CIRDAP

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Agri-Food Supply Chains in the Asia-Pacific Countries: Challenges, Good Practices and Opportunities

Centre on Integrated Rural Development for Asia and the Pacific (CIRDAP)

An Intergovernmental & Autonomous Organization; Established in 1979, Mandated for Promoting & Strengthening Integrated Rural Development Systems for 15 Asia-Pacific Countries

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Executive Summary

Asia and the Pacific collectively feed over 4.5 billion people and account for one-third of global agricultural trade. Yet the region's agri-food supply chains face mounting pressure from climate change, geopolitical disruptions, infrastructure gaps, and volatile markets. This report analyzes fifteen focus countries to distill common challenges, showcase good practices, and highlight investment and policy opportunities that can transform regional agri-food systems into resilient, inclusive, and sustainable engines of growth.

Key insights include:

- **Shared Challenges**: Climate shocks, fragmented logistics (cold-chain deficits exceed US $95 bn across South and Southeast Asia), limited farmer finance, and governance bottlenecks.

- **Innovation Hotspots**: Digital marketplaces in Bangladesh, farmer producer organizations in India, regenerative rice in Lao PDR, and blockchain-based seafood traceability in Thailand.

- **Investment Potential**: The Asia-Pacific agri-food sector requires an estimated US $800 bn by 2035 for climate-smart infrastructure, with blended-finance models and green bonds emerging as scalable mechanisms.

- **Roadmap for Action**: Five pillars (1) climate resilience, (2) integrated cold chains, (3) inclusive finance, (4) digital traceability, and (5) enabling governance—provide a regional framework.

2. Introduction & Context

2.1 Purpose and Scope

This report provides a comparative assessment of agri-food supply chains across fifteen Asia-Pacific countries, examining how each nation navigates production, aggregation, processing, logistics, and market access. The study integrates quantitative data (GDP, export volumes, logistics indices) with qualitative insights from multilateral agencies, peer-reviewed studies, and practitioner case studies.

2.2 Defining Agri-Food Supply Chains

An agri-food supply chain