of potential benefits despite current non-adoption. This interest gap suggests that knowledge transfer and technical support could increase adoption, but only if farmers develop confidence in effectiveness. Beyond farmer awareness, the Maldives lacks established supply chains for biological control agents and locally validated efficacy data for most papaya pests. While Maafahi's success with biocontrol against whitefly demonstrates technical feasibility, scaling to smallholder systems requires: (1) identification and testing of biocontrol agents effective under Maldivian conditions, (2) reliable import or in-country production systems for biological inputs, and (3) farmer-accessible evidence on application protocols and expected outcomes.

Building Confidence in Sustainable Approaches: Successfully transitioning farmers to sustainable pest and disease management requires addressing both technical knowledge gaps and confidence concerns through demonstration rather than promotion. Farmers need to see clear evidence that biological and organic approaches can provide adequate control before reducing their reliance on chemical inputs. Extension programs must provide convincing evidence through on-farm demonstrations, yield comparisons, and financial analysis that shows the business case for sustainable pest management.

Agroforestry Integration and Tree Management

Trees provide protection against the strong winds and storms that affect 93 percent of farmers—making agroforestry particularly valuable for climate adaptation in the Maldives context. Agroforestry, in this study, refers to planting trees in and around papaya plots as windbreaks, buffers, or overstory (e.g. under coconut/breadfruit), distinct from the short-cycle vegetable intercropping discussed previously. Agroforestry adoption shows stark regional differences that reflect land tenure

arrangements, space constraints, and different management philosophies. Overall, 35 percent of farmers always practice agroforestry, but this masks dramatic variation between locations.

Table 28: Agroforestry Adoption

Practice	Overall	Laamu	Thoddoo	Maafahi*
Yes, always (%)	35	0	42	Yes
Yes, sometimes (%)	33	29	33	NA
No (%)	33	71	24	NA

*Maafahi represents a single commercial operation (Seagull Group) rather than multiple farmers, so responses are indicated as "Yes/No" rather than percentages and are not included in overall averages

Zero regular agroforestry adoption in Laamu contrasts sharply with 42.4 percent always practicing in Thoddoo, indicating fundamentally different approaches to tree integration. Focus groups revealed that land tenure security represents a major constraint, with foreign workers explaining that barriers include less land tenure and that they need extra funds to hire labor to do extra work to build a natural or artificial shelter belt. Local Thoddoo farmers similarly noted that "based on land sizes and distribution they didn't have any interest in trying it." By contrast, Laamu farmers noted that "most farms have a buffer zone " and that existing areas "can be converted to more beneficial trees like moringa, lime, or have higher live fences of passionfruit." This suggests that agroforestry adoption depends heavily on available space and tenure security rather than technical barriers. There is a huge knowledge gap among farmers about agroforestry: only agroforestry; 58% of farmers recognized that trees are beneficial for protection against strong winds. Wind Adaptation Strategies: While agroforestry provides natural wind protection, some farmers have adopted non-NbS approaches to address wind damage. Field observations revealed that some farmers tie papaya trees to support structures, while the commercial Maafahi operation has every three trees tethered to PVC pipes—a costly but effective engineering solution for wind protection. These practices demonstrate farmer recognition of strong winds as a critical constraint while highlighting the need for accessible natural alternatives that can provide similar protection at lower cost.

13. MGAP Adoption, Interest, and Adoption Barriers

The MGAP scheme is a national certification framework developed by the MoAAW and MFDA to improve the safety, quality, and sustainability of agricultural production. Its standards cover the entire production process, from seed selection and soil management to pesticide use, water safety, worker hygiene, and post-harvest handling. The scheme is designed to reduce risks of contamination, promote responsible input use, and protect farmers' and consumers' health. For this study, a short list of MGAP practices was selected for closer assessment—focusing on those categorized as major or critical and most suitable for quantitative survey methods. The intention was not to evaluate the full MGAP checklist, but to identify where adoption currently stands on a set of core practices and the barriers and motivations that shape uptake. The practices reviewed are presented in Table 29, which provides a snapshot of compliance across Laamu, Thoddoo, and the commercial Maafahi farm. Table cells are color-coded to indicate compliance rates: green denotes standards followed by more than 80% of respondents; yellow indicates 51-79% compliance, and red shows 50% or less

compliance. For Maafahi (representing a single commercial operation), green indicates full compliance; yellow indicates partial compliance, and red indicates non-compliance. This color coding provides a visual guide for interpreting compliance patterns but should be considered indicative rather than definitive.

Table 29: MGAP Practice Compliance

	Category	Overall	Laamu	Thoddoo	Maafahi*
Practice					
Site history assessed for contamination risks	Major	Not to farmers knowledge			Yes
Documentation that guarantees seed quality (free from injurious pests, diseases, virus, etc.) shall be on the farm	Major	Seeds are predominantly imported with no government quality certification system, seed quality declarations, or monitoring mechanisms in place.			
Non-toxic varieties grown	Major	Yes (standard varieties)	Yes	Yes	Yes
Fertilizer storage separate from produce	Major	69% separate storage	55% separate	78% separate	Yes
Fertilizer application records maintained	Major	52% written records	59% written	47% written	Yes
Application based on soil analysis and/or recommendations	Minor	6.7% follow extension advice	13.6% follow advice	2.6% follow advice	Yes
Water quality tested for contamination	Critical	0% test water	0% test	0% test	No
Water treatment before use *Note: no color coding applied, as treatment is only required if there has been a contaminant identified from water testing*	Major	0% treat water	0% treat	0% treat	No
Only legal pesticides used	Critical	71% legal only 23% don't know what's legal	82% legal only 18% don't know what's legal	64.7% legal only 27% don't know what's legal	No

Pesticides stored in secure, separate location	Major	71% separate locked	59% locked	79% locked	Yes
Chemical application records maintained	Major	39% written records	46% written	34% written	Yes
Label waiting periods followed	Major	52% follow waiting period	91% follow	27% follow	Yes
Workers trained in chemical handling	Major	0% workers trained	0% trained	0% trained	Yes
Chemical disposal done safely	Major	20% haven't disposed, 18% burn, 6% keep storing expired pesticides, 4% bury in the ground	36% burn, 14% keep storing expired pesticides, 9% bury in the ground	67% practice "other methods", 6% burn	NA – haven't disposed of chemical pesticides yet
Clean containers used for harvesting	Major	97% plastic crates, farm observation revealed little cleaning practices maintained	95% plastic crates, farm observation revealed little cleaning practices maintained	97% plastic crates, farm observation revealed little cleaning practices maintained	Yes
Recall system available	Critical	6.7% have recall system	0% have system	10.5% have system	Yes
Farmers/workers trained in GAP practices	Major	5% received training (2 years)	13.6% received	0% received	No
GAP records kept for 2+ years	Major	No	No	No	Yes
Chemical handling by trained workers only	Critical	0% workers trained	0% workers trained	0% workers trained	Yes
Chemical storage in secure structures	Major	71.4% separate locked storage	59.1% locked	79.4% locked	Yes
Toilet facilities available for workers	Major	1.7% have farm toilets	4.5% have toilets	0% have toilets	Yes

Workers trained in hygiene practices	Major	No	No	No	No
Harvesting at optimal maturity	Major	92% use color change	95% color change	89% color change	Yes
Clean water used for washing *Note: No color coding applied as water testing has not been conducted to determine if water sources meet clean, safe drinking water quality standards.*	Major	50% wash with clean water	82% wash	32% wash	Yes

*Maafahi represents a single commercial operation (Seagull Group) rather than multiple farmers, so responses are indicated as "Yes/No" rather than percentages and are not included in overall averages

Adoption of Practices: The survey also assessed the adoption of selected MGAP practices, shown in Table 29. The results illustrate that while farmers are already following some core practices—such as use of non-toxic varieties and harvesting at optimal maturity—compliance with other critical requirements is very low for some key compliance standards. For example, no farmers tested water quality or treated water before use, and no workers had received training in chemical handling. Written record-keeping, secure storage, and safe disposal of chemicals is limited. As identified during the qualitative interviews with farmers, these gaps are due to a lack of knowledge and support systems, rather than farmer resistance. Farmers emphasized that many of the practices "are not very different from what we already do," but that they require training to understand how to perform them in compliance. This suggests that with appropriate guidance, adoption could be scaled quickly for several practices, while others (such as costly testing) will require institutional support. At the time of the survey (July 2025), Seagull Group was not MGAP certified. However, during follow-up in-depth interviews, their farm manager highlighted that the company has begun preparations for MGAP certification. At the time of the survey, there were no MGAP-certified farmers in the Maldives. However, by the end of August 2025, the first group of farmers (ten farmers from Shaviyani Goidhoo) successfully achieved MGAP

MILESTONE ACHIEVEMENT: FIRST MGAP-CERTIFIED FARMERS IN THE MALDIVES In August 2025, a cohort of farmers from Goidhoo became the first in the country to achieve MGAP certification (since previous certification holders lost their MGAP certification). This landmark moment demonstrates that certification is feasible at the smallholder level when targeted support, training, and institutional coordination are in place. The certification process was supported by the Maldives Agribusiness Project (MAP) and UNDP and highlights the potential for scaling MGAP through locally grounded, market-aware implementation strategies. *Photo: MoAAW*

certification—marking a key milestone for the scheme's national rollout.

Current Awareness of MGAP

Awareness of MGAP remains extremely low, with only 11.7 percent of farmers reporting that they had ever heard of the scheme. Awareness is slightly higher in Laamu (18.2 percent) than in Thoddoo (7.9 percent), though neither location shows substantive exposure. Farmers themselves acknowledged that they "do not know what is included in the scheme." This low awareness persists despite initial training efforts conducted during MGAP's development phase in the early 2020s. The awareness gap is due to several factors: lack of continuous follow-up to reinforce initial training messages, farmer turnover particularly in leased farming systems where migrant farm operators may not have been targeted in original awareness campaigns, and the time elapsed since initial rollout without systematic refresher training or ongoing extension support. For example, one guesthouse operator in Thoddoo who attended early MGAP training retained knowledge of the scheme, while the majority of current farmers—particularly foreign workers managing leased plots—reported no exposure. This means MGAP adoption efforts effectively start from zero awareness and will require comprehensive introduction campaigns before meaningful uptake can occur. By contrast, Maafahi management reported full awareness of MGAP.

Table 30: Current Awareness to MGAP

Awareness	Overall	Laamu	Thoddoo	Maafahi*
Heard of MGAP (%)	12	18	8	Yes

*Maafahi represents a single commercial operation (Seagull Group) rather than multiple farmers, so responses are indicated as "Yes/No" rather than percentages and are not included in overall averages

Interest in MGAP Adoption

Despite low awareness, interest levels are encouragingly high. Over 70 percent of farmers expressed interest in MGAP certification, with Thoddoo showing the strongest enthusiasm (82 percent compared to 58 percent in Laamu). As one Thoddoo farmer explained, MGAP could help him "learn how to do things properly" to improve yields. Laamu farmers, on the other hand, expressed more uncertainty (36.4 percent were unsure), which may reflect concerns about the potential benefit of MGAP. This is reflected in MGAP investment willingness, where farmers were asked if they were willing and interested in investing in their production to adopt the necessary practices to be compliant with MGAP, for which 53% said that it would depend on the benefits.

Table 31: Interest and Willingness to Invest in MGAP Adoption

	Overall	Laamu	Thoddoo	Maafahi*
Interesting in Adopting MGAP				
Very interested (%)	38	31	42	Yes
Somewhat interested (%)	35	27	40	NA

Not interested (%)	5	6	5	
Not sure (%)	22	36	13	NA
MGAP Investment Willingness				
Yes, will invest (%)	38	46	34	Yes
Depends on benefits (%)	53	46	58	No
No, will not invest (%)	8	9	8	No

*Maafahi represents a single commercial operation (Seagull Group) rather than multiple farmers, so responses are indicated as "Yes/No" rather than percentages and are not included in overall averages

When asked what would motivate them to adopt MGAP, farmers overwhelmingly pointed to higher prices for produce (85 percent overall). Laamu farmers emphasized price premiums (91 percent), while Thoddoo farmers highlighted yield improvements (53 percent) as their main motivation. A majority also believed that consumers would pay more for certified produce—77 percent in Laamu and 47 percent in Thoddoo. Buyer perspectives will be covered in the End-market section of the report. However, this expectation stands in sharp contrast to current market dynamics. Only 8.3 percent of farmers reported that buyers ever ask about farming methods. This mismatch between farmer expectations and actual buyer demand exposes a fundamental value chain gap: without clear signals from downstream actors—resorts, wholesalers, and retailers—farmers are unlikely to see MGAP as a genuine market opportunity. Instead, certification risks being perceived as an administrative burden rather than a pathway to higher value. Beyond price, farmers also viewed MGAP as a potential enabler of resort market access (43 percent) and a means to secure government support or subsidies (60 percent). These additional motivators point to the importance of coupling MGAP adoption with visible market and institutional incentives, so that certification is seen as both feasible and worthwhile.

Table 32: Perceived Benefits of Adopting MGAP

Perceived Benefit	Overall	Laamu	Thoddoo	Maafahi*
Higher prices for produce (%)	85	91	82	No
Government support/subsidies (%)	60	55	63	No
Access to resort markets (%)	43	41	45	No
Greater productivity/yields (%)	38	14	53	No
Environmental benefits (%)	30	36	26	Yes
Personal satisfaction/pride (%)	7	14	3	Yes

*Maafahi represents a single commercial operation (Seagull Group) rather than multiple farmers, so responses are indicated as "Yes/No" rather than percentages and are not included in overall averages

Barriers to Adoption

The most common barrier reported by 88 percent of farmers is lack of knowledge and training. This finding was reinforced in FGDs, where many said they had "never been told what MGAP actually means." Concerns about paperwork and record keeping were also common, with farmers often describing documentation as intimidating. Costs were another recurring theme. Farmers were also concerned about costs and affordability of soil or water testing and believed such requirements should be covered by public institutions. At the same time, the perceptions of market incentives are mixed. While many farmers hope MGAP will help them access resorts, others expressed skepticism about whether certification would translate into real premiums. One farmer warned that counterfeit stickers could undermine the system, noting that "bad actors" might replicate MGAP labels without undergoing certification—eroding trust among buyers and producers alike. These concerns illustrate that barriers to MGAP adoption are as much about confidence in the system as they are about technical or financial feasibility.

Table 33: Perceived Barriers to Adopting MGAP

Perceived Barrier	Overall	Laamu	Thoddoo	Maafahi*
Lack of knowledge/training (%)	88	91	87	No
Too much paperwork (%)	30	36	26	Yes
Cost of changes needed (%)	30	32	29	No
Time required (%)	8	14	5	Yes

*Maafahi represents a single commercial operation (Seagull Group) rather than multiple farmers, so responses are indicated as "Yes/No" rather than percentages and are not included in overall averages

Market Barriers to MGAP Adoption

The transactional, loosely structured, and largely buyer-driven functioning of the current agricultural value chain is a key barrier to MGAP adoption. Most produce is sold through informal, per-transaction deals with collectors who supply the Malé market. Farmers have little to no leverage in these exchanges. When a vessel arrives, they typically accept the offered price, with no negotiation based on quality or production standards. This dynamic undermines farmers' incentives to invest in better practices. There are no consistent quality requirements, no recognition of MGAP certification, and no price premiums for safer or more sustainable production. Though farmers widely believe that consumers would pay more for certified produce, the market offers no indication of that. With buyers rarely asking about production methods and no mechanism to differentiate MGAP produce, the market sends weak or nonexistent signals that better practices will be rewarded. This disconnect points to a deeper structural issue: MGAP cannot succeed on farmer effort alone. The enabling conditions—stronger demand signals, traceability systems, and ready buyers—are not yet in place. In the current system, even motivated farmers have nowhere to sell MGAP-certified papaya at a premium. Existing collectors and Malé cubicle operators do not differentiate based on production standards, nor do they have systems in place to channel certified products to retailers who might

value them. For MGAP to become a viable pathway to better income or new markets, the market side must evolve in parallel with farm-level change. That involves:

- Developing new channels or buyers that recognize and reward MGAP-certified produce;
- Establishing formal procurement relationships based on quality, safety, and consistency;
- Building traceability tools that allow certified produce to be verified and valued.

Food Safety and Public Health Implications

The findings on the pesticide pre-harvest interval non-compliance, combined with other pesticide management gaps documented in this section, present significant food safety concerns requiring urgent coordinated action from MoAAW and MFDA. The evidence is particularly concerning: admitted use of banned pesticides (5.4 percent) with an additional 23.2 percent unable to identify legal products; reliance on memory rather than written records for pesticide applications (53.7 percent of farmers); unsafe disposal practices with 41.8 percent using unspecified methods; absence of clean water for post-harvest handling; zero formal training for workers handling chemicals; and language barriers preventing foreign workers from reading safety labels. These systemic gaps in pesticide management and food safety protocols create direct pathways for pesticide residue contamination of produce entering both domestic and tourism markets. While MGAP certification provides a framework for addressing these issues at the farm level, the scale of non-compliance documented here—particularly the reported instances of harvesting within 48 hours of pesticide application—indicates that regulatory enforcement and verification mechanisms require immediate strengthening to protect public health. Please see recommendation 3A under the Recommendations and Action Plan Section for further detail.

14. Looking Ahead: Investment Patterns, Support Needs, and Future Planning

Production Plans: Key Signals and Implications

The majority of farmers plan to continue cultivating papaya in the coming years. Survey data indicate that 56.7 percent of farmers intend to expand their production area, while 36.7 percent expect to maintain their current production levels. This high level of continuity and planned growth is particularly evident in Thoddoo, where 63.2 percent of farmers anticipate expansion. In Laamu, 45.5 percent intend to expand, and 40.9 percent plan to maintain existing levels. Only 3.3 percent of farmers reported plans to exit farming, and all of these responses came from Laamu, where logistical and transport constraints are more acute.

These production plans suggest that the majority of papaya producers remain committed to the sector, which provides a strong foundation for future interventions aimed at improving agricultural practices. This continuity is a positive signal for policymakers and technical agencies seeking to promote adoption of the MGAP scheme, NBS, EbA, and CSA practices. However, this forward momentum is not guaranteed. In locations such as Laamu, infrequent transportation and poor connectivity have been reported as significant deterrents to further investment. Farmers in focus

"We want to grow more, but we need better vessel frequency. Right now, we lose money waiting." – Farmer, Laamu

group discussions described vessel arrivals occurring only twice per month, which limits marketing opportunities and delays income generation.

Table 34: Plan for Farming in the Next Five Years

Plan for Farming Growth	Overall	Laamu	Thoddoo	Maafahi*
Expand production (%)	56.7	45.5	63.2	No
Maintain same level (%)	36.7	40.9	34.2	Yes
Reduce production (%)	1.7	0	2.6	No
Stop farming (%)	3.3	9.1	0	No
Not sure (%)	1.7	4.5	0	No

*Maafahi represents a single commercial operation (Seagull Group) rather than multiple farmers, so responses are indicated as "Yes/No" rather than percentages and are not included in overall averages

Stated Support Needs

Across all regions surveyed, farmers clearly articulated a set of priority support areas necessary for improving production outcomes and facilitating adoption of improved practices. These priorities emerged consistently across both the quantitative survey and qualitative interviews.

Table 35: Top farmer Identified Area of Support

Support Area	Overall	Laamu	Thoddoo	Maafahi*
Market linkages (%)	80	59	92	No
Technical training (%)	63	59	66	Yes
Better planting material (%)	60	77	50	Yes
Subsidized inputs (%)	55	64	50	Yes
Access to credit/loans (%)	45	50	42	Yes
Weather information (%)	35	32	37	Yes
Storage facilities (%)	13	23	8	No

*Maafahi represents a single commercial operation (Seagull Group) rather than multiple farmers, so responses are indicated as "Yes/No" rather than percentages and are not included in overall averages

The most frequently cited need was improved market linkages. This was particularly pronounced in Thoddoo, where 92 percent of farmers identified this as a priority. During focus group discussions, farmers expressed a desire for more reliable and transparent relationships with buyers, especially with respect to price consistency and procurement predictability. In Laamu, several participants noted that the discontinuation of AgroNat's coordination role has left farmers with fewer tools to navigate market access, resulting in greater dependence on informal and often unpredictable channels.

Technical training was the second most cited area of need. Farmers highlighted a lack of practical, consistent guidance on a range of issues including chemical use, record-keeping, compliance with MGAP standards, and pest management. The need for ongoing and field-based training, rather than one-off events, was emphasized across locations (more information is provided in the next sub-section).

Perceived Institutional Neglect and Community Resentment

Both Thoddoo and Laamu farmers and Island Councils expressed frustration with what they perceive as institutional abandonment despite their agricultural importance. Island council representatives and farmers consistently noted that these major production centers receive minimal government attention relative to their contributions to the country's agricultural production.

In Laamu, the abrupt closure of AgroNat operations was seen as emblematic of this neglect. The loss represented both market access and trusted information flows. This institutional distance has created adaptive behaviors—farmers form WhatsApp groups with former trainers, maintain contact with previous project staff, and rely heavily on input suppliers for technical guidance—but also underlying resentment that affects receptivity to new programs.

Access to improved planting material, particularly disease-resistant varieties, was most urgently expressed in Laamu. This aligns with earlier findings on disease prevalence in that region. One farmer in Laamu noted: "We want better seeds, and we want to know what actually works here, not just what is available." Similarly, demand for subsidized inputs and access to credit reflect broader concerns around production costs and financial risk. In Laamu, farmers cited high fertilizer prices and stockouts lasting several months as key constraints. These input access and affordability challenges create particularly favorable conditions for promoting composting and organic matter management practices in Laamu—where high-nitrogen composting systems could provide a locally-controlled alternative to expensive and unreliable commercial fertilizer supplies while simultaneously building long-term soil fertility. Requests for weather-related information and risk mitigation tools also emerged, albeit less frequently. Some farmers asked for information related to wind and flood risks and expressed interest in insurance or public infrastructure to protect production systems. Although storage infrastructure was not widely cited as a critical need overall, 23 percent of farmers in Laamu identified it as a priority, most likely due to shipping delays and related post-harvest challenges.

Training and Information Access: Gaps in Coverage and Continuity

Survey findings reveal stark disparities in formal agricultural training access across study locations. Only 5 percent of farmers reported receiving any training in the past two years, with coverage concentrated entirely in Laamu (13.6 percent), while no respondents in Thoddoo reported recent training exposure. The absence of training in Thoddoo is particularly notable given its status as a major agricultural production center. Furthermore, farmers during FGDs and in-depth interviews (IDIs) largely noted that they do not have contact with extension agents but rather use WhatsApp

groups that were created for previous training programs, contact previous trainers directly, rely on their own knowledge, and/or ask their peers (largely in Laamu). It was clear from the field visits, that farmers and island councils did not have a single reliable source of information, or updated guidance on production practices (see text box).

Enabling Environment – Extension Services and Technical Support Systems

The current agricultural extension system faces significant structural constraints that limit farmers' access to technical guidance and limit the adoption of improved practices essential for MGAP compliance and sustainable intensification. Both the MoAAW and the Agricultural Research Center in Hanimaadhoo have identified critical gaps in extension delivery capacity that require systematic institutional responses to support agricultural development and climate adaptation.

Current extension system constraints: The Agricultural Research Center, which serves as the primary source of technical expertise for the country's agricultural sector, operates with severely limited human resources for extension delivery. The center maintains only six technical specialists responsible for both research activities and extension programming across the entire country. This dual mandate creates fundamental trade-offs where extension trips to outer islands interrupt ongoing research trials and experimental work, limiting the center's capacity to fulfill both functions effectively. Field visit data illustrates the scale of this constraint: research center staff have completed only 20 trips to agricultural islands collectively, with short visits that cannot provide sustained technical support. One specialist traveled to Laamu for two days as part of the ENDhERI project, a typical short-duration engagement that limits opportunities for in-depth farmer training and follow-up support. This sporadic engagement prevents farmers from getting systematic technical assistance for complex practices such as integrated disease management, MGAP compliance, or sustainable agriculture adoption.

Institutional Vision for Decentralized Extension: The MoAAW has articulated a clear vision for addressing extension constraints through decentralized, island-based technical support systems. Ministry officials emphasize the need to station extension agents on each of the main agricultural islands, moving away from the current centralized model that concentrates expertise in Hanimaadhoo. This approach recognizes that sustained behavior change, and adoption of agricultural practices require consistent, locally available technical support that can provide ongoing guidance and problem-solving assistance. The proposed model envisions extension agents integrated into island council structures, potentially providing regulatory oversight in addition to technical assistance. This integration could address both farmer training needs and compliance monitoring for standards like MGAP certification. However, budget constraints currently limit implementation, with the Ministry proposing to start pilot programs on 1-2 islands before scaling the approach.

Digital Extension and Technology Integration: The Ministry's development of the Dhanduveriya app represents an opportunity to integrate extension services with market facilitation, potentially providing technical guidance alongside market access. Digital platforms could deliver training materials, pest and disease identification tools, and real-time technical support that complement field-based extension services. This hybrid approach could help address resource constraints while providing farmers with immediate access to technical information.

Agriculture Input and Service Provision

Papaya farmers in the Maldives are actively engaged with commercial input markets, in contrast with subsistence agriculture patterns common in many developing countries. Survey results indicate that 93.3 percent of farmers use chemical pesticides, while fertilizer application is nearly universal, indicating widespread commercial input adoption across production locations. This market participation occurs within a concentrated supplier network, with farmers typically procuring inputs through direct orders to Malé-based providers who arrange vessel shipments to outer islands, supplemented by limited local outlets such as State Trading Organization (STO) branches in locations like Laamu.

Input Cost and Availability Constraints

57 percent of farmers reporting high input costs as a challenge reflects deeper supply chain vulnerabilities. A Laamu farmer provided specific examples of price and availability constraints: "soluble fertilizer is 300 MVR (19.6 USD); also there are frequent stockouts—this is happening with manure, compost, cow dung. Could be one month before restock, sometimes 2-3 months for soluble fertilizers." Researchers documented low stock levels for soluble fertilizers and organic amendments during visits to the State Trading Organization shop in Laamu.

The geographic variation in cost burdens—with Laamu farmers disproportionately affected—aligns with transportation challenges described by multiple respondents, including difficulties accessing inputs from Malé-based suppliers. These findings highlight the interconnected nature of availability and cost constraints, where supply chain disruptions drive both stockouts and price volatility. Addressing transportation and distribution infrastructure is crucial for supporting productive agriculture, particularly in outer atolls where farmers face the greatest input access challenges.

However, this supply chain structure creates notable vulnerabilities for producers. Farmers consistently reported input stockouts that disrupt production schedules, particularly during peak demand periods, or when weather delayed inter-island transport. Focus group participants expressed concerns about quality, pointing out variability in seed germination rates and pesticide efficacy that affects crop outcomes. Farmers' reliance on just a few key concentrated suppliers and providers—amplifies these supply and quality risks while limiting competitive pricing options. 57 percent of farmers attributed high input costs to these procurement challenges and as a major production constraint. This highlights the important role of input suppliers in farmers' success and the broader viability of papaya production systems.

Established Market Players

The agricultural input sector serving papaya farmers consists of experienced suppliers with significant market presence and geographic reach. Key informant interviews with three major providers reveal a mature sector characterized by long-term operations spanning 12 to 25 years and comprehensive island coverage. All respondents operate from Malé while serving multiple islands, including key production areas such as Thoddoo and broader regional markets.

Table 36: Input Supplier Business Profiles

Provider	Years Operating	Geographic Coverage	Primary Products Offered
Alividhaa Maldives Pvt Ltd	25	Mainly Malé and Thoddoo	Seeds, fertilizers, pesticides, irrigation equipment
Agro Services Pvt Ltd	20	All islands	Seeds, fertilizers, pesticides, tools, advisory services
Prime Fertilizer	12	All islands, resorts	Seeds, seedlings, fertilizers, pesticides

The sector demonstrates strong operational foundations with universal provision of core agricultural inputs including seeds, fertilizers, and pesticides. Advisory services are commonly offered, with all respondents providing technical guidance on planting, fertilizer application, and pest management. However, significant gaps exist in value-added services: no providers offer credit or advance payment arrangements, and only two of three maintain farmer sales records. This suggests opportunities for enhanced service delivery, which could support MGAP adoption and improve farmer relationships.

MGAP Certification Support Potential and Readiness

Input suppliers demonstrate varying levels of MGAP familiarity and support capacity, with notable potential for enhanced roles in certification processes. One provider reports being "very familiar" with MGAP standards, while two are "somewhat familiar," indicating some awareness across the sector. All respondents consider MGAP adoption advantageous for farmers, suggesting alignment with certification objectives. Business opportunity perceptions vary significantly. Two providers identify clear commercial potential in MGAP support, specifically through "introduction and marketing of eco-friendly product range" and leveraging existing "eco-friendly products" portfolios. One provider expressed skepticism about business opportunities, citing limited market size. This highlights the need for market development efforts alongside technical capacity building.

Current compliance practices provide a foundation for MGAP support. All providers maintain records of seed and seedling sources with quality certifications and sell only Maldives-approved pesticides. However, documentation capabilities are limited: only two of the three can provide receipts and certificates necessary for MGAP compliance documentation. Closing this gap requires a systematic effort to enable full supplier participation in certification processes.

Climate-smart Agricultural Inputs

Input suppliers demonstrate significant capacity to support the adoption of sustainable agricultural practices, though current farmer demand remains limited. All providers stock composting and soil improvement products, including organic fertilizers, compost activators, and in one case, biochar. Integrated pest management (IPM) tools are widely available, including natural pesticides, sticky traps, and pheromone traps, with all providers reporting staff trained in IPM advisory services. Water

conservation products are also widely available from all suppliers, including drip irrigation systems, water storage tanks, rainwater harvesting equipment, solar-powered pumps, and mulching materials. This extensive product range suggests strong supplier readiness to support CSA practices once farmer demand materializes. Sales of climate-smart agricultural products vary considerably, with one provider noting compost as "fast-moving" while others report slow to medium movement or difficulty tracking specific product sales. All suppliers identify consistent barriers limiting adoption: lack of farmer awareness, high costs, and uncertainty about benefits. Technical complexity also emerges as a constraint, particularly for more sophisticated systems like drip irrigation and solar technologies.

Institutional Collaboration Gaps and Partnership Potential

The input sector operates in isolation from institutional agricultural development efforts. No providers currently collaborate with government extension services, NGOs, development projects, or research institutions. This represents a missed opportunity for systematic engagement with national agricultural and sustainability strategies. This institutional isolation contrasts sharply with provider willingness to participate in collaborative programs. All respondents expressed interest in joint awareness and training programs, collaborative research, and service outsourcing arrangements. Additionally, all are willing or very willing to join a hypothetical MGAP 'Certified Supplier' program, indicating strong potential for formalized participation in MGAP promotion programming.

Table 37: Current Institutional Engagement

Partnership Type	Providers Engaged	Engagement Activities
Government extension	0/3	None reported
Development projects	0/3	None reported
Resort buyers	1/3	Technical advisory only
Research institutions	0/3	None reported

Barriers to Sector Development and Support Needs

Input suppliers identify multiple structural barriers limiting their effectiveness in supporting improved papaya production. Competition is driven primarily by price and quality. Providers cite challenges from "unregulated markets and unfair competition" and "market flooding with poor-quality products." These supplier concerns align with farmer experiences, as focus group participants consistently reported difficulties accessing quality inputs, particularly noting variability in seed germination rates and pesticide efficacy. This agreement of supplier and farmer perspectives on quality challenges creates an unusual policy opportunity. Both sides of the market favor increased regulation to control poor-quality products, contrasting with typical industry resistance to regulatory oversight. Input suppliers specifically identified quality seed access as a critical constraint, acknowledging that "sourcing good quality seeds" is a key challenge requiring systematic attention. Despite these challenges, suppliers demonstrate strong commitment to expanded roles in supporting sustainable

papaya production. When asked about their potential contributions, providers emphasized their willingness to "facilitate import of any required inputs which might be unavailable in the market at the moment" and to "provide technical support and conduct trainings." This proactive interest toward advisory services suggests significant untapped capacity for farmer support beyond traditional product sales.

Enabling Environment – Promoting Quality Inputs that are Affordable and Available
The MoAAW confirmed that there are currently no mechanisms in place to ensure the quality of agricultural inputs, particularly fertilizers and genetic materials. While there are plans to introduce legislation regulating the import of quality inputs, ministry officials raised concerns about whether such legislation could be effectively implemented, citing institutional and resource constraints. This presents a significant challenge, particularly in the context of MGAP, which includes specific standards related to input quality. At present, the Ministry lacks the capacity to monitor or enforce these standards and expressed uncertainty regarding its ability to do so in the near future. The Ministry also acknowledged that both input availability and affordability remain key constraints for farmers. They referenced a recent commitment from the President's Office to address these issues by expanding the national input distribution network. The proposed approach involves establishing agro-input supply shops in the northern and southern atolls through public-private partnerships. Under this model, island councils would allocate land, the central government would design the facility, and private parties would be invited to operate the shops. In addition, ministry officials expressed interest in developing a system to provide subsidized inputs to farmers who are formally registered as commercial producers. However, details regarding the operationalization and timeline of this initiative remain unclear.

Aggregation and Distribution

Effective aggregation and distribution systems are fundamental to well-functioning agricultural value chains that provide farmers with reliable market access and fair pricing. In the Maldives papaya sector, where 96.0 percent of farmers sell to traders and middlemen rather than directly to consumers, the efficiency of aggregation and distribution networks directly determines farmer income and market opportunities. The following findings are drawn from key informant interviews with five value chain actors—two cubicle owners, one transporter, one informal aggregator, and one wholesaler—as well as the research team's observations of vessel loading and unloading processes and in-depth interviews and focus group discussions with farmers.

Migrant-Led Aggregation Networks in Thoddoo

Interviews and field observations reveal a concentrated aggregation system in Thoddoo dominated by foreign labor networks. A lead migrant wholesaler in Malé coordinates purchasing through subordinate contacts who place direct orders to Thoddoo farmers. This network collects from both migrant and local, Maldivian farmers, creating an integrated but ethnically stratified supply chain. The network's effectiveness stems from significant cohesion amongst actors from the main migrant wholesaler in Malé through subordinate contacts to farmers in Thoddoo, enabling dominance of the sector through established relationships and shared language among migrant farm workers. This concentrated control has created substantial barriers for alternative buyers seeking to source from Thoddoo. The migrant network's effective monopoly on market access makes it difficult for other aggregators, wholesalers, or buyers to establish independent sourcing relationships with Thoddoo farmers.

Given that the majority of papaya production flows to Malé through middleman channels, understanding aggregation and distribution patterns becomes critical for identifying bottlenecks and improvement opportunities. These systems also play a crucial role in maintaining papaya quality and safety during post-harvest handling and transport—factors that are essential for MGAP compliance and accessing premium markets where certification price premiums could potentially be realized.

Aggregation Patterns

Papaya aggregation in the Maldives operates through informal networks closely synchronized with vessel transportation schedules. As previously noted, farmers harvest according to transportation timetables, creating short collection periods that require rapid mobilization of informal networks. Initial aggregation follows three primary patterns: 1) aggregation workers on the vessels collecting directly from farmers, 2) farmers transporting produce to vessel loading points, or 3) individual farmers collecting additional quantities from neighbors to fulfill orders received via phone calls from Malé-based cubicle owners.

A secondary aggregation process occurs upon vessel arrival in Malé, where products are redistributed according to pre-arranged buyer allocations. Crates and bags are marked to indicate designated cubicle owners, with individual vessels serving multiple buyers simultaneously. This system enables cubicle owners to source from multiple production locations and vessels while managing diverse buyer requirements. Cubicle owners function as key aggregation nodes in this

system, simultaneously sourcing from multiple suppliers and distributing to various buyer categories. According to the interviews with two cubicle owners and one wholesaler, these actors market between 90-100% of their aggregated volume onwards to resorts and guesthouses.

Quality Specifications: Aggregator responses regarding quality standards reveal a significant disconnect between stated practices and field realities. When asked about price differentiation based on quality characteristics, all three aggregators claimed they maintain separate pricing structures, and two indicated they communicate quality feedback to farmers. However, field observations and farmer interviews contradict these assertions entirely. Zero indication of quality grading or price differentials emerged during the research team's extensive fieldwork, and only 3.3 percent of interviewed farmers reported ever experiencing product rejection. This disconnect suggests either aspirational responses from aggregators or a fundamental breakdown in market signal transmission. Farmers have no incentives to invest in improved production practices due to the absence of quality-based pricing mechanisms. This creates a low-quality equilibrium where neither farmers nor buyers have strong motivation to upgrade standards.

Quality deterioration patterns compound these market failures. All three aggregators reported observing declining papaya quality from local farmers over recent years, citing interconnected challenges that reflect broader value chain constraints. One aggregator noted that quality decline was linked to "farmers using less fertilizers and inputs to cut down costs due to low prices," highlighting how low pricing perpetuates a downward spiral in production standards. Another identified "low quality, smaller sizes, diseases like black mold and mealy bugs on fruits,". The third aggregator emphasized "reduced volume, less availability throughout the year," suggesting that quality issues extend beyond individual fruit characteristics to broader supply reliability concerns.

Transportation Infrastructure and Logistics

Transportation Routes and Journey Times

Vessel-based transportation dominates inter-island movement of agricultural products, with journey times varying significantly by distance and weather conditions. Transportation from Thoddoo to Malé requires approximately 4 hours under normal conditions, while Laamu Atoll to Malé journeys extend to 24-36 hours depending on weather patterns. These extended journey times for outer atolls create substantial quality challenges for perishable products that lack refrigerated transport options. Additionally, farmers from Laamu noted that the vessels typically only come to collect goods twice per month. Vessel operators confirm that agricultural products receive secondary priority in cargo allocation. One transporter explained: "Our vessels travel to different parts of the country and carry various types of goods." We usually target to carry agriculture goods during return journeys to Male to maximize profit. The vessels aren't primarily built to

Photo: Vessel prior to loading in Laamu Atoll, August 2025. Source: Alysa Grude

carry agriculture goods." This operational model treats agricultural cargo as opportunistic rather than prioritized freight.

Infrastructure Limitations and Quality Impacts

Transportation infrastructure demonstrates significant constraints that can affect the quality and safety of agricultural goods. Vessels typically feature open deck configurations with minimal protection from environmental exposure. One transporter detailed current mitigation efforts: "Our vessel is quite open deck, so exposure to sun is a factor. We counter that with shade clothes at the moment. But we believe a storage room needs to be constructed to carry such goods." Cold storage capabilities are absent across all transportation operators interviewed, which can increase spoilage of products. Weather-related delays compound these constraints, as transporters acknowledge: "Sometimes due to bad weather our trips get delayed for crew and vessel safety. In such cases, if there isn't a cold room, the goods will go bad." UNDP supported AgroNat to launch a cold storage boat, but this has not been in operation, as AgroNat is currently non-operational.

Distribution Network Inefficiencies

The transportation network operates through Malé-centric routing patterns that create major inefficiencies for inter-atoll trade. Point-to-point vessel operations between production islands and Malé eliminate direct connectivity between neighboring islands within atolls. This configuration forces products to route through Malé even for consumption on nearby islands, increasing transportation costs and delivery times while reducing product quality. For example, although Gan Island in Laamu Atoll produces agricultural goods, these goods will be transported to Malé before they are transported to other islands within Laamu Atoll or in nearby atolls.

Enabling Environment – Transportation Gaps and Decentralization Plans
The MoAAW acknowledged that transportation constraints continue to hinder both market access and the availability of agricultural inputs. According to ministry officials, the Maldives Transport and Contracting Company (MTCC) operates boats to agricultural islands either once or twice a week. However, they noted that inconsistent pricing by operators, poor handling infrastructure, and inadequate cold chain capacity frequently result in post-harvest losses. As one official explained: "*MTCC has boats that go to all the agricultural islands twice a week or sometimes once a week, but they charge different rates—and the infrastructure and handling isn't good, which will result in damage and losses."* This statement contrasts with farmer reports in Laamu, where participants cited vessel arrivals only twice per month. Despite the discrepancy, the Ministry noted that it plans to engage with MTCC to address these operational challenges. Additionally, the Ministry shared that there are plans to reduce dependency on Malé and the central atolls by developing agricultural zones in both the northern and southern regions. This would involve improving inter-atoll transport links to strengthen regional supply chains and facilitate more consistent movement of goods across the country.

Value addition

Papaya value addition in the Maldives remains minimal, reflecting both market constraints and the product's consumption patterns. The fruit is predominantly consumed fresh, with limited processing occurring only at small-scale retail and food service levels. Local shops and cafés provide basic value addition through fruit cutting services for immediate consumption and smoothie preparation as part of menu offerings. These activities represent convenience processing rather than manufacturing-scale value addition designed to extend shelf life or create differentiated products. The absence of industrial-scale papaya processing aligns with broader economic factors that typically drive value addition decisions. Manufacturing-level processing generally emerges either when producers can capture significant price premiums for processed products or when surplus production requires preservation to avoid losses. Neither condition currently exists in the Maldivian papaya sector. Local production levels rarely generate surpluses requiring processing intervention—instead, the sector faces periodic shortages that necessitate imports to meet domestic demand. Additionally, the tourism market's preference for fresh tropical fruit creates stronger incentives for maintaining quality in fresh form rather than investing in processing infrastructure.

While small-scale processing could theoretically help farmers in remote islands manage irregular transportation schedules—for example, in Laamu where vessels arrive only twice monthly—no current papaya processing activities exist to demonstrate market viability. Beyond ready-to-eat fresh fruit markets, demand for processed papaya products (dried, pulped, or value-added preparations) remains unexplored and uncertain. Any processing development would require market feasibility studies to assess consumer demand, identify viable product formats, and evaluate whether processing economics could justify investment given the logistics and scale constraints of island production systems. This can be a potential area for future investigation rather than an immediate actionable opportunity.

Retailing and end markets

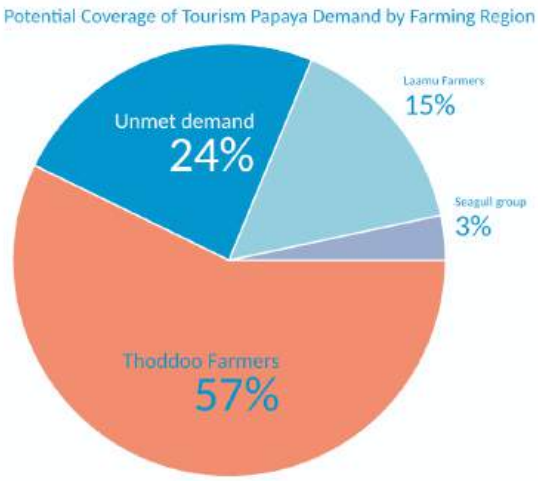
The papaya value chain in the Maldives terminates through a complex network of retail channels serving distinct consumer segments, each with specific procurement patterns and operational characteristics. Understanding these end-market dynamics reveals how product flows from dispersed island production to final consumers across domestic and tourism markets. However, it is difficult to quantify precise volume flows through these channels, as such data are not currently recorded by government agencies. The analysis therefore focuses on identifying main end-market channels, sourcing patterns, and general product flows, rather than providing specific volume percentages or quantities distributed to various market actors. To inform the analysis presented below, the research team conducted interviews with four guesthouses in Thoddoo, one resort chain, one hotel, and two cubicle owner retailers, supplemented by other key stakeholders who can comment on the sector, such as the MoTE and the MoAAW.

Distribution Infrastructure and Market Concentration

Papaya distribution in the Maldives operates through a hub-and-spoke model centered on Malé, with cubicle owners and wholesalers serving as the primary aggregation and distribution point for the entire archipelago. These intermediaries function simultaneously as wholesalers to downstream retailers and direct retailers to consumers, creating a concentrated control point that channels product from dispersed island production to multiple end markets. From their Malé operations, cubicle owners and other wholesalers supply downstream channels including small retailers, supermarkets, tourism suppliers providing direct resort sales, guesthouses, hotels, safari vessels, and direct consumer purchases. From the interviews conducted with wholesalers and cubicle owners, they estimated that they sell 90%+ of their papaya to the tourism sector, specifically to resorts.

Tourism Market Structure and Scale

The tourism sector represents the largest potential domestic market for papaya consumption, driven by nearly 1.9 million international visitors in 2023. The sector's accommodation infrastructure spans 817 guesthouses across 114 inhabited islands with nearly 14,000 bed capacity, 178 resorts providing over 44,000 beds (representing 70% of total tourism accommodation), 16 hotels, and 147 safari vessels, creating a combined tourism bed capacity of 61,830. This scale of hospitality operations generates substantial daily fresh produce requirements that could theoretically absorb significant portions of local agricultural output (Ministry of Tourism, 2024).



Conservative demand estimates suggest resorts, guesthouses, and hotels require approximately 1.9 million kg of papaya annually, based on assumptions of 145g daily consumption per guest. These calculations exclude staff consumption, food preparation losses, and typical resort buffet service offerings that would substantially increase actual demand. Current production capacity from the study focus regions—Thoddoo with approximately 130 farmers, Laamu with 22 farmers, and Maafahi with the commercial operations—totals approximately 1.44 million kg annually, indicating that existing production from these areas alone could supply about 76% of estimated tourism sector demand. This analysis suggests significant potential for local sourcing but also highlights the need for additional farming capacity or productivity improvements to fully serve the domestic tourism market.

Resort Procurement

Food procurement by resorts in the Maldives follows a sophisticated but import-dependent model that prioritizes supply chain reliability and quality consistency over local sourcing relationships. Most resort establishments source fresh produce through specialized suppliers based in Malé who maintain either dedicated procurement divisions or contracted distribution networks with established

international supply chains. These intermediaries provide predictable weekly ordering systems that allow resort purchasing managers to access standardized produce from global markets rather than managing relationships with dispersed smallholder farmers across multiple islands.

Import sourcing shows clear geographical preferences, with India serving as the primary source for fresh fruits and vegetables. Additional suppliers from Sri Lanka, Thailand, Australia, and Europe supplement these primary channels, creating diversified supply networks that can respond to seasonal variations and quality requirements. One major resort group interviewed for this study sources only 20-30% of produce locally, with imported papaya prioritized for guest service and local papaya allocated to staff consumption. This usage pattern reflects quality consistency concerns rather than absolute quality differences between local and imported products. The preference for import-dependent procurement stems from systemic advantages that established international suppliers provide. Resort operators consistently identify the predictability of overseas supply chains—which can deliver standardized quality produce on scheduled delivery cycles—as a key factor in their sourcing decisions.

Barriers to Local Agricultural Sourcing: Despite the potential for supporting local agriculture, few resorts have established direct procurement relationships with nearby farming communities. The absence of organized farm-to-resort supply chains presents significant operational challenges, as smallholder farmers are dispersed across islands with limited coordination mechanisms for aggregating produce or ensuring consistent delivery schedules. Resort purchasing managers frequently identify irregular supply volumes, seasonal production limitations, quality control inconsistencies, and logistical complexities as primary deterrents to local sourcing. These systemic challenges have reinforced the dominance of import-based procurement, where resort operators can place predictable weekly orders with established agents rather than managing relationships with multiple small-scale producers across different islands. The resulting supply chain structure effectively marginalizes local agricultural producers from accessing one of the country's largest and most lucrative food markets (Ministry of Tourism, 2015). Interviews with farmers validated this sentiment (see text box).

Farmer Disconnect: Supplying to Resorts

A fundamental disconnect exists between farmer aspirations and retail market realities that constrains value chain development. Focus group discussions revealed that farmers express interest in direct resort sales while rejecting cooperative arrangements that could facilitate such access. This apparent contradiction reflects farmers' desire to capture retail margins without accepting the organizational requirements that large buyers typically demand. Farmers are reluctant to work through aggregation systems, viewing intermediaries as profit-skimming entities rather than value-adding services. Yet resort buyers consistently express preference for single-source suppliers who can meet diverse product needs rather than managing multiple individual farmer relationships. An Anantara representative noted the benefits of centralized purchasing, explaining their quarterly bidding system where "whoever is the cheapest they will award the contract to and that person will then fulfill their requirements across multiple products."

This structural mismatch perpetuates farmer dependence on traditional middleman channels while limiting their access to premium markets that could justify MGAP certification investments. The absence of institutional mechanisms to bridge this gap is a major constraint for sustainable intensification initiatives that depend on market incentives for adoption.

Guesthouse Procurement

Guesthouse procurement patterns differ significantly from resort operations, creating more direct but limited opportunities for local farmers depending on location and operational scale. On agricultural islands such as Thoddoo, guesthouses benefit from proximity to production and often source directly from farmers through established social networks. Interviews revealed that 80-90% of Thoddoo guesthouse operators have their own farms, or someone in their family has a farm, creating integrated production-consumption systems that reduce procurement complexity. Where direct ownership is not feasible, operators rely on community knowledge networks to identify farms with ready produce and maintain friendship-based arrangements for sourcing during peak tourism seasons. However, the fundamental mismatch in scale between guesthouse demand and farm production limits the potential for market development. Focus group discussions with Thoddoo farmers highlighted that "the produced volume is quite high per farm per week." A guesthouse will not be able to buy the entire product. Therefore, they prefer to sell the entire produce to the Malé market as they can take the entire produce." This volume mismatch creates farmer preferences for bulk buyers who can absorb entire harvests rather than guesthouse buyers requiring smaller, consistent quantities over extended periods. Guesthouses located on non-agricultural islands face different procurement challenges, typically sourcing through Malé wholesale markets. These establishments lack direct relationships and local production access that benefit agricultural island operations, making them more dependent on the centralized distribution systems.

Hotel Procurement

Hotels occupy a middle ground between resort and guesthouse procurement systems, sourcing through wholesale suppliers in Malé who prepare orders and coordinate transportation logistics. Unlike resorts with sophisticated procurement systems, hotel quality decisions are based primarily on visual appearance, with operators switching suppliers after experiencing poor shipments rather than implementing systematic quality assurance processes. Price and availability serve as primary decision drivers, with local farms often charging higher prices to nearby islands than to distant Malé markets, creating counterintuitive pricing dynamics that discourage direct local sourcing.

Tourist Market Access Constraints for Local Production

Survey results reveal substantial barriers preventing local farmers from accessing tourism markets, with 74.6% of respondents finding it difficult to sell to the tourism sector. Regional differences demonstrate location-specific constraints, with Laamu farmers reporting higher barriers (90.5%) compared to Thoddoo farmers (65.8%). Only 6.8% of farmers overall consider tourism sales easily accessible, concentrated entirely in Thoddoo, reflecting that island's proximity to tourism development and established supply relationships. Analysis of specific barriers reveals that buyer procurement practices are a primary obstacle to tourism market access, with 70% of farmers citing that "buyers don't purchase directly from farmers." This structural barrier reflects the tourism sector’s preferences for centralized suppliers rather than individual farmer relationships, creating systematic exclusion from high-value markets. Demand inconsistency is another major constraint, affecting 50% of farmers, as seasonal tourism patterns create unpredictable purchasing cycles that complicate

production planning for farmers requiring steady market outlets. Knowledge gaps compound access difficulties, with 27% of farmers stating they "don't know" how to access tourism markets. This indicates limited information flow between agricultural and tourism sectors rather than simple farmer disinterest or lack of capability. Additional constraints including price concerns (11% of farmers), distribution system limitations, and production practice requirements affect smaller percentages, suggesting that structural rather than technical barriers predominate in limiting market access.

Grocery Store and Retail Market Operations

Grocery stores represent another significant retail channel for papaya, operating both in Malé and across inhabited islands with varying degrees of import dependence and domestic sourcing. Many of these retail establishments function simultaneously as importers and retailers, creating vertically integrated supply chains that bypass traditional wholesale intermediaries. Notable examples include Happy Market and Honey Corner, which maintain both import operations and retail outlets, and the State Trading Organization, a government commercial entity that combines import functions with designated cold storage facilities and grocery operations.

Field observations during visits to two grocery stores in Malé revealed mixed sourcing patterns. At Seagull Group's grocery store in Malé, papaya was being sold from their Maafahi Island commercial farm operations, demonstrating successful vertical integration from their own agricultural production through retail sales in the capital. At another grocery store visited, imported papaya was being sold, illustrating the continued reliance on international supply chains even in domestic retail outlets. Other shop owners, particularly smaller grocery outlets, typically conduct weekly shopping visits to the Malé cubicle markets, where they will purchase their papaya and other fruits and vegetables to sell during the week. Typically, these small grocery retailers are buying in small quantities (e.g. 5-10 papayas, 5-10 watermelons) and will purchase more as needed throughout the week.

Photo: Papaya from Maafahi Island sold at Seagull Group's grocery store in Malé. August 2025. Source: Alysa Grude

Domestic Consumer Markets and Import Competition

Beyond the tourism sector, papaya reaches domestic consumers through multiple retail channels including supermarkets supplied by cubicle wholesalers, local island markets and shops, and direct family and community networks. While comprehensive data on domestic consumer preferences remains limited, the market operates with mixed local and imported supply that creates ongoing competition dynamics affecting farmer prices and market access. Local papaya enjoys preference among domestic consumers, with consumers frequently noting superior taste and texture compared to imported products that are typically harvested before full ripening to withstand transportation. However, supply inconsistency means imports regularly fill market shelves during local production gaps, particularly when seasonal variations or weather events disrupt island-based production. Price dynamics significantly influence market competition, with imported Indian papayas landing at

approximately MVR 10 per kg wholesale, creating competitive pressure that local farmers struggle to match given higher production costs and smaller scale operations.

Enabling Environment

Public Sector

Ministry of Agriculture and Animal Welfare

The MoAAW serves as the primary institutional actor shaping the enabling environment for agriculture, contributing to the adoption of MGAP, NbS and CSA adoption in the Maldives. However, the Ministry faces significant capacity constraints and systemic challenges that limit its effectiveness in supporting agricultural transformation, while simultaneously exploring ambitious digitalization and decentralization strategies to overcome these limitations.

Extension Services and Institutional Capacity Constraints: The Ministry's extension system faces severe structural limitations that directly impact farmers' access to technical guidance essential for MGAP compliance and sustainable agriculture. The Agricultural Research Center, serving as the primary source of technical expertise, operates with only six technical specialists responsible for both research activities and extension programming across the entire archipelago. This dual mandate creates trade-offs, where extension trips to outer islands interrupt ongoing research trials, limiting the center's capacity to fulfill both functions effectively. Field visit data illustrates the scale of this constraint: research center staff have completed only 20 trips to agricultural islands collectively between January and August of 2025, with limited duration visits that prevent sustained technical support for complex practices like integrated disease management.

Photo: Hanimaadhoo Agriculture Center. August 2025. Source: Alysa Grude

Institutional Vision for Decentralized Extension: The Ministry has articulated a desired strategy for addressing extension constraints through decentralized, island-based technical support systems. Ministry officials emphasized the need to station extension agents on each main agricultural island, moving away from the current centralized model that concentrates expertise in Hanimaadhoo. This approach recognizes that sustained behavior change and practice adoption require consistent, locally available technical support. However, budget constraints currently limit implementation, with the Ministry proposing to begin with pilot programs on 1-2 islands before scaling the approach.

Input Accessibility and Affordability Initiatives: The Ministry recognizes both input availability and affordability as key constraints requiring systematic intervention. Key informants noted there are plans to develop public-private partnership models for input distribution aim to establish agro-input supply shops in northern and southern atolls, potentially improving both access and pricing.

Additionally, the Ministry has expressed interest in targeted subsidy systems for registered commercial farmers, though operational details and eligibility criteria remain underdeveloped.

Infrastructure Development and Decentralization Strategy

Transportation and Logistics: The Ministry acknowledges that transportation constraints represent fundamental barriers to agricultural development, particularly affecting market access and input availability. Current arrangements with the Maldives Transport and Contracting Company (MTCC) involve inconsistent pricing, poor handling infrastructure, and inadequate cold chain capacity that frequently result in post-harvest losses. The Ministry plans to engage directly with MTCC to address operational challenges while exploring alternative logistics strategies.

Regional Agricultural Zones: To reduce dependency on Malé-centric distribution systems, the Ministry is pursuing agricultural zone development in northern and southern regions. This strategy involves improving inter-atoll transport links and developing regional supply chains that could strengthen agricultural viability in outer atolls. Presidential commitments support establishing input distribution networks through public-private partnerships, where island councils allocate land; central government provides facility design, and private operators manage service delivery.

Digital Infrastructure

Dhanduveriya App Platform: The Ministry is developing a digital platform—Dhanduveriya application—designed to function as an extension and marketing app enabling direct farmer-buyer connections, and a data collection system for the Ministry. This platform represents the Ministry's primary strategy for addressing market coordination failures that constrain farmer income. Specifically, the app aims to enable farmers to upload production information while allowing buyers to purchase directly, potentially bypassing concentrated intermediary systems that currently dominate papaya marketing. Further, the application is planned to house agricultural training material, including on MGAP, that farmers can directly access with their phones. Farmers will also be able to send messages to extension agents to ask for feedback or ask questions regarding their production, potentially providing a more streamlined extension service. Additionally, the Ministry is hopeful that farmers will use the recordkeeping functions of the application, which could improve the Ministry's access to data on production and marketing of farmers in the Maldives. According to Ministry officials, the application will launch in October 2025.

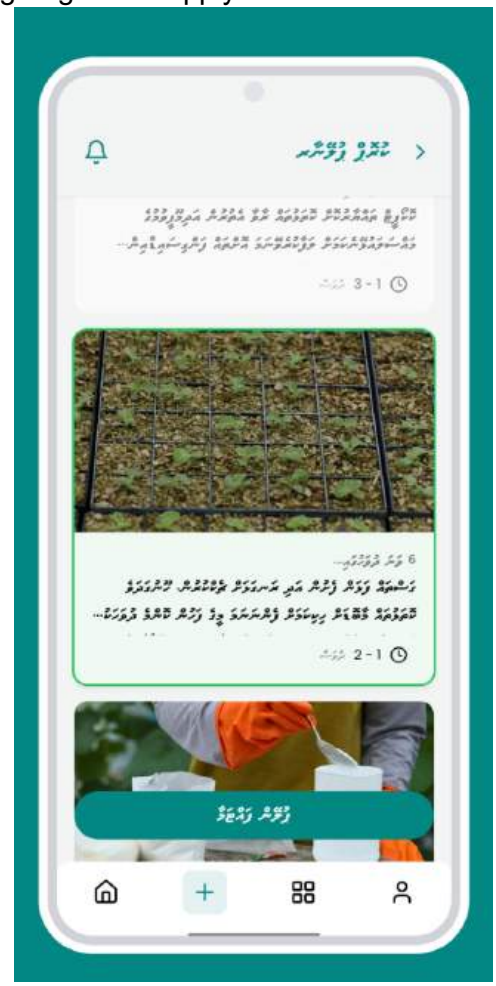


Photo: Dhanduveriya App Platform, Source: Google App Store

Regulatory Framework Gaps and Quality Assurance Challenges

Input Quality and Standards: The Ministry faces critical regulatory gaps in ensuring agricultural input quality, which affects MGAP implementation requirements. While importers are required to obtain import permits from MoAAW for fertilizers and pesticides (processed through the Makudi Portal of the Ministry of Defense), these permits do not currently include verification of specific quality parameters or testing requirements. This means that while import quantities and product categories are tracked, there are no systematic mechanisms to verify that imported fertilizers meet declared specifications, that seeds are disease-free and true-to-type, or that organic amendments are free from contaminants or adulterants. While there are plans to introduce legislation establishing quality standards and testing requirements for agricultural inputs, Ministry officials express uncertainty about implementation capacity given institutional and resource constraints. This presents challenges for MGAP certification, which includes specific standards related to input quality, that the Ministry currently lacks capacity to monitor or enforce beyond basic import documentation. Furthermore, this affects production, as reports of poor-quality inputs, particularly for soil amendments, were noted during the August 2025 scoping mission.

Seed Regulation and Plant Health: The absence of quality standards for imported seeds represents a fundamental constraint on disease management and varietal improvement. Although the Ministry endorses certain varieties tested at the Agricultural Research Center, no national standards govern seed quality or phytosanitary requirements. Ministry officials acknowledge that stronger regulation of imported seeds is critical for disease control, particularly given the widespread prevalence of the papaya yellow crinkle virus. The existing Plant Protection Policy has not been implemented, highlighting broader challenges in translating policy frameworks into operational regulatory systems.

Data Collection, Evidence-based Decision-making, and Enhanced Feedback: Lack of systematic agricultural data is a barrier to evidence-based policy making. The Ministry completed agricultural census questionnaires but lacks the budget for implementation, highlighting resource limitations that affect planning capacity. This data gap has direct policy implications—when researchers relayed farmer suggestions for import taxes on locally produced agricultural commodities, Ministry officials acknowledged they cannot recommend such measures without comprehensive production data. However, data collection represents only part of a broader communication breakdown. No sound feedback mechanisms exist between farmers in key production areas like Laamu and Thoddoo, their island councils, and the Ministry. This institutional disconnect highlights opportunities for strengthening communication and coordination between central and island-level agricultural actors. Farmers and island councils in key production areas indicate that clearer communication channels regarding Ministry priorities and resource allocation decisions would enhance their confidence in agricultural development strategies. Without systematic mechanisms for this dialogue, the perceived misalignment between institutional priorities and resource allocation undermines confidence in agricultural development strategies and limits opportunities for collaborative problem-solving between government and farming communities.

MGAP Implementation Strategy and Adaptation

The Ministry recognizes that current MGAP standards are "too high" for the Maldivian smallholder context and is aiming to better understand adaptation opportunities. Under an upcoming project, the Ministry plans to hire a consultant to review the standards to identify opportunities for them to better align with the Maldivian smallholder context. One MoAAW stakeholder noted that group certification is perceived as more efficient than individual farm certification, with the Ministry indicating willingness to provide financial support for testing requirements when farmer groups formally approach the institution. The Ministry's vision is for Island Councils or Women's Development Committees (WDCs) to coordinate collective farm requests by enabling grouped training, sample collections, and audit visits that reduce per-farmer certification costs. However, this approach has not been clearly communicated to island-level stakeholders, nor have councils been provided with the technical capacity, resources, or guidance to fulfill such coordination functions. During field research, neither Island Councils nor farmers indicated awareness of this potential pathway for group certification. Without systematic capacity building, clear implementation guidelines, and dedicated resources for island-level coordination, the Ministry's group certification concept cannot be implemented effectively.

The MFDA serves as the lead implementation agency for MGAP certification, responsible for auditing, compliance monitoring, and standard enforcement. The successful certification of ten farmers from Shaviyani Goidhoo in August 2025 marked a critical milestone for MGAP rollout, representing the first group to achieve certification under the national scheme. However, MFDA faces institutional constraints that limit its capacity to scale the certification effectively, while balancing food safety requirements with operational realities of Maldivian smallholder farmers.

MGAP Implementation Challenges and Farmer Realities

MFDA officials identify documentation requirements and testing protocols as the most significant barriers to farmer adoption, reflecting the same constraints highlighted throughout farmer surveys and focus groups. The agency recognizes that current standards may be too complex for the Maldivian smallholder context. A consultant from Sri Lanka was engaged to recommend simplifications to enhance farmer accessibility, particularly around record-keeping requirements and purchasing documentation. However, these recommended changes have not yet been implemented. The agency faces a fundamental tension between maintaining food safety integrity and ensuring farmer accessibility. While MFDA acknowledges the need to reduce documentation redundancy and testing frequency, officials emphasize that any modifications "shouldn't bring a change to the quality of the product." This cautious approach reflects appropriate food safety priorities but may slow adaptation efforts that could increase farmer participation. Testing requirements represent a particular challenge, with MFDA conducting initial sampling but requiring external funding to cover costs, creating financial barriers for farmers seeking certification.

MFDA also noted that food safety concerns extend well beyond farm-level production practices to include the entire post-harvest value chain. Agency officials acknowledge gaps in handling, transportation, and storage protocols that affect the safety and quality of fruits and vegetables throughout the distribution system. In response, MFDA is developing comprehensive Standard

Operating Procedures (SOPs) for these value chain stages, with completion targeted by December 2025. As MGAP is scaled up, it will be important for MFDA and other institutions overseeing other parts of the value chain to promote, monitor, and enforce food safety practices beyond production.

Institutional Capacity and Coordination Challenges

Technical Knowledge Constraints: MFDA needs more capacity development in agricultural production systems to enhance effectiveness in implementing MGAP certification. MFDA staff note that their primary expertise is in food safety rather than agronomy, and that additional agricultural training would strengthen their ability to assess farm-level practices during MGAP certification exercises. MFDA staff indicated that the MGAP 2021 Thoddoo training, while valuable as an introduction, did not provide the depth of technical coverage needed for comprehensive validation of agricultural practices during audits. Additionally, MFDA reports limited access to international donor training programs in agricultural production, which more frequently targets MoAAW despite MFDA's central role in MGAP implementation. Strengthening coordination between MoAAW and MFDA to ensure MFDA staff are included in relevant capacity-building initiatives would enhance MGAP rollout and create more consistent technical assessment across certification processes.

Testing Constraints: Current testing infrastructure limitations severely limit MFDA's monitoring and enforcement capabilities. The agency has only two testing parameters (lead and phosphorus in water) and lacks capacity for soil testing or pesticide residue analysis—critical components of MGAP compliance verification. Plans exist for capacity enhancement through the National Health Laboratory and potential MOUs with external laboratories, but these remain in development stages.

Access to Finance and Insurance

Loan Products for Agriculture

The SME Development Finance Corporation (SDFC) is the only financial service provider in the Maldives that specifically targets the agricultural sector. As of August 2025, SDFC reported 45 active agricultural loans, a modest increase compared to 2021 when it had disbursed 14.2 million MVR (~928,000 USD) to 31 farmers. Established in 2019, SDFC is the primary lender for micro, small, and medium enterprises in the Maldives, with lending portfolios spanning local tourism, agriculture, manufacturing, and information and communications technology.

SDFC currently offers two agricultural loan categories. Loans below 100,000 MVR (~6,536 USD) do not require collateral or equity, while loans above that threshold require borrowers to contribute 15 to 20 percent of the requested amount. Both products carry a fixed interest rate of 6 percent. The maximum loan amount is 2 million MVR (~130,719 USD). Repayment terms are relatively flexible for the sector, with grace periods ranging from six to twelve months. SDFC staff noted that this extended grace period is particularly important for farmers, who often need longer repayment timelines to account for crop cycles and delayed returns.

Agriculture has consistently been the smallest segment of SDFC’s portfolio. In 2019, it was the least financed sector, and even today agricultural lending retains only a small share of overall

disbursements (ibid). Demand is also uneven across commodities: SDFC has received higher loan applications for cucumber and chili than for papaya, which remains a niche request. According to SDFC and additional literature, the following constraints affect the supply of finance to farmers and other value chain actors:

- **Limited Outreach:** The Maldives' 198 inhabited islands scattered across vast ocean distances create logistical challenges for financial service delivery that traditional banking models cannot economically address (Driessche & Paul, 2024). Farmers on outer atolls face travel costs and time commitments that often exceed potential loan values, with irregular inter-island transportation making banking relationships practically impossible to maintain.
- **Limited in-house expertise:** SDFC staff highlighted a lack of technical agricultural knowledge within the institution. At present, loan applications are routed to the MoAAW for review by an agricultural expert before SDFC conducts financial due diligence. Staff expressed a desire for in-house agricultural training to strengthen their ability to independently assess projects and monitor risks, as well as to reduce the time-consuming back and forth between the MoAAW.
- **Monitoring and outreach capacity:** Monitoring of agricultural loans remains inconsistent, which is important for risk management for ongoing loans. SDFC relies on Business Centers Corporation (BCC) or, in some cases, the MoAAW to support monitoring functions, but there is no systematic process in place. SDFC also identified the potential for working more closely with island councils to establish monitoring and outreach agents on the islands.
- **Financial literacy and application barriers:** Borrowers often struggle with documentation. Loan applications forms are in English, while business plans are submitted in Dhivehi. Farmers frequently require assistance to complete them. While BCC can provide such support, SDFC noted limited collaboration to date. The Maldives Agribusiness Project (MAP) demonstrated that proactive outreach can increase demand, but MAP has now been completed.
- **Investment potential and risk appetite:** From SDFC’s perspective, the investment potential, as well as risks, of agriculture is complicated by the following constraints:
- **Land tenure security:** Many farmers operate under short-term leases issued by island councils, typically three to five years in length. These short leases discourage long-term investment by farmers and simultaneously raise the risk profile for lenders. For SDFC, the inability to guarantee that land will remain under the farmer’s control for the duration of the loan makes agricultural lending less tenable and often forces conservative lending decisions.
- **Weak marketing channels:** Farmers often lack reliable routes to the market, particularly for high-value perishable crops such as papaya. Inconsistent aggregation and distribution systems reduce farmers’ ability to secure stable buyers or premium prices, which in turn undermines profitability and repayment capacity. Market connectivity problems identified in a 2018 study of 373 farmers across 51 islands revealed that geographic isolation not only constrains access to financial services but also limits farmers' ability to generate sufficient cash flows for loan repayment (ibid). Without predictable market returns, the financial viability of loan-supported investments remains uncertain.
- **Lack of crop insurance:** The absence of crop insurance exposes both farmers and lenders to significant risk. In the event of climate shocks or pest outbreaks, production losses directly

translate into income losses, undermining farmers' ability to repay loans. SDFC highlighted this as a core structural vulnerability in agricultural lending, noting that without insurance mechanisms in place, even well-performing farmers may default due to factors beyond their control. Although SDFC has explored collaboration with Allied Insurance, engagement has been limited to date, with no bundled financial product or advisory services provided.

These structural issues informed SDFC's broader call for what they termed a circular approach to agricultural investment. As one staff member noted, "It has to be a circular approach – it can't just focus on the farmers; you need to develop the other points of the value chain. In addition to agriculture, there really needs to be a focus on the support services." In practice, this means that viable agricultural finance cannot be limited to farm-level credit. Investment must also target the enabling functions of the value chain: input supply, post-harvest handling, cold storage, distribution networks, and market access infrastructure. Without such parallel investments, lending to farmers in isolation risks perpetuating low returns and repayment difficulties.

Agricultural Insurance Products

Allied Insurance is the sole provider of agricultural insurance products in the Maldives, offering coverage that includes papaya among other crops. However, significant gaps exist between product availability and farmer uptake, reflecting broader challenges in agricultural risk management and institutional coordination that constrain the development of robust insurance markets for smallholder farmers.

Product Structure and Coverage Framework: Allied Insurance has developed an agricultural insurance product specifically designed for the Maldivian context, with coverage periods aligned to crop cycles and risk profiles tailored to island agriculture vulnerabilities. The insurance covers wind and windstorms—critical risks for papaya farmers given the islands' exposure to seasonal weather patterns and extreme events that frequently damage standing crops. Coverage extends across a 280-day cycle, aligned with typical papaya production timelines from planting to harvest maturity. The product operates through a fully digital platform via the Allied Insurance mobile application, which enables farmers to complete insurance applications, submit required documentation (including photos of crops and damage), manage active policies, file claims, and track claim status—potentially reducing transaction costs and improving accessibility for geographically dispersed agricultural islands. However, as discussed below, awareness of this application is extremely limited among the farming community.

Claims Processing and Verification Systems: Allied Insurance has established a multi-stage verification process designed to ensure claim validity while managing operational costs across dispersed island locations. Farmers must provide notice within 24 hours of damage occurrence, followed by documentation including island council verification letters and photographic evidence of losses. According to Allied Insurance, the police are meant to verify the documentation provided by the farmer. The company aims for relatively rapid payouts with two-week settlement timelines, representing relatively rapid payouts compared to traditional agricultural insurance models. However, the multi-agency verification requirement involving island councils and police may create

coordination challenges, particularly on outer islands where government representation may be limited or intermittent.

Market Penetration Challenges and Institutional Constraint: Despite product availability, Allied Insurance faces severe adoption challenges. Only three farmers have enrolled in agricultural insurance products across all covered crops, representing virtually negligible market penetration relative to the thousands of farmers engaged in commercial agriculture throughout the Maldives. Notably, insurance coverage is crop-specific rather than farm-based, meaning farmers cultivating multiple crops (such as papaya alongside vegetables or other fruits) would need to purchase separate policies for each crop type—potentially increasing both premium costs and administrative complexity for diversified farming operations. This uptake failure is due to multiple barriers that limit insurance market development, including institutional and awareness barriers as well as potential economic factors. Premium affordability relative to farmer cash flows, the absence of agricultural subsidies that could offset insurance costs, and expectations regarding government loss and damage compensation following major climate events may all influence farmer decisions about whether insurance is a worthwhile investment. Additionally, farmers operating on short-term leases may be reluctant to invest in insurance for crops they may not be cultivating on the same land in subsequent seasons.

Awareness and Outreach Limitations: Allied Insurance acknowledges that "most people haven't heard about the app," indicating fundamental awareness gaps that constrain demand generation. The company has specifically identified major agricultural production areas for outreach, including Thoddoo (AA. Thoddoo), Gaafu Atoll, and Shaviyani Atoll. Allied Insurance is planning to implement targeted awareness campaigns to build demand in these target islands in the fall of 2025.

Coordination Gaps with Government Institutions: No formal joint awareness program or systematic coordination mechanism currently exists between Allied Insurance and the MoAAW. Allied Insurance initially hoped that MoAAW would play a more active role in promoting insurance products alongside other agricultural support services, but without formalized coordination structures or dedicated awareness programming, insurance information dissemination to farmers is limited. More structured collaboration between MoAAW and Allied Insurance could enhance farmer awareness through integrated messaging that positions insurance as a complementary risk management tool alongside other agricultural inputs and services, while leveraging extension officers' existing farmer relationships for more effective outreach.

Demand for financing and Insurance

Quantitative survey data indicates that 45 percent of farmers express demand for formal credit. However, qualitative interviews reveal that this figure underestimates the true extent of financial need. Many farmers face structural and informational barriers that suppress demand, even when willingness to invest is high. Product design limitations, eligibility constraints, and misaligned repayment terms have restricted uptake—despite widespread interest in upgrading production systems.

Priority investment areas: Farmers across both Laamu and Thoddoo identified a consistent set of priority investment areas based on the operational realities and constraints of papaya production in the Maldivian context. These demands are not abstract or speculative but grounded in the practical needs of maintaining viable production amidst labor shortages, increasing climate pressures, and limited market connectivity. The most frequently cited investment needs include irrigation systems, basic infrastructure upgrades, and weather-resilient adaptations. These priorities align directly with the enabling conditions required for MGAP compliance and the adoption of sustainable agricultural practices.

- Irrigation systems were the most widely requested investment across all farmer types. The transition from manual watering to mechanized or solar-powered systems was seen as a way to address both labor constraints and water-use efficiency. Farmers frequently referenced neighboring farms with functional systems as evidence of their value and feasibility. “I would like finance for irrigation and storage.” (Thoddoo, foreign worker), “I investigated solar irrigation—85,000 MVR (~5,555 USD)—but need finance.” (Laamu farmer).
- On-farm infrastructure, including storage sheds, was also noted as an expense they likely need financing for. These structures are necessary to meet MGAP chemical storage and post-harvest handling requirements. Farmers on both islands expressed willingness to invest in such infrastructure if paired with technical guidance or financial support.
- Weatherproofing measures, including simple technologies such as PVC supports to stabilize papaya trees during high winds, were repeatedly raised. Farmers cited damage from strong storms and wind events as one of the most visible and frequent threats to production. However, these were identified as relatively costly expenses, for which farmers didn’t have the capital to cover on their own.

While these investments are key to long-term sustainability, it is notable that access to finance was not raised as a primary constraint during focus group discussions and interviews on MGAP, NbS, or CSA. Instead, when farmers were asked directly about barriers to adoption, they consistently pointed to:

- Lack of technical knowledge or uncertainty about how to implement standards
- Time and labor limitations for practices perceived as complex or management-intensive
- Skepticism about market premiums or increased profitability from adopting new practices
- Uncertainty around land tenure, particularly in leased farming systems where investment horizons are short

Access to finance – Interest and Barriers: Farmers expressed strong interest in accessing formal finance, if loans are offered at affordable interest rates, and repayment terms are aligned with agricultural income cycles. However, several structural barriers limit their ability to access or benefit from existing financial products. Foreign workers, who are central to papaya production in Thoddoo, are excluded from formal lending due to their inability to open bank accounts or qualify under current eligibility criteria as access is only possible through landowners. Short-term land leases, typically ranging from one to five years, further constrain investment, particularly for long-term infrastructure such as irrigation systems or permanent storage facilities. Farmers noted that longer lease durations—ideally 10 to 15 years—would significantly increase their willingness to invest.

Additionally, market volatility and irregular transport schedules discourage borrowing, as many farmers are hesitant to commit to fixed repayment obligations in the absence of stable cash flows. These constraints highlight the need for more flexible, agriculture-specific financial products tailored to the realities of smallholder production systems.

Insurance: Low Awareness but Emerging Interest: Although farmers across both Laamu and Thoddoo reported experiencing significant crop damage due to weather-related events—particularly wind and storm impacts—adoption of crop insurance remains negligible. While the research did not directly assess farmers' awareness of insurance products, discussions during focus groups and interviews suggest that knowledge of available options is limited. Despite this, there is clear latent demand for agricultural insurance, especially in Laamu, where farmers expressed interest in protection against climate-related losses. A common concern, however, was the speed of response: farmers emphasized the need for rapid payouts in the event of loss. As one Laamu chili farmer noted, "I'd pay a premium for insurance, but it must respond quickly." These insights point to the importance of weather-triggered insurance products designed for timely disbursement, which aligns with Allied Insurance's offerings.

Exploratory Market Analysis

Exploratory Market Analysis for MGAP and Sustainably Produced Papaya

Market Demand Assessment and Segmentation

The domestic market for MGAP-certified and sustainably produced papaya in the Maldives demonstrates heterogeneous demand patterns across buyer segments, with significant variation in willingness to pay premiums, quality specifications, and procurement flexibility. This exploratory assessment reveals that while market demand exists for certified sustainable papaya, targeted approaches that align with specific buyer segment characteristics rather than broad-based market promotion are required. The analysis identifies clear market segmentation between buyers willing and able to support premium sustainable products and those prioritizing cost minimization, suggesting that MGAP and sustainable production strategies should initially focus on high-value market niches before attempting broader market penetration.

Understanding the economic viability of this market positioning requires consideration of both premium pricing potential and transition costs. MGAP certification requires an estimated 20,040 MVR (1,390 USD) per farm plus annual auditing costs of 10,600 MVR (693 USD), while comprehensive sustainable practices adoption costs approximately 58,937 MVR (3,833 USD) per crop cycle after accounting for input savings. Detailed cost-benefit analysis of these investment requirements and their relationship to market premiums is presented in the subsequent Cost Analysis section.

Wholesaler and Supplier Perspectives: A Rapid Market Survey

To better understand market dynamics and buyer preferences from the perspective of key intermediaries, a rapid survey was conducted with eight wholesalers and suppliers who distribute

papaya across the Maldives market. These actors serve as critical links between producers and end buyers, giving them unique insights into purchasing patterns, quality preferences, and price sensitivity across different market segments. Their responses provide a valuable perspective on buyer behavior and willingness to pay premiums for MGAP-certified produce, based on their direct commercial relationships and daily interactions with various customer types.

Current distribution patterns: The survey revealed distinct distribution patterns among suppliers, with the tourism sector emerging as the dominant market segment. As shown in Table 38, wholesalers allocate their papaya sales across diverse channels, with resorts consistently representing the largest single customer category. Except for one supplier, all import papaya to satisfy demand. On average, imports make up 29% of the papaya they supply to end-market buyers.

Table 38: Papaya Distribution by Market Segment (Percentage of Sales)

Market Channel	% of volume sold
Grocery retailers in Malé	22%
Retailers on islands outside of Malé	5%
Guesthouses	19%
Hotels	9%
Resorts	50%
Percentage sold to resort market segments	
• Basic/budget resorts	60%
• Mid-range resorts	32%
• High-end/luxury resorts	8%

Premium Payment Willingness by Market Segment: When asked about different buyer segments' willingness to pay premiums for MGAP-certified papaya, suppliers revealed a clear market hierarchy based on their commercial experience with these customers. The responses, summarized in Table 39, show distinct patterns reflecting suppliers' observations of buyer behavior and purchasing priorities across different market segments.

Table 39: Buyer Willingness to Pay Premiums for MGAP-Certified Papaya (Supplier Perceptions)

Market Channel	Yes	No	Unsure	Premium Potential
High-end/Luxury Resorts	7	0	1	Very Strong

Mid-range Resorts	6	0	2	Strong
Hotels	3	2	3	Moderate
Guesthouses	3	2	3	Moderate
Supermarkets in Malé	1	5	2	Low
Basic/Budget Resorts	1	5	2	Low
Island Retailers	0	6	2	Very Low

According to suppliers' experience, there's a stark segmentation in premium willingness across customer types. Nearly all suppliers (7 out of 8) believe high-end resorts would pay premiums for certified papaya, based on their existing procurement conversations and observed purchasing patterns. Mid-range resorts also show strong potential from the suppliers' perspective (6 out of 8 positive assessments). This contrasts sharply with suppliers' experience of price-sensitive segments like island retailers and basic resorts, where they observe little customer appetite for certified products.

Several suppliers observed that tourism market interest is growing. One respondent noted "there seems to be a growing demand on buyers' side" for sustainably produced goods, particularly among resorts with environmental commitments, based on their direct sales conversations. However, they also highlighted market limitations they've encountered: "for local island suppliers, the demand is very limited and very low for sustainably produced goods—maybe awareness is lacking."

This segmentation reflects suppliers' daily commercial reality—they see luxury resorts asking about sustainable sourcing and expressing willingness to pay more for quality and certification, while local retailers and budget accommodations focus primarily on price competitiveness. As one supplier explained, their experience shows that while high-end properties are interested in sustainability credentials, "for consumption yes, marketing will focus on best margins" when dealing with more price-sensitive customers.

Expected Price Premium Levels: Suppliers demonstrated remarkable consensus on expected premium levels, with most citing a range of 25-40 MVR per kilogram for MGAP-certified papaya. The most frequently mentioned premium was 30-35 MVR, though several suppliers noted that exact premiums would vary by specific resort contracts and negotiated arrangements.

Supplier Interest and Market Transition Concerns: When asked about their own willingness to source MGAP-certified papaya, suppliers revealed a complex mix of interest and caution. Five of eight respondents expressed interest, but with important conditions and concerns about market transition. Interested suppliers highlighted several motivations:

- Access to "*wider range of resorts that focus on sustainably produced goods*"
- Growing buyer demand, particularly from environmentally conscious properties

- Potential for better margins with premium products

However, concerns were equally prominent:

- **Market transition risks**: "*Transition entirely would mean losing existing buyers and finding new ones*"
- **Import competition**: "*If import prices are too low then it will be difficult, because any product can be sold as safe since checking is not done*"
- **Demand uncertainty**: "*Can buy but not sure about the demand for such goods." So far very low from the buyers' side*"
- Market access barriers: "*Difficult to access high-end buyers due to more requirements to fulfill*"

One supplier succinctly captured the challenge: they would be interested in MGAP sourcing "if a good price can be guaranteed only," highlighting the need for market assurance before suppliers commit to sourcing certified products.

Potential Targets for Local Sourcing Partnerships

Additional resorts demonstrating strong sustainability commitments and potential interest in locally-sourced, certified produce include:

- Luxury segment: Amilla Maldives (EarthCheck Gold Certified with on-site food production through their "Homemade@Amilla" program), Four Seasons Maldives at Kuda Huraa (EarthCheck Silver Certified, sourcing 90% of fish from sustainable local suppliers), Patina Maldives (EarthCheck Silver Certified with zero-waste kitchens utilizing on-site gardens), Joali Being (solar energy with locally sourced organic produce), and Constance Halaveli (Green Globe Certified for six consecutive years).
- Mid-range segment: Villa Resorts properties including Villa Park and Villa Nautica (Green Key Certified with organic farms producing over 20,000 coconuts monthly plus vegetables and herbs), Le Méridien Maldives (Green Globe Certified 2025 with a 430m² state-of-the-art hydroponic farm), and Atmosphere Hotels & Resorts' eight Green Globe-certified properties featuring extensive solar infrastructure and sustainability programs.

Strategic Market Insights: These supplier perspectives reveal several insights for MGAP market development. First, there's a clear two-tier market structure: tourism segments (especially high-end) demonstrate strong premium willingness, while local markets are highly price-sensitive with limited interest in certifications. Second, import competition poses a significant challenge to premium positioning. As one supplier noted, low-priced imports make it difficult to justify premiums, particularly when "any product can be sold as safe since checking is not done." This suggests that MGAP's value proposition must emphasize not just safety but also freshness, quality, and traceability advantages over imported alternatives. Third, market access barriers limit suppliers' ability to reach premium buyers. High-end resorts have specific requirements and procurement processes that many current suppliers find challenging to navigate. Building capabilities and connections to access these premium segments appears critical for MGAP success.

Finally, awareness and education remain significant challenges, particularly in local markets. Multiple suppliers emphasized that demand for sustainably produced goods is "very limited" outside the tourism sector, suggesting substantial market development work is needed to build broader appreciation for certified products. The supplier survey data indicates that while premium markets exist for MGAP-certified papaya, successful market development will require targeted approaches

that address segment-specific needs, competitive pressures from imports, and access barriers to high-value customers. The tourism sector, particularly luxury resorts, represents the most immediate opportunity for premium positioning, while local markets may require longer-term education and awareness building to develop appreciation for certified produce.

Resort Market: Quality-Conscious but Volume-Constrained Demand

As previously noted, there are 178 resorts in the Maldives. The resort sector presents a potentially promising market segment for MGAP-certified and sustainably produced papaya, driven by quality-conscious procurement practices and often explicit sustainability commitments. However, the research team encountered significant challenges in securing resort participation in interviews, reflecting the isolated and independent operating nature of resort operations on private islands where establishments maintain considerable autonomy from local governance structures. Given these access constraints, the analysis focuses on Anantara Resort Group as emblematic of the type of resort buyer that should be targeted through market facilitation activities, due to their explicit sustainability and social responsibility commitments.

Anantara operates nine properties with 900 rooms and 3,000 staff in the Maldives and maintains Green Growth 2050 certification, a comprehensive global standard incorporating over 400 social responsibility and sustainability indicators across travel and tourism operations. The resort group currently sources 20-30% of produce locally while importing the remainder, consuming roughly 100kg of papaya daily, an estimated 36,500kg annually. Local papaya is allocated primarily to staff consumption due to supply consistency concerns rather than quality deficiencies, with the procurement manager noting that imports are used for guests not because the quality is better but because they need to have a reliable supply, which the current market structure does not allow for produce from local farmers.

Despite supply chain challenges, Anantara demonstrates clear market potential for MGAP-certified sustainable papaya. The resort expressed preference for local procurement and receives guest inquiries about locally produced goods, indicating consumer demand alignment. Anantara indicated willingness to source MGAP-certified, sustainably produced papaya and to support future farmer transition initiatives. Specifically, they expressed their willingness to pay a 15% premium for certified produce, noting that they currently have to pay a 15% duty for importing many fruits and vegetables anyways. However, they noted preference for comprehensive sourcing solutions rather than managing multiple channels for different goods. This suggests that successful market development requires a coordinated, multi-product approach.

Photo: Anantara Veli Maldives Resort. Source: Anantara Website

A major barrier to increased local sourcing by resorts is volume reliability due to irregular supply volumes, seasonal production limitations, and logistical complexities. Until fundamental value chain

constraints around aggregation, consistent supply, and transportation logistics are addressed, resorts are unlikely to see compelling business cases for investing in farmer certification support, regardless of their sustainability commitments or demonstrated willingness to pay premium prices for certified products.

Guesthouse Market: Relationship-Based Demand with Quality Differentiation

The guesthouse sector demonstrates fundamentally different demand patterns for MGAP-certified and sustainably produced papaya compared to resort operations, with sourcing decisions driven by individual owner preferences and knowledge rather than standardized procurement requirements. Interviews conducted with four guesthouses on Thoddoo Island reveal that interest in certified produce depends more on operator awareness and knowledge about food safety, quality, and sustainability than on market positioning or pricing tiers. While these findings may differ from guesthouses on other islands, they illustrate the importance of owner-level factors in driving demand for certified products.

Of the four guesthouses interviewed, two expressed significant interest in sourcing MGAP certified produce and willingness to pay premium prices of at least 15%, with one guesthouse owner saying he would pay double for MGAP-certified papaya. Notably, both interested operators demonstrated high levels of knowledge about food safety, quality, and sustainability issues. One budget guesthouse operator had actually attended MGAP training when it was first introduced to Thoddoo, directly linking his certification interest to knowledge exposure. The correlation between knowledge and demand reveals both market development opportunities and challenges. A higher-end operator was skeptical about premium pricing despite operating in a quality-conscious market segment, noting that tourists expect local produce to be cheaper: "if it's produced on the island, then it should be cheap." This finding suggests that market segment assumptions about premium willingness may be unreliable, while targeted education and awareness campaigns about MGAP benefits could shift sourcing preferences across different guesthouse types.

Table 40: Guesthouse Interest in MGAP

Respondent	Market Segment	MGAP Interest	Willingness to Pay Premium	Key Reasoning
1	Higher end	No	No	"Tourists don't demand premium quality... if it's produced on the island, it should be cheap"
2	Higher end	Yes	Yes	Concerned about chemical residues, caters to quality-conscious guests
3	Budget	Yes	Yes	Attended MGAP training, sees value in certification
4	Budget	No	No	"Looking for cheaper prices due to thin margins"

However, fundamental economic constraints limit universal adoption potential within this sector. Price sensitivity is a key consideration for guesthouses that typically operate on thin margins, regardless of owner interest in sustainability or quality assurance. While demand generation campaigns highlighting the importance of MGAP fruits and vegetables could increase interest and demand, not all guesthouses maybe willing or able to absorb certification premiums given their economic constraints and price expectations from guests.

Hotel Market: Price-Sensitive Demand with Certification Interest

Hotels represent a middle-ground market segment between resort sophistication and guesthouse relationship-based procurement, serving international visitors through more standardized procurement practices than guesthouses but with less rigorous quality standards than resorts. Hotel operators typically source through wholesale suppliers in Malé, who evaluate quality based on visual appearance rather than understanding farming practices or production methods. This suggests limited current awareness of agricultural certification systems but indicates potential receptiveness to quality assurance messaging. Despite their basic quality assessment approach, the interviewed hotel operator demonstrated clear interest in MGAP certification. They expressed conditional willingness to pay premiums, stating: "if the assurance can be provided and validated by a proper institution then yes, we are looking forward to paying a premium for good quality products which are safely produced." This response shows that while certification credibility and institutional validation are critical, there is also genuine interest in supporting better production standards. The interviewed hotel also highlighted that they would be interested in supporting initiatives to support farmers transition to MGAP-certified, sustainably produced papaya.

However, price sensitivity remains a major factor, with hotels prioritizing cost management alongside quality considerations. The sector faces similar volume and consistency challenges as other tourism accommodation types, lacking direct relationships with dispersed smallholder farmers. Nevertheless, their procurement through Malé wholesalers creates opportunities for MGAP marketing through existing distribution channels, provided that certified produce can be effectively differentiated and competitively priced at wholesale levels. Success in this segment requires balancing certification premiums with competitive pricing relative to import alternatives while leveraging institutional validation to build buyer confidence.

Premium Pricing Potential and Market Positioning

Analysis of premium pricing scenarios reveals varied but generally positive responses across buyer segments when presented with 15%+ price premiums for MGAP certified products, with several actors noting they would be willing to pay more than 15%. However, farmer interviews indicated cautious optimism about premium market opportunities, with responses varying significantly by location and production scale. Bangladeshi workers in Thoddoo expressed clear interest, stating "with a price markup, yes surely. But will need assistance with training and documentation," indicating willingness to adopt new practices for price premiums combined with recognition of capacity building needs. Laamu farmers were more cautious, noting they are "interested to sell at

higher prices if payment assurance can be provided," highlighting the importance of guaranteed purchase agreements and payment security in premium market development. However, farmers were skeptical about feasibility, with statements such as "do not believe that this can be done easily and can be done through the government." If it was possible, I believe it would have been done by now." This skepticism reflects previous experiences with market development initiatives that failed to deliver promised outcomes, underscoring the importance of credible implementation mechanisms and realistic market development timelines. The premium pricing analysis suggests that successful MGAP market development requires simultaneous attention to both supply-side certification support and demand-side market creation. Premium pricing alone cannot drive adoption without addressing underlying constraints around volume aggregation, consistent supply, transportation logistics, and buyer-farmer relationship development that currently prevent even interested buyers from establishing dependable local sourcing relationships.

Cost Analysis of MGAP and NbA and CSA Practice Adoption

The transition to MGAP-certified, sustainable papaya production in the Maldives requires substantial upfront investment, with distinct cost profiles for MGAP certification versus comprehensive adoption of NbS, EbA, and CSA practices. MGAP certification demands an estimated 20,040 MVR (1,390 USD) per farm (12,000 square feet) in predominantly one-time capital investments, focused on infrastructure upgrades including proper storage facilities, safety equipment, and food-safe handling systems that address current gaps in formal farming infrastructure. This investment excludes the auditing cost (10,600 MVR (693 USD), which would be required every three years and represents a substantial ongoing expense that may require policy support for sustained compliance.

For farmers seeking to implement comprehensive sustainable practices, the transition to NbS, EbA, and CSA systems requires a gross investment of 58,937 MVR (3,833 USD) per farm (12,000 square feet) per crop cycle after accounting for savings of roughly 44,000 MVR from eliminated chemical fertilizers and pesticides.

Detailed MGAP Certification Costs

Understanding the financial requirements for MGAP certification is critical for both farmers and policymakers to assess the feasibility and design appropriate support mechanisms for widespread adoption. Comprehensive field research, including farmer interviews and market surveys across key production areas (Thoddoo and Laamu Atoll), revealed specific practices that are currently not being implemented by papaya producers and calculated the associated costs for transitioning to MGAP compliance. To achieve MGAP standards, farmers must invest in proper chemical and fertilizer storage facilities, food-safe harvest and transport containers, calibrated application equipment, and worker safety gear. Cost estimates are not included for Seagull Group for Maafahi Island, as they were largely in alignment with MGAP and are currently undergoing upgrading needed to receive MGAP certification for their commercial island operation.

The cost analysis reveals that MGAP certification requires an estimated 20,040 MVR (1,390 USD) per farm, with the majority representing upfront capital investments rather than ongoing operational costs. This finding aligns with farmer feedback during interviews, where producers consistently

identified infrastructure-related investments as the most significant barrier to MGAP adoption. Specifically, farmers highlighted that investing in storage facilities, safety equipment, and handling infrastructure represented the largest financial hurdles, as these require substantial initial capital. The cost structure reflects the reality that many current papaya farming operations in Maldives operate with minimal formal infrastructure and safety protocols. While some costs are recurring per crop cycle—such as protective equipment replacement, cleaning chemicals—the predominant cost burden comes from the one-time infrastructure investments that bring farms up to certification standards. This cost analysis provides the foundation for developing targeted financial support mechanisms, such as the concessional loans through SDFC or grant programs, that can help bridge the gap between current practices and MGAP requirements while ensuring the economic viability of certified papaya production.

Auditing cost: The cost of MGAP compliance audits is not included in the initial investment calculations presented in this report. As of September 2025, government officials highlighted that audits would be required every three years, rather than annually. Nonetheless, the estimated cost of these audits is approximately 10,600 MVR (693 USD)—a significant ongoing expense for most farmers. For context, one Thoddoo farmer reported paying 40,000 MVR annually just to lease farmland. Given the size of this recurring cost relative to annual operating expenses, audit fees may represent a substantial barrier to continued compliance. At the time of this study, initial auditing costs were covered by MFDA and UNDP for a targeted group of project beneficiaries as part of a time-bound pilot initiative, rather than as a general or recurring support mechanism. This project-specific support is why initial audit costs are excluded from the total investment figures presented in this analysis. Policymakers and implementing agencies should anticipate the need to either subsidize future audit costs or ensure that farmers are sensitized early to this requirement so they can plan accordingly, as ongoing audit fees will become farmers' responsibility once project support concludes.

Table 41: Farmer Costs of MGAP Adoption

Cost Item	Amount (MVR)	Cost Type
Separate chemical storage facility	3,000	Upfront Investment
Fertilizer storage facility	3,000	Upfront Investment
Equipment storage shed	3,000	Upfront Investment
Handwashing stations	1,500	Upfront Investment
First aid kit	500	Upfront Investment
Emergency equipment	100	Upfront Investment
Safety/warning signage	100	Upfront Investment
Calibrated spraying equipment	3,200	Upfront Investment
Chemical measuring devices	320	Upfront Investment
Worker protective equipment	2,400	Recurring (per crop cycle)

Chemical mixing equipment	350	Upfront Investment
Food-safe harvest containers	420	Upfront Investment
Clean transport containers	420	Upfront Investment
Proper harvesting tools	200	Upfront Investment
pH meters	250	Upfront Investment
Food-safe cleaning chemicals	150	Recurring (per crop cycle)
Cleaning materials	100	Recurring (per crop cycle)
Farm diary/logbooks	50	Recurring (per crop cycle)
Traceability systems (setup, stickers, etc.)	1,000	Recurring (per crop cycle)

Estimated Cost to Adopt MGAP per Farmer: 20,040 MVR (1,390 USD)

Government/Island Council Responsibility

Based on farmer interviews, there were certain costs that farmers identified they would not be willing to pay, viewing these as the responsibility of the island council or government. These include professional site mapping (estimated to be MVR 15,000 (980 USD)) to identify any potential hazards, as well as comprehensive water quality testing (estimated to be MVR 10,840 (708 USD)), which farmers see as essential island-level infrastructure responsibilities. Additionally, any other testing that would need to be conducted to receive certification—such as pesticide residue testing—is viewed by farmers as the responsibility of the government or island council. There has been precedent for this approach: farmers who received MGAP certification in August 2025 through the Maldives Agribusiness Project had these associated testing and assessment costs covered by UNDP as part of project support. Separately, there are numerous training courses that would be required to get farmers up to speed on what MGAP entails, how to align with its requirements, and understanding what they need to do to improve their technical capabilities. These capacity-building costs, including chemical handling training, safety training, hygiene training, IPM training, MGAP certification training, technical training updates, and record-keeping training, would also need to be incurred by the government, island council, or other development programs to ensure successful MGAP adoption.

Detailed NbS, EbA, and CSA Adoption Costs

The transition to NbS, EbA, and CSA practices represents a fundamental shift in how papaya farmers approach production, moving from conventional input-intensive methods toward regenerative systems that use natural processes. The research identified costs for key practices in this transition, based on an average farm size of approximately 12,000 square feet dedicated to papaya. Accounting for the elimination of chemical inputs, the adjusted transition cost is approximately 58,937 MVR (3,833 USD) per farm per papaya cycle. This figure incorporates both one-time or infrequent

upgrades, such as irrigation or rainwater harvesting systems, and recurring costs for practices like organic fertilizers, composting, cover cropping, intercropping, and biopesticides. It also reflects the elimination of roughly 39,448 MVR in chemical fertilizer purchases and 4,615 MVR in chemical pesticide purchases per crop cycle, which farmers currently incur under conventional production systems. The practices and items costed as part of this exercise are presented in Table 42 below.

Costing notes: At the onset of the assignment, it was necessary to identify a set of representative NbS, EbA, and CSA practices to include in the quantitative survey, to understand adoption patterns across farms. Through the survey results and field observations, this report highlights the key challenges farmers face—providing a basis for further discussion and prioritization by the MoAAW and MoTE. A more detailed, cross-sectoral process is now recommended to define a clear, granular set of NbS, EbA, and CSA practices appropriate to address the production challenges articulated in this report. For example, while this costing exercise captures general pest management costs, it does not provide the detailed costing of specific interventions such as the release of parasitoid wasps for mealybug control, which emerged as a critical pest control solution during the field observations.

Complete Replacement of Chemical Fertilizer: Mixed Results

A study in India comparing six organic treatments to conventional NPK fertilizer on papaya found that while productivity was lower under organic management, soil health benefits were significant. NPK-treated trees produced 37.9 fruits per plant compared to 30.0 fruits from the best organic treatment (20 kg sunn hemp + 150g rock phosphate). However, organic treatments substantially improved soil microbial population, soil respiration, and mineralizable nitrogen, indicating enhanced long-term soil health despite short-term yield trade-offs.

In another study, the use of the organic sources of nitrogen and Arbuscular Vesicular Mycorrhiza (AMF) and Plant Growth Promoting Rhizobacteria (PGPR) produced 39.9 kg/per plant, compared to 33.6kg/per plant with 100% NPK dosing.

Additionally, the cost analysis assumes complete elimination of chemical fertilizers and pesticides, which may not reflect the approach farmers' readiness or the approach that the MoAAW would recommend (see text box) (Reddy et al., 2010; Hari & Bindu, 2021). In practice, many farmers may opt for graduated approaches that partially reduce chemical inputs while incorporating sustainable practices, or hybrid systems that balance productivity requirements with environmental benefits. The analysis did not account for these intermediate adoption scenarios, which could significantly alter the cost structure and economic viability of sustainable practices.

Therefore, the cost data presented below should be treated as preliminary, after which a prioritization of practices is recommended, along with consideration of alternative implementation approaches that may be more aligned with farmer preferences and ministry recommendations. Such refinements would likely alter the costs for farmers to transition to NbS, EbA, and CSA, potentially making adoption more economically accessible while still achieving meaningful environmental and sustainability benefits.

Table 42: Farmer Costs for NbS, EbA, and CSA Adoption per 12,000 square feet for a crop cycle

Practices	Specific Practices	Benefit	Costed Item	Cost
Soil Fertility & Carbon Management	Compost and organic amendments (primarily for soil health)	Improves soil organic matter, enhances nutrient cycling, improves water retention and soil structure, reduces chemical fertilizer dependence (Bot & Benites, 2005)	Upgraded compost system	1,200 MVR (one-time cost)
			Organic amendments	3,000 MVR (each crop cycle)
	Organic fertilizer (primarily for plant nutrition)	Provides slow-release plant nutrition, builds soil microbial activity, reduces nutrient leaching compared to synthetic fertilizers	Organic fertilizers	66,000 MVR (each crop cycle). *This represents the total organic fertilizer cost needed to completely replace synthetic inputs.*
	Green manures and cover crops	Nitrogen fixation, weed suppression, erosion control, water retention, biomass for mulching (Teasdale, 2003; USDA, 2024)	Cover crop seeds	300 MVR (each crop cycle)
			Seagrass	Free (use of local seagrass, labor cost not accounted for)
Water & Climate Regulation	Enhanced irrigation	Improves water use efficiency by 30-60%, reduces heat stress, enables precision watering (irrigation) (Singh & Singh, 2019)	Irrigation or sprinkler system	5,000 MVR (one-time cost, does not include solar or gas pump)
		Reduces groundwater pressure, provides water security during dry periods, buffers against saltwater intrusion (rainwater harvesting)	Rainwater harvesting	500 MVR (one-time cost)
	Mulching	Reduces soil evaporation by more than 30% (El-Belthagi et al., 2022), buffers soil temperatures, reduces erosion by upwards of 76% (Fan et al., 2023)	Crop residues	Free (use of local crop residues like coconut leaves, labor cost not accounted for)
	Agroforestry	Wind damage reduction, microclimate stabilization, soil protection, provides	Windbreak trees	2,500 MVR (one-time cost)

		additional income streams (Jose, 2009)		
Pest, Disease, & Biodiversity Management	Integrated pest management	Reduces pest pressure while conserving beneficial species, decreases chemical pesticide use by 50-80% (Pretty & Bharucha, 2015)	IPM materials	18,000 MVR (each crop cycle)
			Pest monitoring set-up	300 MVR (one-time cost)
	Intercropping and habitat creation	Attracts pollinators, supports beneficial insects, enhances biodiversity, natural pest suppression (Othim et al., 2024)	Habitat/intercrop seeds	300 MVR (each crop cycle)
	Biopesticides	Reduces chemical pesticide dependence, protects ecosystem health, targets specific pests (CABI, 2024)	Essential oil (neem oil)	1,000 MVR (each crop cycle)
Practice implementation	Labor	NA	Additional labor needed for additional planting and IPM practices	4,900 MVR (each crop cycle, does not account for potential saving from reduced watering time)

Estimated cost to adopt NbS, EbA, and/or CSA practices per farmer: 103,000 MVR (6,698 USD)
Accounting for cost savings from the elimination of chemical inputs: 58,937 (3,833 USD)

Anticipated Benefits of NbS, EbA, and CSA Adoption in Papaya Production

The transition to NbS, EbA, and CSA practices requires significant upfront investment, as detailed in the cost analysis above. However, it is equally important that policymakers and program implementers consider the substantial co-benefits of these practices—many of which address systemic constraints in Maldivian agriculture, including climate vulnerability, soil degradation, pest pressure, and water scarcity. While adoption entails added costs, these practices offer functional returns that strengthen farm-level resilience, improve resource efficiency, and reduce dependency on costly chemical inputs—benefits that are not always captured in a short-term financial accounting. They also support progress toward MGAP compliance and broader climate adaptation goals laid out in the Maldives' national strategies. The evidence below, drawn from global agronomic research and regionally relevant field trials, outlines the biophysical and agronomic benefits of key practices across three core areas of impact: soil fertility and carbon management, water and climate regulation, and pest, disease, and biodiversity management.

Soil Fertility and Carbon Management: Given the sandy, low-organic matter soils in the Maldives, building soil health is essential to cut the average annual chemical fertilizer cost of MVR 39,448 per farmer. The 70,500 MVR investment in soil fertility practices delivers compounding returns:

- **Compost and organic amendments:** On coral atolls where soils are coarse-textured and low in organic matter, one of the methods available to farmers is adding stabilized compost to build soil organic matter and aggregate stability to improve soil function. Global guidance

demonstrates that compost improves aggregation, infiltration, and plant-available water while enhancing nutrient cycling that can partially substitute mineral inputs over time (Fan et al., 2023). These mechanisms directly address atoll constraints: high leaching, weak structure, and rapid moisture loss.

- **Organic fertilizers:** Where farmers can source organic nutrient products, these provide slow-release nutrition and stimulate soil microbial activity—critical in sandy soils with poor nutrient retention. Papaya trials show that while fully organic regimes may under-yield mineral NPK initially, blended programs combining organics with targeted mineral N/K maintain yields while rebuilding soil function and reducing input dependency (El-Belthagi et al., 2022).
- **Green manure and cover crops:** Short-cycle legumes fit intercrop alleys of small papaya blocks, contributing biological nitrogen, suppressing weeds, and reducing erosion while providing biomass mulch (Teasdale, 2003). This is particularly valuable on Maldivian sands, where living cover and surface residue are effective in slowing wind/water detachment and retaining scarce moisture.

Water and Climate Regulation: With water scarcity and climate extremes threatening production stability, the 8,000 MVR investment in water and climate regulation practices provides critical risk mitigation:

- **Enhanced irrigation:** Papaya field studies show precision systems improve water-use efficiency by 30–60% while maintaining or increasing yield, with ET-based scheduling reducing leaching and stabilizing root-zone moisture under heat stress (El-Belthagi et al., 2022). On islands with thin freshwater lenses and high pumping costs, this directly translates to greater drought tolerance, reduced salinity stress, and a more uniform fruit set.
- **Mulching**: Residue mulches cut soil evaporation by more than 30%, buffer soil temperatures, and reduce runoff by approximately 47% and soil loss by approximately 76% (Fan et al., 2023; Jose, 2009). For papaya's shallow, fibrous roots—sensitive to heat and moisture swings—this stabilizes growth while reducing weeding frequency and protecting surface horizons from wind erosion.
- **Agroforestry windbreaks:** Permeable windbreaks reduce wind speed across 10–15 times the barrier height, lowering mechanical damage and evapotranspiration while improving microclimate (Pretty & Bharucha, 2015). On exposed atolls, this provides primary defense against the storm damage currently experienced by 93% of farmers.

Pest, Disease, and Biodiversity Management: The 19,600 MVR investment in ecological pest management directly replaces the 4,615 MVR in annual chemical pesticide costs while delivering superior long-term control:

- **IPM:** Across Asia and Africa, IPM programs cut chemical pesticide use by 50–80% while maintaining or raising yields through monitoring, thresholds, cultural controls, and natural enemy conservation (Othim et al., 2024). For Maldives, where input logistics are costly and biodiversity is high, IPM reduces pest resistance risks and aligns with tourism-sector demand for residue-safe fruit.
- **Intercropping and habitat creation:** These practices attract pollinators and support natural enemies, strengthening pest suppression while enhancing biodiversity. In papaya specifically, sunn hemp strips reduced wind speed and virus damage while improving growth—particularly relevant to windy island fields (CABI, 2024).

- **Biocontrol and biopesticides:** Farmer-managed natural-enemy reservoirs and botanical products like neem offer targeted control with lower non-target impacts, supporting premium market access while reducing input costs (CABI, 2024).

Implementation Considerations

The transition to NbS, EbA, and CSA practices represents a substantial financial commitment that cannot be understated. Even after accounting for the elimination of chemical inputs, farmers face a net additional cost of approximately 58,937 MVR (3,833 USD) per papaya cycle—a significant increase that will require careful planning and support mechanisms to ensure widespread adoption. The biggest cost drivers are organic fertilizers and integrated pest management systems, which together account for 84,000 MVR (5,465 USD) per cycle, representing the core operational shift from chemical-dependent to sustainable, regenerative farming systems. These high recurring costs highlight the need to investigate opportunities to reduce input costs that align with sustainable production principles.

Opportunities for Local Innovation and Cost Reduction: These transition costs can be reduced through local innovation and infrastructure development. During field research in Thoddoo, farmers identified existing but underutilized composting facilities that could dramatically reduce organic amendment costs if proper technical expertise were available. The island council also expressed interest in developing solar-powered biodigesters as an island enterprise that could convert food waste and green waste into high-quality compost. Such systems could potentially supply organic amendments at costs substantially below current import prices, while simultaneously addressing waste management challenges and creating new revenue streams for island councils. This approach aligns with the circular economy principles embedded in NbS practices and could transform waste streams into valuable agricultural inputs.

Low-Cost, High-Impact Interventions: Despite the overall cost burden, several practices offer high value at relatively modest expense. Cover crop seeds (300 MVR per cycle) represent one of the most cost-effective interventions, providing green manure that can reduce the required quantity of expensive organic fertilizers while improving soil structure and fertility. Similarly, habitat development and intercrop seeds (300 MVR per cycle) offer biodiversity benefits and pest management support at minimal cost. The use of local seagrass for mulching provides ecosystem benefits at zero direct cost, utilizing readily available coastal resources. However, it's important to note that even these "low-cost" interventions may be a significant expense for price-sensitive smallholder farmers. Field interviews consistently revealed farmers' concerns about input costs, with one farmer specifically citing 300 MVR expenses as financially challenging. This price sensitivity underscores the importance of designing support mechanisms that either subsidize key inputs or help farmers access bulk purchasing arrangements to reduce per-unit costs.

Implementation Pathway Considerations: The cost analysis suggests that a phased implementation approach may be most appropriate, beginning with low-cost interventions that provide immediate soil health and pest management benefits, followed by gradual adoption of more expensive but transformative practices. Priority should be given to establishing island-level infrastructure (composting systems, biodigesters) that can reduce ongoing input costs while building the technical capacity needed to support widespread sustainable production.

Critical Policy Action Required: If the MoAAW and the MoTE are committed to facilitating the transition to more sustainable and regenerative agricultural practices, it will be critical for them to actively investigate and pilot innovative approaches to decrease the cost of key practices, particularly soil fertility and carbon management interventions. The 69,000 MVR per cycle cost for organic fertilizers and amendments represents the single largest barrier to adoption and requires urgent policy attention. This investigation should include exploring developing pilot programs to test cost-effective composting, biodigester technologies at the atoll level and investigating bulk purchasing arrangements or input subsidy schemes that could make organic fertilizers more accessible to smallholder farmers. Without addressing these fundamental cost barriers, the transition to sustainable papaya production will remain limited to farmers with sufficient capital or access to concessional financing, thereby limiting the sector's overall climate resilience and sustainability objectives. Financial support mechanisms must account for both the upfront infrastructure investments and the recurring cost differential during the transition period, recognizing that it may take multiple crop cycles to get the full benefits of sustainable systems.

Premium Pricing Analysis: Financial Viability of MGAP and Sustainable Papaya Production

Methodology and Calculations: The premium pricing analysis is based on comprehensive field data collected from papaya farmers in Thoddoo and Laamu, providing realistic production and revenue baselines for economic modeling. Farmers reported an average annual production of 11,586 kg of papaya, with 92.4% successfully sold at an average price of 14.1 MVR per kg. This generates an annual revenue of 150,293 MVR per farmer under current conventional production methods. To align with the 26-month papaya crop cycle, annual revenue is scaled proportionally: 150,293 MVR × (26 months ÷ 12 months) = 325,635 MVR per complete crop cycle. This baseline revenue figure serves as the foundation for calculating premium requirements across all adoption scenarios: 1) MGAP only, 2) sustainable practices only, 3) combined MGAP + sustainable practices. Premium calculations determine what percentage price increase farmers need to recover their investment costs. For example, if a farmer needs an additional 20,000 MVR to cover certification costs over a crop cycle generating 325,635 MVR in baseline revenue, they require a 6.1% premium (20,000 ÷ 325,635). This methodology allows direct comparison of different investment scenarios and their market feasibility.

Please note: The analysis uses production data rather than self-reported income figures because production quantities are generally more reliable and verifiable than farmer income estimates.

Table 43: Investment and Premium Requirements by Adoption Scenario

Cost Component	Scenario 1 : MGAP Only	Scenario 2 : Sustainable Practices Only	Scenario 3 : Combined MGAP + Sustainable
Total Investment Cost	20,040 MVR	58,937 MVR per cycle	78,977 MVR
Costs for One-Time Investment	16,340 MVR (82%)	9,500 MVR (16%)	25,840 MVR (33%)

Recurring Cost per Cycle	3,700 MVR (18%)	49,437 MVR (84%)	53,137 MVR (67%)
Premium Required - First Production Cycle *(accounts for all costs)*	6.2%	18.1%	24.2%
Premium Required - Subsequent Production Cycles *(only accounts for recurring costs)*	1.1%	15.2%	16.3%
Long-Term Profit Enhancement *if premium from first cycle is maintained and minus recurring costs for each scenario*	16,489 MVR per cycle	9,503 MVR per cycle	25,667 MVR per cycle
Flat 15% price premium *accounting for recurring costs*	45,145 MVR per cycle	-412 (negative) MVR per cycle	-4,292 (negative) MVR per cycle

Scenario 1: MGAP Certification - Accessible Market Entry

MGAP certification requires a total investment of 20,040 MVR, but the cost structure heavily favors long-term profitability. The investment breakdown reveals that 16,340 MVR (82%) represents one-time infrastructure investments including chemical storage facilities (3,000 MVR), equipment storage (3,000 MVR), safety equipment and signage (2,100 MVR), and specialized handling equipment (4,020 MVR). These infrastructure investments provide lasting value and do not require replacement for each crop cycle.

Recurring costs total 3,700 MVR per 26-month cycle, comprising worker protective equipment (2,400 MVR), cleaning materials and chemicals (250 MVR), record-keeping systems (50 MVR), and traceability system maintenance (1,000 MVR). This low recurring cost structure creates compelling economics for certified farmers who can maintain premium market access.

The premium requirements reflect this cost structure: farmers need 6.2% premiums during the first crop cycle to recover total certification costs (20,040 ÷ 325,635), but only 1.1% premiums in subsequent cycles to cover recurring expenses (3,700 ÷ 325,635). This dramatic reduction in premium requirements after the first cycle creates substantial profit enhancement potential. However, market interviews suggest buyers are willing to pay significantly higher premiums than these minimum thresholds. Assuming farmers can secure the 15% premium rate that resort operators are willing to pay for MGAP-certified papaya, maintaining this market pricing beyond cost recovery would generate additional profits of 45,145 MVR per cycle (15% premium revenue of 48,845 MVR minus 3,700 MVR recurring costs). This represents a 13.9% increase in total revenue that directly translates to enhanced farmer income, making MGAP certification economically attractive for farmers who can establish reliable premium buyer relationships.

Scenario 2: Sustainable Practices Only - Higher Investment, Ongoing Benefits

Comprehensive adoption of NbS, EbA, and CSA practices requires significantly higher premium pricing (18.1% initially, 15.2% ongoing) but offers substantial environmental and resilience benefits alongside potential market differentiation. The cost structure differs fundamentally from MGAP, with recurring expenses representing 84% of total investment (49,437 MVR per cycle) primarily driven by organic fertilizer costs of 66,000 MVR and integrated pest management systems costing 18,000 MVR per cycle. One-time investments of 9,500 MVR include upgraded compost systems (1,200 MVR), irrigation infrastructure (5,000 MVR), rainwater harvesting (500 MVR), windbreak establishment (2,500 MVR), and pest monitoring setup (300 MVR). While these represent smaller upfront capital requirements than MGAP infrastructure, the high recurring costs create ongoing premium pricing dependencies that require sustained market access to specialized buyers willing to pay for sustainability attributes. Assuming the initial $18.1 percent price premium holds, the long-term profit potential is MVR 9,503 per cycle. This higher profit reflects the reduced impact of initial infrastructure costs over time. However, farmers must maintain premium market access consistently to justify the high recurring input costs associated with sustainable production systems.

Scenario 3: Combined MGAP and Sustainable Practices - Premium Market Positioning

The combined approach requires the highest premium pricing (24.2% initially, 16.3% ongoing) but positions farmers for the highest-value market segments while providing both certification credibility and comprehensive sustainability benefits. At the required 24.2% premium rate, farmers would generate substantial profits of 25,667 MVR per cycle after covering all recurring costs (53,137 MVR) from premium revenue of 78,804 MVR. Total one-time investments of 25,840 MVR represent substantial capital requirements that may necessitate financing support, but the approach offers significant long-term profitability for farmers who can access premium sustainability markets.

While MGAP certification alone would be more profitable at a 15% premium rate (generating 45,145 MVR per cycle), the 24.2% premium requirement for the combined approach appears feasible based on market interviews with sustainability-committed buyers. Resort operators with explicit sustainability commitments represent the most promising market for this premium positioning, and some buyers indicated willingness to pay substantial premiums for comprehensively sustainable products. Success would depend on identifying and cultivating relationships with the specific market segments willing to pay premium rates for the combined certification and sustainability attributes, though volume reliability constraints must still be addressed to access these markets effectively.

Strategic Implications and Implementation Pathways

The premium pricing analysis reveals a clear economic hierarchy that should inform strategic decision-making across farmer, policy, and market development levels. MGAP certification emerges as the most economically attractive entry point for farmers seeking premium market access, requiring minimal upfront premiums (6.2%) while generating substantial profits (45,145 MVR per cycle) at the 15% premium rates that buyers have indicated willingness to pay. This economic advantage, combined with the predominantly upfront investment structure that creates lasting infrastructure value, positions MGAP certification as the optimal starting point for value chain upgrading initiatives.

However, the analysis also demonstrates that comprehensive sustainable practices adoption faces significant economic barriers at current market premium levels, with both standalone sustainable practices and combined approaches generating losses at the 15% premium rate that represents realistic buyer willingness for most market segments. The viability of the combined approach at 24.2% premiums (generating 25,667 MVR profits) depends critically on identifying and cultivating relationships with highly sustainability-committed buyers willing to pay premium rates. This suggests a bifurcated market development strategy: broad-based MGAP promotion targeting mainstream tourism buyers, and targeted sustainable practices development focusing on premium sustainability market niches.

Climate Adaptation Imperative and Long-term Viability: While economic viability drives immediate adoption decisions, the climate adaptation benefits of sustainable practices represent essential investments in agricultural resilience that extend beyond short-term profit calculations. With 93% of farmers experiencing wind and storm damage, 63% reporting excessive rainfall events, and 60% linking increased pest and disease pressure to climate change, the costs of maintaining conventional production systems will likely escalate as climate impacts intensify. Sustainable practices—including soil organic matter building, water conservation systems, windbreak establishment, and integrated pest management—address the root causes of productivity decline rather than treating symptoms through increased chemical inputs. The research reveals that even with higher fertilizer use, yields are declining in conventional systems, suggesting that current approaches face diminishing returns as climate stressors compound. The 58,937 MVR investment in sustainable practices should therefore be understood not only as a premium market positioning strategy but as climate risk mitigation that protects long-term farm viability. However, this climate adaptation rationale alone cannot drive adoption without either: (1) premium pricing that makes sustainable systems economically competitive with conventional production, or (2) targeted subsidies for climate-smart inputs—particularly organic fertilizers—that reduce the 26,552 MVR incremental cost farmers face when transitioning from synthetic to organic nutrition systems. Policy frameworks must recognize that asking farmers to bear full costs of climate adaptation investments without market premiums or public support effectively asks them to subsidize broader societal climate resilience goals while operating under already-thin profit margins.

Policy and Market Development Priorities: The findings highlight several intervention points for policymakers and development partners. First, the economic viability of MGAP certification at realistic market premium levels suggests that targeted financial support for initial infrastructure investments (16,340 MVR per farmer) could catalyze widespread adoption with minimal ongoing subsidy requirements. Current SDFC loan programs appear well-suited to finance these investments, though coordination with buyer market development will be essential to ensure farmers can access the premium markets necessary to justify certification investments.

Second, the high recurring costs that limit the viability of sustainable practices, particularly organic fertilizer expenses representing 66,000 MVR per cycle, require urgent policy attention to improve economic feasibility. Interventions such as island-level composting infrastructure development, bulk purchasing arrangements, or targeted input subsidies could significantly reduce these cost barriers while maintaining environmental benefits. Without addressing these fundamental cost challenges,

adoption of sustainable practices will remain limited to farmers with access to premium market segments willing to pay substantially above typical buyer willingness levels.

Finally, the analysis underscores the critical importance of coordinated market development efforts that simultaneously build buyer awareness of certification benefits while ensuring adequate supply aggregation and quality consistency to justify premium pricing commitments. Success in developing both MGAP and sustainable papaya markets will require strategic alignment between production-side investments, buyer education initiatives, and value chain infrastructure development to bridge the gap between farmer capabilities and end-market requirements.

RECOMMENDATIONS & ACTIONABLE ROADMAP

Theory of Change

The transformation of the Maldivian papaya sector toward sustainable, MGAP-certified production requires a comprehensive systems approach that addresses multiple interconnected challenges simultaneously. While individual interventions may yield modest improvements, meaningful and lasting change in the papaya value chain can only be achieved through coordinated action across production, market, infrastructure, and policy domains. This theory of change recognizes that sustainable papaya production is not merely a technical challenge, but a complex system requiring alignment between farmer capabilities, market incentives, infrastructure capacity, and institutional support.

The pathway to widespread adoption of sustainably produced, MGAP-certified papaya depends on creating the right conditions across the entire value chain ecosystem. No single intervention—whether improving farmer training, enhancing transportation, or developing market channels—can succeed in isolation. Instead, success requires a lead focal point to take ownership of this systems-level transformation and ensure that complementary changes occur across multiple areas simultaneously.

Conditions for Transformation

- IF there is sufficient knowledge and skill transfer on MGAP standards and sustainable agricultural practices
- AND IF quality inputs that align with MGAP and sustainable standards are available and affordable
- AND IF farmers have increased access to credit and insurance
- AND IF land leasing challenges are resolved (particularly for Thoddoo)
- AND IF farmers are able to access higher sales prices for MGAP certified papaya
- AND IF the transportation system (cargo vessel transportation) is adapted so that farmers have diversified marketing opportunities, reducing reliance on the Malé market and opening up to other markets
- AND IF market channels are developed, including end-market generation that allows for the specific, transparent supply of sustainably produced MGAP certified papaya from farmers to end-buyers
- AND IF the policies are in place to support sustainably produced MGAP certified papaya
- AND IF the ministries, regulation agencies, and island authorities improve their coordination and implementation to promote sustainably produced MGAP certified papaya

Excepted Outcomes

- THEN there is significant potential for the widespread adoption of sustainably produced MGAP certified papaya in the Maldives, leading to:
    - Enhanced farmer livelihoods through premium pricing
    - Improved environmental sustainability in papaya production
    - Strengthened local food systems and reduced import dependence
    - Greater alignment between tourism demand and local agricultural supply
    - Increased resilience of papaya value chains to climate and market shocks

Recommendations

The transformation of the Maldivian papaya sector toward sustainable, MGAP-certified production requires coordinated interventions across multiple dimensions of the value chain ecosystem. As articulated in the theory of change, meaningful progress depends not on isolated actions but on systematic alignment between farmer capabilities, market incentives, infrastructure capacity, and institutional support. The 21 recommendations outlined in this section are designed to work in concert, addressing the interconnected challenges that currently constrain papaya farmers from accessing premium markets and adopting sustainable production practices.

These recommendations are organized into six strategic categories that reflect both the analytical framework of this study and the practical realities of implementation coordination.

- **Strategy recommendations** (1-2) establish the foundational approaches for integrating sustainable agricultural solutions and aligning sectoral development with national climate adaptation priorities.

- **Policy and governance recommendations** (3-7) address the institutional coordination, policy alignment, and regulatory frameworks necessary to create an enabling environment for sustainable papaya production.

- **Financing recommendations** (8-10) target the critical barriers around access to credit, insurance, and land tenure security that currently limit farmers' ability to invest in certification and sustainable practices.

- **Innovation and development recommendations** (11-13) focus on building the technical knowledge base, data systems, and island-level capacity needed to support widespread adoption of improved practices.

- **Training recommendations** (14-15) address the fundamental awareness and knowledge gaps that prevent farmers from accessing MGAP certification and premium market opportunities.

- **Value chain-specific recommendations** (16-21) target the distinct challenges facing production systems, input supply chains, aggregation and distribution networks, and market access mechanisms that must function effectively for farmers to capture value from sustainable production investments.

The sequencing and interdependence of these recommendations reflect the systems perspective that underlies this analysis. Success in developing premium markets for MGAP-certified papaya (recommendations 21(requires concurrent improvements in transportation infrastructure (recommendations 18-20), farmer technical capacity (recommendations 14-16), input quality assurance (recommendation 17), and policy support mechanisms (recommendations 3-7). Similarly, achieving widespread adoption of sustainable agricultural practices depends on coordinated progress across financing accessibility (recommendations 8-10), institutional capacity (recommendations 11-13), and strategic prioritization (recommendations 1-2). The recommendations presented in the table below provide specific implementation actions, identify lead implementing entities, and articulate the particular challenges each intervention is designed to address. While individual recommendations may yield incremental improvements, their collective implementation offers the potential for transformative change that positions the Maldivian papaya sector as a model for climate-resilient, market-oriented agricultural development in small island developing states.

Table 44: Recommendations

Recommendation	Challenge Addressed	Implementation Actions	Lead Entities
STRATEGY			
1. Development of a horticulture master plan for MGAP certified, sustainably produced horticultural products in the Maldives	Lack of comprehensive strategic framework to guide horticultural development and coordinate interventions	• Lead consultative process to develop comprehensive horticulture master plan • Utilize papaya research findings and conduct additional assessments for other value chains • Include prioritization of specific NbS, EbA, and CSA practices • Align horticultural development strategies with NDCs and NAP framework	MoAAW MoTE Research Institutions Development partners
2. Develop a private sector engagement strategy with concrete commitments for horticultural value chain transformation	Current engagement approaches focus on government actions rather than securing concrete private sector commitments	• Establish structured private sector engagement process producing concrete commitments • Secure agreements from input suppliers to embed MGAP guidance into service delivery • Obtain commitments from transportation actors for food safety practices • Develop specific local sourcing targets and premium pricing arrangements with end-market actors	MoAAW MoTE Private Sector Development partners
GOVERNANCE			

3. Develop and enforce a national policy on quality assurance for agricultural inputs	Reports of substandard and adulterated agricultural inputs affecting productivity	• Develop national policy defining minimum quality standards for agricultural inputs • Implement routine monitoring and oversight of input imports • Establish quality certification standards and farmer reporting mechanisms • Develop penalties for substandard input distribution	MoAAW MFDA Customs Authority Private sector
4. Enhance the MGAP scheme based on feedback and past adoption experiences	Current MGAP standards perceived as overly burdensome and not adapted to local farming contexts	• Conduct comprehensive MGAP standard review and adaptation for papaya farming • Publish contextualized guidelines and implementation support materials • Develop simplified compliance pathways for smallholder farmers • Create training materials specific to Maldivian papaya cultivation	MFDA MoAAW Technical consultants Private sector
5. Strengthen institutional coordination and farmer feedback mechanisms	Insufficient connection between MoAAW, island councils, and farmers limiting responsive policy development	• Establish systematic farmer-government communication processes • Create formal challenge escalation and resolution procedures • Implement regular stakeholder consultation forums • Develop digital platforms for farmer feedback and information sharing	MoAAW Island councils Local Government Authority Development partners
6. Strengthen island council capacity to strategize, support farmers, and coordinate adaptation interventions	Limited technical and strategic capacity of island councils to effectively support local agricultural development	• Conduct capacity assessment of island councils in agricultural support functions • Develop targeted training programs for council staff on agricultural planning and support • Establish mentorship programs linking councils with agricultural experts • Create resource-sharing mechanisms between councils	Local Government Authority MoAAW Island Councils Development partners
7. Reform land leasing structures to support long-term investment	Unfavorable lease terms preventing medium to long-term agricultural investments	• Extend minimum lease terms to 10+ years for agricultural land • Review and adapt leasing frameworks to encourage investment • Simplify lease renewal processes • Create incentives for sustainable land use practices	Island Councils Ministry of National Planning, Housing and Infrastructure Local Government Authority MoAAW

8. Establish in-country laboratory capacity for agricultural and food safety testing	Absence of domestic laboratory infrastructure constraining regulatory enforcement and farmer MGAP compliance	• Establish national laboratory facility for agricultural and food safety testing • Equip facility for soil, water, compost, and produce testing • Establish partnership framework with universities for training and research • Embed testing services into agricultural training programs	MFDA MoAAW National academic institutions Development partners
FINANCING			
9. Enhance access to agricultural finance, insurance products, and strengthen sector capacity and outreach	Limited access to credit and risk mitigation instruments constraining investment capacity, combined with low financial service provider capacity	• Strengthen farmer financial literacy programs • Set specific agricultural lending targets for financial institutions • Implement targeted financial service provider training • Conduct systematic farmer outreach on financial products	Private financial institutions Maldives Monetary Authority MoAAW Development partners
10. Expand crop insurance awareness and coverage	Low awareness and utilization of available crop insurance products leaving farmers vulnerable to climate risks	• Implement public-private insurance awareness campaigns Expand insurance product coverage and accessibility Create subsidized insurance options for smallholder farmers	Insurance companies MoAAW Private sector Development partners
INNOVATION & DEVELOPMENT			
11. Develop value-chain specific pest and disease protocols	Significant productivity losses due to pest and disease pressures with limited effective solutions	• Conduct systematic identification of optimal pest and disease control methods for papaya • Promote farmer adoption of evidence-based integrated pest management • Strengthen phytosanitary oversight and genetic material quality control • Develop early warning systems for pest and disease outbreaks	MoAAW Research institutions MFDA Private sector
12. Implement comprehensive agricultural data collection system	Lack of data for evidence-based agricultural policy and resource allocation decisions	• Fund and implement planned agricultural surveys • Establish ongoing data collection mechanisms • Develop digital data management systems • Create data-sharing protocols between institutions, including island councils	MoAAW National Bureau of Statistics Island Councils Development partners
13. Strengthen island council capacity to implement targeted technical solutions as enterprises	Limited technical capacity of island councils to deploy climate-smart technologies and sustainable infrastructure	• Assess island council capacity for implementing biodigesters, renewable energy systems • Develop technical training programs for council staff • Create financing mechanisms for council-led technical enterprises	Local Government Authority MoTE Island Councils

		• Establish maintenance and operation support systems	Development partners
TRAINING			
14. Strengthen adoption of MGAP and NbS and CSA practices	Limited knowledge and adoption of sustainable practices aligned with MGAP standards	• Prioritize practice promotion through ministerial guidance • Develop sensitization and training programs • Implement demonstration plots showcasing best practices • Pilot farmer-to-farmer learning networks	MoAAW MFDA Private sector partners Development partners
15. Implement comprehensive MGAP awareness campaign	Limited stakeholder awareness of MGAP benefits and requirements across the value chain	• Launch multi-stakeholder MGAP awareness initiative • Empower farmer responsibility and engagement in supply safe, sustainable foods • Develop end-buyer education and consumer awareness campaigns • Engage tourism sector on sustainability alignment	MFDA MoAAW Private sector Development partners
INPUT QUALITY AND ACCESS			
16. Enhance availability and affordability of quality inputs	Frequent stockouts and high costs limiting farmer access to essential inputs	• Investigate private sector distribution models and public-private partnerships • Explore economic zone integration opportunities • Implement targeted subsidies for organic and climate-smart inputs • Develop input financing schemes particularly for organic and climate-smart inputs	MoAAW Private sector Development agencies Economic Development Ministry
AGGREGATION AND DISTRIBUTION			
17. Develop cold storage infrastructure with renewable energy integration	Absence of cold storage capacity limiting product quality and market access, particularly for remote atolls	• Revitalize and expand existing AgroNat cold storage facility in Laamu • Construct expanded renewable energy-powered cold storage units • Establish strategic storage network • Develop public-private partnerships for infrastructure development	MoAAW MoTE Development Partners Private sector
18. Enhance inter-island transportation reliability and frequency	Irregular and expensive transportation creating supply chain bottlenecks and limiting market consistency	• Investigate mechanisms to improve transportation frequency and reduce costs • Develop dedicated agricultural transport services • Create subsidized transport schemes for agricultural products	MoAAW MTCC Private transport operators Island Councils

		• Establish transportation scheduling coordination mechanisms	
19. Establish intra-atoll distribution networks	Over-centralization through Malé despite proximity of consumers in nearby atolls	• Develop zone-based distribution systems (north, central, south) • Establish regional market hubs • Implement inter-island marketing coordination • Create policy frameworks supporting decentralized trade	Prime Minister's Office Regional Councils Island Councils Private sector
MARKETING AND MARKET ACCESS			
20. Strengthen farmer bargaining power and market positioning	Farmers operating as price-takers with limited market influence	• Establish market facilitation unit within MoAAW • Implement targeted market facilitation project with B2B connections • Provide contract negotiation support and training • Reinstate AgroNat's farmer aggregation and marketing function • Develop farmer collective marketing initiatives	MoAAW Development partners Market management authorities Private sector
21. Establish quality-based pricing mechanisms	Absence of price premiums for quality and MGAP-certified production limiting farmer incentives	• Identify early-adopter premium buyers • Develop market strategies alternative to the current centralized system • Create quality differentiation and certification marketing • Pilot and provide facilitation support for direct farmer-resort linkage programs	MFDA MoAAW Private sector buyers Tourism ministry

OVERARCHING STRATEGY RECOMMENDATIONS

Recommendation 1: Development of a horticulture master plan for MGAP certified, sustainably produced horticultural products in the Maldives

Importance: Horticulture represents a critical component of Maldivian agriculture, with significant domestic demand and substantial potential for import substitution and tourism market integration. However, the sector currently lacks a comprehensive strategic framework to guide development efforts and coordinate interventions across the diverse challenges facing horticultural producers. This study's findings on papaya production reveal systemic constraints—including pest and disease pressure, input access challenges, transportation bottlenecks, and market coordination failures—that are emblematic of broader horticultural value chain challenges rather than crop-specific issues.

Critically, these production constraints are intensifying under climate change, with over 90% of farmers experiencing wind and storm damage, 68% facing pest pressure, and widespread reports of declining yields despite increased chemical input use. Without a unified strategic approach that positions climate adaptation and sustainable production as central rather than peripheral objectives, individual interventions remain fragmented and fail to address the interconnected nature of production, market access, and sustainability challenges. The economic analysis reveals that comprehensive sustainable practices require either premium market pricing (18-24%) or targeted input subsidies to be financially viable—indicating that a horticulture master plan must simultaneously address farmer production constraints, market development for certified products, and input cost barriers that prevent climate-smart practice adoption. A horticulture master plan would provide the institutional framework necessary to coordinate efforts across MoAAW, MoTE, island councils, private sector actors, and development partners while ensuring alignment with national climate commitments and agricultural modernization objectives.

Implementation: MoAAW and MoTE should lead a consultative process to develop a comprehensive horticulture master plan that establishes clear priorities for climate-resilient, MGAP certified, sustainably produced horticultural development. This process should utilize the papaya research findings as a foundation while conducting additional assessments for other key horticultural value chains where necessary. The planning process should explicitly align horticultural development strategies with the country's NDCs and NAP framework, ensuring that sectoral interventions contribute to broader climate adaptation and mitigation goals while recognizing that climate resilience investments require either market premiums or public support to be economically viable for farmers. The resulting master plan should serve as a guiding framework for resource allocation, program design, and institutional coordination across all horticultural development initiatives, with explicit recognition that MGAP certification serves as a vehicle for scaling sustainable agricultural practices rather than an end in itself.

The master plan should prioritize:

- **Climate adaptation as the primary driver:** Identification and prioritization of specific NbS, EbA, and CSA practices most appropriate for Maldivian horticultural sector based on documented climate vulnerabilities, with clear implementation pathways and adoption targets

- **Input cost and transition support strategy:** Development of strategies to address these transition costs through mechanisms such as: exploring redirection of any existing input support from imported synthetic fertilizers toward locally-produced organic alternatives, facilitating bulk purchasing arrangements that reduce per-unit costs, supporting island-level composting enterprises that provide affordable organic amendments, and/or developing innovative financing approaches that spread transition costs over multiple cropping cycles while conserving foreign currency expenditure.
- **Island-level production capacity:** Support for development of composting enterprises, biodigester systems, and other local input production facilities that reduce import dependency and create circular economy benefits.
- **Market development and consumer awareness:** Coordinated strategies for building consumer demand for sustainably produced local horticulture through awareness campaigns targeting both domestic consumers and tourism sector, recognizing that premium pricing is essential for making sustainable practices economically viable
- **Infrastructure and policy interventions:** Identification of critical investments in cold storage, transportation, testing facilities, and regulatory frameworks needed to support farmer productivity and market access
- **Financing mechanisms:** Clear pathways for accessing credit, insurance, and targeted subsidies that reduce farmer risk during transition to sustainable production systems

Recommendation 2: Develop a private sector engagement strategy with concrete commitments for horticultural value chain transformation

Importance: While government institutions can establish policy frameworks and provide technical support, transforming the horticultural sector requires active private sector participation and investment. The research highlights critical gaps that the private sector could fill to improve the system. This includes input suppliers offering extension services, transport companies implementing food safety protocols, and buyers creating demand for certified products. However, current engagement approaches tend to focus on what government needs to do rather than securing concrete commitments from private sector actors about what they will contribute. Without structured engagement that produces specific commitments, private sector potential remains untapped, leaving farmers to navigate market failures and service gaps independently. This recommendation addresses the need to move beyond consultation toward collaborative action planning that leverages private sector capabilities while aligning commercial interests with farmer development objectives.

Implementation: MoAAW and MoTE should establish a structured private sector engagement process that produces concrete commitments from key actor categories. For input suppliers, this means securing agreements to embed MGAP and sustainable practice guidance into their service delivery models, including staff training and advisory protocols. Transportation actors must commit to adopting specific food safety and hygiene practices during handling and storage of horticultural products, with clear implementation timelines and monitoring mechanisms. End-market actors—including resorts, hotels, guesthouses, and their wholesale suppliers—should commit to specific local sourcing targets and premium pricing arrangements for certified products, moving beyond expressions of interest toward purchase agreements and market development investments. Financial institutions (SDFC and Allied Insurance) must adapt their outreach strategies and product offerings to better serve farmers transitioning to certified sustainable production, including risk assessment modifications and targeted service delivery improvements. Each engagement should

produce written commitments with specific deliverables, timelines, and performance indicators, creating accountability mechanisms that ensure private sector follow-through on collaborative agreements.

GOVERNANCE AND POLICY RECOMMENDATIONS

Recommendation 3: Develop and enforce a national policy on quality assurance for agricultural inputs

Importance: The absence of clear quality control systems for agricultural inputs poses a major risk to farm productivity, environmental sustainability, and farmer trust in input suppliers. Farmers across both Laamu and Thoddoo consistently raised concerns about the inconsistent quality of fertilizers, pesticides, and seeds—particularly hybrid papaya seeds imported from Sri Lanka and India. These concerns are compounded by the fact that no formal mechanisms currently exist to verify the quality of imported inputs or monitor their distribution and use. The lack of oversight not only results in poor crop performance and wasted investment for farmers but also undermines the adoption of MGAP and CSA practices, which rely on inputs such as certified seeds, organic fertilizers, and stabilized compost that meet specific standards. Without strong monitoring, enforcement, and accountability systems in place, substandard products will continue to be used, preventing farmers from scaling quality production.

Recommendation 3A: Implement emergency food safety monitoring and enforcement program [IMMEDIATE PRIORITY]

Importance: Survey findings reveal critical food safety gaps including PHI non-compliance, use of banned pesticides, and unsafe handling practices that pose immediate public health risks.

Implementation: MoAAW and MFDA should immediately establish coordinated monitoring of pesticide residues in marketed produce, strengthen enforcement of PHI requirements, and implement emergency training for farmers and workers on basic safety protocols while longer-term MGAP adoption proceeds.

Implementation: The MoAAW, in coordination with the MFDA and relevant import control agencies, should lead the development of a national policy for agricultural input quality assurance. This policy should define minimum quality standards for key agricultural inputs—including hybrid seeds, chemical and organic fertilizers, compost, and pest control products—and establish clear enforcement responsibilities across government agencies. Once approved, the policy should be operationalized through a phased rollout of quality assurance mechanisms, with an initial focus on inputs most relevant to MGAP and sustainable agricultural production. Implementation should include the following actions:

- Routine monitoring and oversight of agricultural input imports at key entry points, including random product sampling, testing, and documentation checks.
- Establishing national certification standards for key input categories, supported by partnerships with accredited laboratories (either in-country or regionally) that can validate compliance.

- Creation of a farmer-facing input quality reporting mechanism, such as a hotline or digital feedback tool, to crowdsource complaints and flag recurring issues with specific products or suppliers.
- Issuance of importer and distributor guidelines, clarifying the documentation, labeling, and testing requirements for all agricultural inputs entering the country.
- Enforcement of penalties and import restrictions for repeated non-compliance, including the possibility of blacklisting suppliers or banning specific product lines that fail to meet standards.

Recommendation 4: Enhance the MGAP scheme based on feedback and past adoption experiences

Importance: Current MGAP standards present significant adoption barriers for Maldivian smallholder farmers, with only 11.7% of surveyed farmers aware of the certification scheme and widespread perception that requirements are overly complex and burdensome. The research reveals fundamental disconnects between standard requirements and farmer realities—zero farmers currently test water quality, no smallholder workers have received chemical handling training, and record-keeping practices fall well short of certification requirements. MFDA officials acknowledge that current standards may be "too high" for the Maldivian context, while farmers consistently identify documentation requirements and testing protocols as primary barriers to adoption. This creates a tension between maintaining food safety integrity and ensuring farmer accessibility to certification benefits. Unless MGAP standards are contextualized to reflect smallholder farmers' constraints while preserving safety, the program will only benefit larger commercial operations. This will severely limit its power to drive sector-wide change toward sustainable practices. The lessons learned from papaya-specific contextualization can inform similar adaptations across other horticultural crops facing comparable production and market challenges.

Implementation: MoAAW and MFDA should lead a systematic review and adaptation process for MGAP standards to develop contextualized guidelines specifically suited to Maldivian smallholder farming conditions. This process should focus on reducing documentation redundancy while maintaining traceability requirements, simplifying compliance pathways for critical practices like chemical storage and worker safety, and developing alternatives to expensive testing requirements managed through shared facilities or government support. The review should create simplified record-keeping templates and procedures that align with farmer literacy levels and operational realities, while establishing clear implementation support mechanisms including training materials, demonstration protocols, and certification pathways. Contextualized standards should be piloted with papaya farmers across different production systems to validate accessibility and effectiveness before broader rollout. The resulting framework should serve as a model for adapting MGAP standards to other horticultural crops, creating a replicable approach for balancing food safety requirements with smallholder farmer capabilities across the agricultural sector.

Recommendation 5: Strengthen institutional coordination and farmer feedback mechanisms

Importance: The research reveals significant disconnects between farmer experiences and institutional priorities, with farmers and island councils reporting frustration that their challenges are

not systematically captured or addressed by MoAAW resource allocation decisions. Farmers in key production areas such as Thoddoo and Laamu have expressed concern that islands with lower agricultural potential, but more acute socioeconomic needs may receive greater attention from the Ministry, leading to perceptions of imbalance that could affect confidence in broader agricultural development efforts. This institutional disconnect prevents evidence-based policy making and resource allocation, as MoAAW lacks systematic mechanisms to collect, analyze, and respond to farmer-identified constraints. The absence of formal feedback channels can contribute to farmers feeling unheard and island councils strained in their intermediary role, limiting the Ministry's access to the ground-level insights that are critical for effective and responsive program design. Without structured communication processes, agricultural policies risk misalignment with actual farmer needs, leading to resource inefficiencies and missed opportunities for targeted interventions that could yield significant productivity improvements.

Implementation: MoAAW should establish systematic farmer-government communication processes that ensure regular collection and analysis of farmer-identified challenges across all major agricultural islands. This requires creating formal escalation and resolution procedures where farmer concerns are documented, prioritized, and tracked through to resolution, with clear timelines and accountability mechanisms. Implementation should include regular stakeholder consultation forums that bring together farmers, island councils, and Ministry representatives to discuss challenges and coordinate solutions. Digital platforms, like the planned Dhanduveriya app, should facilitate continuous feedback collection and provide farmers with visibility into how their input influences policy decisions. The system must include clear protocols for how farmer feedback informs Ministry resource allocation and program prioritization, ensuring that ground-level intelligence directly shapes institutional strategies. Island councils should be formally integrated into this feedback system as key intermediaries, with enhanced capacity and clear roles in documenting, escalating, and following up on farmer concerns within their jurisdictions.

Recommendation 6: Strengthen island council capacity to strategize, support farmers, and coordinate adaptation interventions

Importance: Island councils serve as the primary local governance interface with farming communities but currently lack the technical knowledge and strategic capacity to effectively support agricultural development within their jurisdictions. The research reveals that councils have limited understanding of how land use planning decisions affect agricultural productivity, how climate adaptation measures like buffer zones can simultaneously protect infrastructure and support farming systems, or how they could develop revenue-generating services that address critical farmer needs. This capacity gap undermines the potential for locally responsive agricultural support and limits councils' ability to integrate agricultural considerations into broader island development planning, as well as to communicate priorities effectively with the central government. Enhanced council capacity would create complementary local support systems that work alongside Ministry programs rather than replacing them, enabling more responsive and sustainable agricultural development approaches.

Implementation: The Local Government Authority should lead a systematic capacity assessment of island councils to identify specific technical and strategic knowledge gaps related to agricultural

support functions. This should be followed by targeted training programs that build council staff capabilities in agricultural and climate adaptation planning; and economic development strategies relevant to farming communities. Training should focus on practical skills, such as incorporating agricultural considerations into land use plans, designing, and implementing buffer zones that provide both climate protection and agricultural benefits, and developing council-led enterprises such as composting facilities or biodigester systems that generate revenue while addressing farmer needs, amongst others. Mentorship programs should link councils with agricultural experts and successful council models from other locations, facilitating peer-to-peer learning and ongoing technical support. Resource-sharing mechanisms should be established between councils to enable collaborative approaches to common challenges, while clear protocols should define council roles in supporting farmers without duplicating or conflicting with Ministry responsibilities.

Recommendation 7: Reform land leasing structures to support long-term investment

Importance: Short and uncertain land leases are one of the most significant barriers preventing farmers from investing in climate-resilient practices and sustainable intensification. In Thoddoo, in particular, farmers reported leases as short as two years, often without clarity on renewal terms or the legal ability to transfer or sub-lease land. This lack of tenure security discourages investment in medium- to long-term improvements such as compost systems, windbreaks, upgraded irrigation, and post-harvest handling infrastructure—all of which are critical for achieving MGAP compliance and adopting sustainable agricultural practices. These constraints also limit access to finance, as banks and microfinance institutions are hesitant to lend without clear land rights or multi-season production guarantees. Without reform, land tenure insecurity will continue to undermine efforts to scale MGAP and sustainable agricultural practices and reduce the overall resilience and productivity of the sector.

Implementation: The Local Government Authority, in collaboration with Island Councils and the Ministry of National Planning, Housing and Infrastructure, should lead a structured process to reform agricultural lease terms in key farming islands, starting with Thoddoo as a pilot location. This should include a consultative process with farmers, council members, and relevant line ministries to examine current challenges and priorities, followed by a series of policy workshops to adapt existing lease arrangements in line with emerging needs. Revised lease structures should guarantee a minimum 10-year lease term, incorporate clear and automatic renewal clauses tied to performance, and enable the installation of climate-resilient infrastructure such as rainwater harvesting tanks, windbreaks, and composting systems. Lease arrangements should also allow for registered subleasing or cooperative agreements, enabling farmer groups to scale production across multiple plots where appropriate. Where appropriate, fee-based leasing structures for commercial agricultural use could be introduced to promote more efficient land allocation and allow productive farmers to expand. Many farmers have indicated willingness to pay for such arrangements, provided that tenure is secure and tied to clear production rights.

Importantly, reformed leases should include incentives for sustainable land use—for example, offering extended terms or discounted fees to farmers who achieve MGAP certification, maintain soil cover through green manure or mulching, or adopt other approved nature-based solutions. To support implementation, Island Councils should receive capacity building on lease administration,

policy enforcement, and tracking of performance-based conditions, enabling them to play a stronger role in ensuring productive and sustainable land use at the local level.

Recommendation 8: Establish in-country laboratory capacity for agricultural and food safety testing

Importance: The absence of domestic laboratory infrastructure for agricultural and food safety testing poses a serious constraint to both regulatory enforcement and farmer compliance with MGAP. At present, routine testing of soil, water, compost, agricultural produce, pesticide residues, and microbial contaminants must be conducted in foreign laboratories. This results in high costs, long delays, and limited accessibility for both regulators and producers. It also creates a barrier to achieving and maintaining MGAP certification, which requires regular testing of water and soil and verification of produce safety. For MFDA, it undermines their ability to conduct routine inspections and surveillance across the horticulture sector. Without local capacity, the Maldivian agriculture system remains heavily dependent on external systems for quality control, which weakens traceability, limits data availability, and reduces national ownership over food safety systems.

Implementation: MFDA should lead the establishment of a national laboratory facility with the capacity to conduct agricultural and food safety testing, in partnership with the MoAAW and national academic institutions. The facility should be equipped to carry out soil nutrient profiling, water quality analysis (including salinity and microbial load), compost maturity testing, pesticide residue screening, and microbial testing of horticultural products. Equipment procurement and staffing should prioritize modular growth—starting with essential MGAP-required tests and gradually expanding into broader food system monitoring. A formal partnership framework should be established between MFDA and local universities to train lab technicians, conduct joint research, and ensure long-term workforce sustainability. University partners could also help embed testing services into agricultural training programs and extension curricula, increasing farmer awareness and uptake.

FINANCE

Recommendation 9: Expand access to agricultural finance for MGAP and sustainable agriculture

Importance: Access to capital is a major barrier to adoption of MGAP and sustainable agricultural practices in the Maldives. Field research showed that very few farmers are currently using financial services to support on-farm investments. While SDFC offers some agriculture-related products, uptake is extremely limited. Farmers expressed a clear willingness to invest in improved inputs, infrastructure, and practices—such as compost systems, irrigation upgrades, and protective structures—if affordable capital were available. Without proactive engagement strategies, most farmers will remain locked out of the investment cycle needed to improve productivity, meet food safety standards, and transition toward more sustainable, regenerative production systems.

Implementation: The Ministry of Economic Development and the MoAAW, in collaboration with SDFC and other financial service providers, should lead a targeted consultation process to develop a strategy for expanding access to agricultural finance, with a specific focus on supporting MGAP certification and adoption of sustainable practices. This process should be informed by direct engagement with farmers, producer groups, and island councils to better understand demand-side barriers and investment priorities. As part of this process, financial institutions should be encouraged to:

- Design dedicated agricultural loan products that align with seasonal cash flows and common investment needs, such as composting infrastructure, windbreaks, or food-safe harvest and storage containers. Loan products should include flexible repayment terms that reflect the 26-month papaya cycle and allow for partial grace periods.
- Set specific lending targets for agriculture, including performance indicators related to sustainable production and MGAP compliance.
- Expand service delivery models through local agents, mobile finance services, or partnerships with extension providers to increase financial access in agricultural communities.
- Invest in farmer financial literacy and demand generation through simple, practical materials embedded within existing training platforms or delivered via extension services.

Recommendation 10: Expand awareness and adoption of agricultural insurance to reduce climate-related investment risk

Importance: Despite the availability of agricultural insurance products in the Maldives, such as those offered by Allied Insurance, adoption among farmers is extremely limited. This is a major obstacle to enabling medium- to long-term investments in infrastructure, MGAP compliance, and sustainable agriculture. During the assessment, both farmers and insurance providers confirmed that awareness of available products is very low, and there has been no systematic effort to promote crop insurance or explain its relevance to the agricultural sector. Uptake is further suppressed by some policy terms, or premium structures may not be well aligned with the needs or capacities of smallholder producers. This gap is particularly concerning given the high exposure of Maldivian farmers to climate-related risks, especially wind events that cause significant damage to papaya trees and other horticultural crops. Without accessible and well-understood insurance options, farmers are hesitant to invest in the very infrastructure and practices such as windbreaks, irrigation, or composting systems that would increase long-term productivity and resilience.

Implementation: The MoAAW, in partnership with Allied Insurance and other relevant insurance providers, should lead an effort to identify and address barriers to agricultural insurance uptake. An initial rapid diagnostic should determine whether low uptake stems from limited awareness, lack of trust, product design mismatches, or premium affordability. Based on the findings, a suitability analysis should be conducted to assess alternative model such as parametric insurance that may better align with Maldivian production systems and help overcome common verification and claims-processing challenges. This review should also explore ways to integrate insurance into broader risk management packages, including MGAP adoption and climate-smart practice uptake. Based on the

findings, adjustments to coverage terms, payout triggers, or pricing structures may be warranted to better align with farmer needs, particularly for weather-related events. In parallel, a coordinated awareness campaign should be launched in key production areas to introduce farmers to available insurance products and explain their value in reducing risk and enabling investment. In the longer term, MFDA and MoAAW could work with insurers to explore bundling insurance with other support services, such as MGAP audit subsidies or input loans, to simplify access and improve overall risk management across the value chain.

INNOVATION AND DEVELOPMENT

Recommendation 11: Develop value chain–specific pest and disease protocols for papaya

Importance: Pest and disease pressures remain one of the most serious and persistent threats to papaya productivity in the Maldives. During field research, farmers consistently identified issues such as mealybug infestations, yellow crinkle disease, and other pests and diseases as major constraints, often citing total crop loss in certain plots. Current responses tend to be reactive and inconsistent, with farmers relying on anecdotal advice or applying chemical pesticides with limited efficacy and without pre-harvest interval compliance. Compounding the problem, there is no standardized pest and disease management protocol for papaya, and the absence of a coordinated system for early detection and response to emerging threats further compounds the problem. This lack of structured guidance and oversight undermines farmer confidence, increases environmental and health risks from improper pesticide use, and limits the potential to meet MGAP requirements related to safe and responsible pest management. Without targeted, evidence-based strategies that respond to the specific vulnerabilities of the papaya value chain, both productivity and market access will remain constrained.

Implementation: MoAAW, in collaboration with MFDA, research institutions, and private sector partners, should lead the development of comprehensive pest and disease management protocols tailored to the papaya production system. This process should begin with systematic review of the most common and emerging pests and diseases, including research partnerships with regional biocontrol institutions to identify, test, and validate biological control agents effective under Maldivian climatic and production conditions. Based on this review, a national protocol should be developed that outlines integrated pest management strategies, including the establishment of supply chains for biological control agents through either facilitated import mechanisms or exploration of in-country mass-rearing capabilities for priority biocontrol agents. The protocol should be designed for practical use by farmers and extension agents and should include guidance on appropriate pre-harvest intervals and recordkeeping practices in line with MGAP standards. To complement this effort:

- Farmer-facing IPM training modules should be developed and delivered through existing extension mechanisms, with a focus on low-cost and locally feasible practices
- MFDA and MoAAW should strengthen phytosanitary oversight by improving import controls for plant material and expanding monitoring of disease vectors at the farm level

- Genetic material quality control should be reinforced by working with suppliers to ensure that imported seeds and seedlings are disease-free and accompanied by appropriate certification
- A simple early warning system for pest and disease outbreaks should be piloted, potentially using mobile alerts or council-led bulletin boards, to improve response coordination during peak risk periods

Recommendation 12: Implement a comprehensive agricultural data collection and management system

Importance: A major constraint to evidence-based agricultural planning and policy in the Maldives is the near-total absence of reliable, systematically collected data. At present, there is no regular mechanism for tracking agricultural production, land use, adoption of sustainable practices, or input availability. Instead, data is collected sporadically, often through one-off surveys that are not institutionalized or funded on a recurring basis. This lack of structured data collection undermines the ability of MoAAW and Island Councils to allocate resources effectively, identify gaps, or monitor progress toward key objectives such as MGAP adoption, expansion of sustainable agricultural practices, or increased resilience to climate change. Without a more structured and integrated approach to data, agricultural planning will continue to be reactive, anecdotal, and poorly aligned with actual needs.

Implementation: MoAAW, in partnership with the National Bureau of Statistics, Island Councils, and development partners, should take steps to develop a formal, government-led agricultural data collection system. This includes finalizing and funding the planned agricultural surveys, ensuring that they incorporate key production indicators, as well as MGAP and sustainability indicators. In addition, there is a need to establish ongoing data collection mechanisms that allow for seasonal or semiannual updates, particularly at the island level, where changes in land use, pest outbreaks, or weather-related disruptions occur frequently. These efforts should be supported by the development of a digital data management platform that enables entry and access by both national and local stakeholders, and the creation of formal data-sharing protocols between institutions to ensure alignment and avoid duplication.

Investments in this system must also include capacity strengthening for Island Councils and MoAAW field staff to ensure consistent, high-quality data collection and use. A functioning, integrated data system will be critical not only for day-to-day planning but also for long-term agricultural development, climate resilience, and private sector engagement.

Recommendation 13: Catalyze enterprise-driven solutions to address technical and infrastructure gaps in horticultural value chains

Importance: Across papaya and other horticultural systems, farmers face persistent technical and infrastructure challenges that cannot be solved through training or input access alone. These include the absence of localized cold storage, lack of renewable energy options for irrigation and post-harvest handling, unaffordable or unavailable climate-smart agricultural inputs, and weak transportation services to link producers with distant market channels. In many cases, the underlying issue is not just a lack of public investment, but the absence of business models that can deliver these services and products affordably and reliably at the island level. Island Councils, through their

enterprise mandates, are well-positioned to play a catalytic role in piloting and operating solutions—particularly in partnership with private actors and development partners. At the same time, the broader enabling environment must do more to encourage innovative entrepreneurship in this space. There is potential to build a pipeline of commercially viable services that respond directly to farmer and buyer needs while accelerating the adoption of sustainable agriculture practices and technologies.

Implementation: MoAAW, the Local Government Authority, and MoTE should collaborate with the Business Center Corporation (BCC), Island Councils, and development partners to support enterprise-led solutions that address technical and supply-side bottlenecks in horticultural value chains. These solutions may be implemented directly by councils or through private entrepreneurs, cooperatives, or blended models. A targeted support program should include technical assistance, access to concessional finance, and small grants to incubate and pilot island-level services such as:

- Island-wide biodigester systems that transform agricultural waste into renewable energy and organic fertilizer
- Solar-powered irrigation services that reduce input costs and increase resilience to rainfall variability
- Cold storage and packhouse facilities operated as shared services
- Last-mile transport services designed for inter-island delivery to additional end-market channels
- Technical advisory services that help smallholders adopt and maintain MGAP-aligned practices
- Composting and organic input enterprises that produce and sell affordable, high-quality soil amendments locally

TRAINING

Recommendation 14: Strengthen adoption of MGAP and sustainable agricultural practices through targeted farmer support

Importance: Despite clear interest from farmers in improving production methods, adoption of MGAP and sustainable agriculture practices is low. Field research revealed widespread confusion about what MGAP entails, limited understanding of sustainable techniques such as composting or biological pest management, and an absence of structured farmer support systems to promote adoption. This gap is not simply due to resistance or disinterest, rather it reflects deeper issues of unclear guidance, limited access to training, and the lack of a coordinated strategy to equip farmers with the skills, tools, and ongoing support needed to transition their practices. To expand MGAP adoption beyond a few pilot islands or commercial farms, the government must shift from promoting MGAP standards to actively enabling it in practice. That means identifying which practices are most relevant in the Maldivian context—those that align with MGAP standards and enhance productivity—and developing a complete system for training, mentoring, and reinforcing those practices. Further, with 93% of farmers experiencing wind and storm damage, 68% facing pest and disease pressure, and 60% reporting climate-linked productivity challenges, the need for climate-resilient practices is

urgent. MGAP's rollout presents a strategic opportunity to simultaneously build certification capacity and scale climate-smart agricultural practices to address environmental stressors that reduce productivity.

Implementation: MoAAW, in collaboration with MFDA, MoTE, private sector actors, and development partners, should lead a national effort to scale the adoption of prioritized MGAP and sustainable practices through an integrated approach that positions climate-smart agriculture as the preferred pathway for achieving MGAP compliance. This should begin with a technical review to define a core set of recommended practices for papaya and other key crops—such as compost application, rainwater harvesting, organic fertilizer use, integrated pest management, and windbreak establishment—based on their relevance to the Maldivian climate, soils, and farm structures, and their alignment with MGAP certification requirements. The review should explicitly identify how MGAP compliance standards—including soil amendment documentation, water quality management, and pest control protocols—can be met through climate-resilient implementation methods that simultaneously address farmer vulnerabilities and build long-term agricultural resilience.

Once priority practices are identified, MoAAW should develop a comprehensive support strategy that outlines how farmers will be equipped to adopt them. This strategy should consider farmer knowledge, skills, and resource gaps, and be delivered through a combination of in-person training, digital tools, and peer learning. Specific activities include:

- Developing integrated training materials and manuals that demonstrate how sustainable production methods (composting, water conservation, IPM) meet MGAP standards while building climate resilience, ensuring all MGAP extension materials explicitly address climate adaptation co-benefits of required practices
- Training extension agents and MFDA auditors to promote climate-smart approaches as preferred pathways for achieving MGAP compliance, ensuring consistent messaging across the certification and extension systems
- Retraining existing extension agents and hiring new staff where needed to ensure coverage across production islands
- Expanding use of MoAAW's farmer-facing mobile application (Dhanduveriya) to include guidance on MGAP-compliant practices, training modules on climate-smart agriculture, and visual walkthroughs demonstrating integrated approaches
- Establishing demonstration plots on both public and private land that showcase MGAP-certified farms implementing sustainable practices, providing proof-of-concept for integrated approaches and practical application of priority practices in real farm conditions
- Piloting farmer-to-farmer learning networks that connect experienced growers with those in earlier stages of adoption, emphasizing how certified farmers manage both MGAP requirements and climate risks through sustainable practices

Recommendation 15: Implement comprehensive MGAP awareness campaign

Importance: The research reveals critically low awareness of MGAP across the entire papaya value chain, with only 11.7% of farmers having heard of the certification scheme and minimal understanding among buyers, wholesalers, and other market actors about its benefits and requirements. This widespread awareness gap undermines the entire certification system, as farmers cannot pursue certification they don't understand, while buyers cannot recognize or value certified products. Without comprehensive awareness building, MGAP risks being a technical exercise confined to pilot projects rather than a market-driven transformation tool. The absence of stakeholder understanding also perpetuates current market dynamics where quality and safety attributes receive no price premiums, removing economic incentives for farmer adoption. Furthermore, the lack of awareness extends beyond technical requirements to broader understanding of food safety responsibilities, with farmers and value chain actors operating without clear knowledge of contamination risks, proper handling protocols, or their roles in ensuring safe food production. This knowledge vacuum prevents the development of quality-conscious market relationships essential for premium positioning of Maldivian horticultural products.

Implementation: MFDA should lead a multi-stakeholder awareness initiative targeting all value chain actors with tailored messaging about MGAP benefits, requirements, and implementation support. For farmers, this requires developing accessible materials that explain certification benefits in economic terms, demonstrate practical compliance approaches, and address common misconceptions about complexity and cost. End-buyer education should focus on quality differentiation benefits, food safety assurance, and premium positioning opportunities for certified products. Consumer awareness campaigns should highlight the value of locally produced, certified horticultural products to create market pull for MGAP-certified produce. The campaign should utilize multiple communication channels including digital platforms, island-level workshops, peer-to-peer demonstrations, and integration with existing extension activities. Private sector actors, particularly input suppliers and wholesalers, should be engaged as awareness ambassadors who can reinforce MGAP messaging through their regular farmer interactions. Tourism sector engagement should emphasize how MGAP certification aligns with sustainability commitments and guest expectations for safe, locally sourced foods. The initiative must move beyond simple information dissemination to empower farmer responsibility and engagement in supplying safe, sustainable foods by building understanding of food safety risks, proper handling practices, and the economic benefits of quality assurance. Success requires coordinated messaging across MoAAW, MFDA, and private sector partners to ensure consistent communication and avoid conflicting information that could undermine farmer confidence in certification benefits.

Recommendation 16: Enhance availability and affordability of quality inputs

Importance: Input access represents a fundamental constraint limiting both current productivity and farmers' ability to transition to MGAP-certified sustainable production systems. The research reveals that farmers face frequent stockouts of essential inputs, with some fertilizers unavailable for 1-3 months in Laamu, disrupting production schedules and forcing farmers to adjust their cultivation practices. High input costs and concerns about quality emerged as significant issues affecting crop outcomes, with 57% of farmers citing input expenses as a major constraint. Input suppliers confirmed these challenges, noting competition from "unregulated markets and poor-quality products" that

undermine both farmers' success and legitimate business operations. For sustainable agriculture transition, these concerns become even more relevant, as organic fertilizers and climate-smart inputs are often more expensive, making them inaccessible to smallholder farmers. The cost analysis reveals that organic fertilizers alone cost 66,000 MVR per crop cycle, making them the single largest barrier to sustainable practice adoption. Without addressing input availability and affordability constraints, farmers will remain locked into conventional production systems regardless of their interest in certification or sustainable practices.

Implementation: MoAAW should lead a comprehensive strategy to improve input accessibility through multiple coordinated approaches, working with the Ministry of Economic Development, private sector actors, and development agencies. Key interventions to consider include:

- Investigating private sector distribution models and developing public-private partnerships that can improve supply chain efficiency while reducing costs for farmers
- Exploring economic zone integration opportunities to leverage regional supply chains and reduce import costs for agricultural inputs
- Implementing targeted subsidy schemes specifically for organic and climate-smart inputs to bridge the affordability gap that prevents sustainable practice adoption, and potentially leverage the Green Tax scheme
- Developing input financing schemes that allow farmers to access essential inputs on credit terms aligned with agricultural cash flows, particularly for expensive organic fertilizers and soil amendments required for sustainable production

AGGREGATION AND DISTRIBUTION

Recommendation 17: Develop cold storage infrastructure with renewable energy integration

Importance: The absence of adequate cold storage capacity is a critical bottleneck limiting product quality, shelf life, and market access across the papaya value chain. Transportation from remote production areas like Laamu requires 24-36 hours to reach Malé markets, during which time papaya quality deteriorates due to lack of proper cold chain management. Field observations revealed that vessels typically feature open deck configurations with minimal protection from the elements, leading to quality losses that undermine farmer income and buyer satisfaction. The research demonstrates that these post-harvest challenges particularly affect farmers in remote atolls, who face both longer transportation times and higher spoilage rates. This reduces their competitiveness relative to imports and producers closer to markets. AgroNat previously operated cold storage infrastructure, including plans for refrigerated vessel transport, but these facilities became non-operational when AgroNat was discontinued in December 2024. Without systematic cold storage development, farmers will continue to face significant post-harvest losses that undermine the economic viability of quality investments, while buyers will lack access to consistently high-quality local products that could compete with imports and justify premium pricing for MGAP-certified produce.

Implementation: MoAAW and MoTE should lead a strategic approach to developing comprehensive cold storage infrastructure that integrates renewable energy systems to ensure sustainability and cost-effectiveness. Key implementation options to consider include:

- Revitalizing and expanding the existing AgroNat cold storage facility in Laamu, which is currently small-scale, as a pilot for demonstrating integrated renewable energy-powered systems and establishing operational protocols for multi-island service delivery
- Constructing expanded renewable energy-powered cold storage units strategically located across major production regions to minimize transport distances and maximize quality preservation
- Establishing a coordinated storage network that enables efficient product aggregation and distribution, while maintaining cold chain integrity from farm to end-market delivery
- Developing public-private partnerships for infrastructure development and operation that leverage private sector efficiency while ensuring affordable access for smallholder farmers and sustainable long-term management

Recommendation 18: Enhance inter-island transportation reliability and frequency

Importance: Irregular and expensive transportation represents one of the most significant structural barriers constraining papaya value chain development, with farmers in Laamu reporting vessel arrivals only twice per month compared to the twice-weekly service that MTCC is supposed to provide. These transportation constraints create multiple problems that undermine both farmers' income and market development. Irregular scheduling forces farmers to harvest according to vessel availability rather than optimal ripeness, compromising product quality and reducing shelf life. Extended journey times of 24-36 hours from outer atolls without adequate cold storage result in significant post-harvest losses that erode farmer profitability. The research reveals that vessel operators treat agricultural products as secondary cargo, loading them opportunistically during return journeys rather than providing dedicated service. Without reliable, frequent, and affordable transportation, farmers remain unable to access consistent market opportunities, while buyers cannot depend on steady supply flows necessary for developing premium market relationships based on quality and certification.

Implementation: MoAAW should lead coordination with MTCC and private transport operators to develop systematic improvements to agricultural transportation services. The Ministry has already identified the need to engage MTCC regarding operational challenges, providing a foundation for structured dialogue. Key implementation approaches include:

- Investigating mechanisms to improve transportation frequency and reduce costs through schedule optimization, route coordination, and service agreements that prioritize agricultural cargo during specific seasons
- Developing dedicated agricultural transport services, potentially including specialized vessels or cargo compartments designed for horticultural products with appropriate handling and storage capabilities
- Creating subsidized transport schemes for agricultural products that reduce farmer costs while ensuring viable operations for transport providers

- Establishing transportation scheduling coordination mechanisms that provide farmers with predictable service availability and enable better production planning aligned with market demand

Recommendation 19: Establish intra-atoll distribution networks

Importance: The current distribution system's over-centralization through Malé creates significant inefficiencies and missed opportunities for serving consumers in nearby atolls and regions. The research reveals that products often travel circuitous routes through Malé even when production and consumption occur within the same atoll or neighboring regions, unnecessarily increasing transportation costs, delivery times, and quality deterioration. This centralized model forces farmers to compete in distant markets while nearby consumers purchase imports, creating a paradox where locally produced papaya may be unavailable on islands just hours away from production areas. The hub-and-spoke distribution pattern concentrates market power in Malé-based intermediaries while limiting direct trade relationships that could benefit both producers and consumers in regional markets. For tourism development particularly, guesthouses and smaller accommodation providers in outer atolls lack access to nearby agricultural production, forcing them to source through expensive Malé-based supply chains or rely entirely on imports. The country cannot reduce its dependence on imports and strengthen regional food systems without decentralized distribution networks.

Implementation: National-level authorities should coordinate with regional councils, island councils, private sector actors, and relevant line ministries to develop systematic approaches for decentralizing agricultural distribution. This requires high-level policy coordination to align with broader decentralization objectives and regional development strategies. Key implementation approaches include:

- Developing zone-based distribution systems (north, central, south) that enable direct trade relationships between production and consumption areas within regional clusters
- Establishing regional market hubs with appropriate infrastructure and coordination mechanisms to serve multiple islands within geographic regions
- Implementing inter-island marketing coordination systems that facilitate direct producer-buyer relationships and reduce dependence on Malé-based intermediaries
- Creating policy frameworks and institutional arrangements that support decentralized trade while maintaining food safety and quality standards across regional network.

MARKETING AND MARKET ACCESS

Recommendation 20: Strengthen farmer bargaining power and market positioning

Importance: The research reveals that farmers operate as price-takers with severely limited market influence, creating fundamental imbalances that undermine agricultural profitability and development potential. With 96% of farmers selling exclusively to middlemen and traders, producers have minimal direct relationships with end-markets and lack visibility into demand patterns, quality requirements, or pricing opportunities. This concentration of market relationships in the hands of Malé-based

intermediaries limits farmers' ability to negotiate prices, access information about buyer preferences, or capture value from quality improvements and certification investments. The price disparities observed between regions—with Laamu farmers receiving 90% higher prices than Thoddoo farmers despite geographic disadvantages—suggest that market access patterns rather than production efficiency determine farmer income. Without strengthened bargaining power, farmers cannot justify investments in MGAP certification or sustainable practices, as they are unable to communicate quality attributes or secure premium pricing from buyers who value these characteristics. The absence of farmer collective action and direct market relationships perpetuates a low-equilibrium system where neither producers nor buyers have incentives to invest in quality improvements or long-term supply relationships.

Implementation: MoAAW should establish comprehensive market facilitation systems that enhance farmer marketing capabilities and create direct linkages with end-markets. This requires both institutional development and targeted intervention programming. Key approaches include:

- Establishing a market facilitation unit within MoAAW, modeled on successful approaches used under the fisheries ministry, to provide ongoing support for farmer marketing and buyer relationship development
- Implementing a targeted market facilitation project that creates structured opportunities for business-to-business connections between farmers and end-markets through organized buyer-seller meetings, trade fairs, and procurement events
- Providing contract negotiation support and training that enables farmers to engage directly with buyers on pricing, quality specifications, and delivery arrangements
- Reinstating AgroNat's farmer aggregation and marketing functions to provide institutional support for collective marketing and supply coordination
- Developing farmer collective marketing initiatives that enable producers to aggregate supply, share transportation costs, and present unified quality standards to potential buyers

Recommendation 21: Establish quality-based pricing mechanisms

Importance: The absence of price premiums for quality and MGAP-certified production results in a fundamental market failure that eliminates economic incentives for farmer investment in improved practices. The research reveals that only 8.3% of farmers report buyers ever inquiring about farming methods, while current market systems provide no mechanisms for differentiating or communicating quality attributes to end-buyers. This creates a low-quality equilibrium where farmers have no financial incentive to invest in certification or sustainable practices, as improved production methods generate no additional revenue. Despite buyer interviews indicating willingness to pay 15%+ premiums for certified products, the centralized intermediary system cannot communicate quality attributes or maintain traceability necessary for premium pricing. Farmers consistently expect that MGAP certification should lead to higher prices (85% cite this as primary motivation), but current market structures provide no pathway for capturing these premiums. Without quality-based pricing mechanisms, investments in MGAP certification (20,040 MVR per farm) and sustainable practices (58,937 MVR per cycle) cannot be economically justified, preventing the sector transformation envisioned in national climate and agricultural strategies.

Implementation: MFDA and MoAAW should lead to coordinated efforts to create market mechanisms that reward quality and certification investments through systematic premium pricing systems. The Tourism Ministry should facilitate engagement with resort and hospitality buyers who represent the most promising premium market segments. Key approaches include:

- Identifying and cultivating relationships with early-adopter premium buyers who have demonstrated willingness to pay for certified products and can serve as market development anchors
- Developing market disruption strategies that enable certified producers to bypass current centralized intermediary systems and access direct buyer relationships that value quality attributes
- Creating quality differentiation and certification marketing systems that enable buyers to identify, verify, and promote MGAP-certified products to their customers and stakeholders
- Piloting and providing facilitation support for direct farmer-resort linkage programs that demonstrate viable models for premium pricing relationships and can be scaled across the tourism sector

Actionable Roadmap

The successful transformation of the Maldivian papaya sector toward sustainable, MGAP-certified production requires a sequenced approach that recognizes the interdependencies between recommendations while accommodating the practical constraints of implementation capacity and resource availability. This roadmap presents a phased implementation strategy spanning five years, organized around critical path dependencies and strategic priorities. The implementation phases are designed to create momentum through early wins while building the institutional and technical foundation necessary for systemic transformation of the papaya value chain.

Table 45: Actionable Roadmap

Recommendation	Phase 1 (Months 1-12)	Phase 2 (Months 13-24)	Phase 3 (Months 25-36)	Phase 4 (Months 37-48)	Phase 5 (Months 49-60)
STRATEGY					
1. Development of a horticulture master plan for MGAP certified, sustainably produced horticultural products in the Maldives 2. Develop a private sector engagement strategy with concrete commitments for horticultural value chain transformation					
GOVERNANCE					
3. Develop and enforce a national policy on quality assurance for agricultural inputs 4. Contextualize MGAP standards for Maldivian papaya farming conditions					

5. Strengthen institutional coordination and farmer feedback mechanisms					
6. Strengthen island council capacity to strategize, support farmers, and coordinate adaptation interventions					
7. Reform land leasing structures to support long-term investment					
8. Establish in-country laboratory capacity for agricultural and food safety testing					
FINANCING					
9. Enhance access to agricultural finance, insurance products, and strengthen sector capacity and outreach					
10. Expand crop insurance awareness and coverage					
INNOVATION & DEVELOPMENT					
11. Develop value-chain specific pest and disease protocols					
12. Implement comprehensive agricultural data collection system					
13. Strengthen island council capacity to implement targeted technical solutions as enterprises					
TRAINING					
14. Strengthen adoption of MGAP and NbS and CSA practices					
15. Implement comprehensive MGAP awareness campaign					
INPUT QUALITY AND ACCESS					
16. Enhance availability and affordability of quality inputs					
AGGREGATION AND DISTRIBUTION					
17. Develop cold storage infrastructure with renewable energy integration					
18. Enhance inter-island transportation reliability and frequency					
19. Establish intra-atoll distribution networks					
MARKETING AND MARKET ACCESS					
20. Strengthen farmer bargaining power and market positioning					
21. Establish quality-based pricing mechanisms					

Financing Framework for Implementation

The successful implementation of these 21 recommendations requires a coordinated financing strategy that leverages multiple funding sources and mechanisms. While a comprehensive costing exercise is beyond the scope of this assessment, the Government of Maldives can pursue several complementary financing pathways to support the transition toward sustainable, MGAP-certified papaya production.

Multi-Source Financing Architecture

The financing requirements for transforming the papaya value chain span from immediate operational needs (such as training programs and policy development) to substantial capital investments (including cold storage infrastructure and research facilities). This diversity of needs necessitates a blended finance approach that combines public resources, international development finance, and private sector investment.

Public Sector Financing Mechanisms

Budget Allocation and Sectoral Prioritization: The foundation for implementation lies in adequate budget allocation to relevant line ministries, particularly the MoAAW, MoTE, Climate Change and Technology, and island councils. These allocations should reflect the strategic importance of agricultural transformation within national climate adaptation and food security objectives.

Climate Finance Mobilization: The tourism sector's Green Tax generated MVR 980 million in 2023, representing a substantial domestic climate finance resource. Given that agriculture is directly affected by climate change and contributes to both adaptation and mitigation objectives, a portion of Green Tax revenue could legitimately support the transition to sustainable agricultural practices. Establishing clear criteria for Green Tax allocation to agricultural climate adaptation would provide a dedicated domestic funding stream for MGAP implementation, infrastructure development, and farmer support programs.

Sovereign Green Bonds: The Maldives could explore issuing sovereign green bonds specifically targeted at sustainable agriculture and climate adaptation, providing access to international capital markets while demonstrating commitment to green development pathways.

International Development Finance

The Government of Maldives has established relationships with multiple development partners that could support comprehensive papaya value chain transformation:

- **Green Climate Fund (GCF)**: as the world's largest dedicated climate fund with over $70 million in existing Maldives projects, GCF has specific mandates for small island developing states and routinely channels grants to vulnerable communities through agencies like UNEP and UNDP for climate adaptation and agricultural resilience measures
- **Asian Development Bank (ADB)**: a leading regional multilateral development bank that approved a $21.95 million package in November 2024 for the Enhancing Climate Resilience and Food Security Project, focusing on early warning systems, flood protection, mangrove restoration, and climate-smart farming, making it a natural partner for expanded agricultural climate strategies

- **International Fund for Agricultural Development (IFAD)**: specializing in rural agriculture and resilience with extensive experience in climate-smart agriculture projects across Asia-Pacific, IFAD could support inclusive value chain transformation
- **Global Environment Facility (GEF)**: GEF finances adaptation and nature-based solutions via UN agencies and multilateral development banks, with FAO's recent GEF-backed programs including Maldives as a partner in climate-resilient food systems and regional ocean health initiatives
- **Asian Infrastructure Investment Bank (AIIB)**: with 67% of its $8.4 billion in 2024 financing directed toward climate-related projects and recent support for Maldives fiscal management and solar energy systems, AIIB could fund larger adaptation and agricultural technology projects under its green infrastructure mandate
- **Islamic Development Bank (IsDB)**: as a member of Maldives' constituency, IsDB approved a proposal in February 2024 to strengthen Maldives' access to climate finance and routinely finances water supply, sanitation, and agriculture in member countries with focus on sustainable development
- **Bilateral Development Partners**: including Japan through JICA (which signed a $11.6 million grant in September 2025 for coastal resilience infrastructure); Germany through KfW and GIZ (with recent GCF readiness grants for water sector planning and Climate Smart Resilient Island initiatives); and the United Kingdom through FCDO's CLARE programme (£110 million supporting climate resilience research in 38 countries including Maldives)
- **European Union**: supporting Maldives through climate grants including a €4 million GCCA+ project in Addu Atoll for ecotourism, waste management, and ecosystem protection, with broader Global Gateway and EU Climate Diplomacy efforts targeting blue economy and green infrastructure in the Indian Ocean region
- **United Nations agencies**: including FAO (Food and Agriculture Organization) for technical assistance and capacity building; UNDP (United Nations Development Programme) for governance systems and private sector engagement; UNEP (United Nations Environment Programme) for ecosystem-based adaptation; and UNCTAD (United Nations Conference on Trade and Development) for trade facilitation and market access support

Private Sector and Innovative Financing

Agricultural Investment Capital: Several recommendations, particularly those related to production expansion and value addition, present bankable investment opportunities. Private investors, including climate-focused impact funds, may find opportunities in sustainable agriculture ventures that demonstrate both financial returns and climate impact.

Financial Service Provider Innovation: SDFC's existing agricultural loan programme provides a foundation for expanding access to credit for sustainable agriculture investments. Additional financial service providers could develop specialized products for MGAP certification costs, equipment financing, and working capital for certified producers.

Resort Sector Partnerships: The tourism industry's expressed interest in local sourcing creates opportunities for public-private partnerships where resorts co-invest in supply chain development, potentially through advance purchase agreements, infrastructure cost-sharing, or technical assistance provision.

Blended Finance Mechanisms: Combining concessional public finance with private investment can reduce risk and improve the financial viability of agricultural investments. This approach is particularly relevant for infrastructure development and producer organization strengthening.

Implementation Sequencing and Financing Priorities

The Government of Maldives should prioritize recommendations with the highest impact-to-cost ratios while building foundations for more capital-intensive interventions. Policy development, institutional coordination, and training programs typically require lower upfront investment but create enabling conditions for subsequent infrastructure and production investments. Immediate priorities should focus on securing funding for governance frameworks, baseline establishment, and pilot demonstrations that can attract additional investment. Medium-term financing should target infrastructure development and scaling successful pilot initiatives. Long-term investment should support comprehensive value chain transformation and market development. The diversity of financing mechanisms available reflects both the complexity of the transformation required and the multiple pathways available for implementation. Success will depend on the Government of Maldives' ability to coordinate these various funding sources while maintaining strategic coherence across the papaya value chain development agenda.

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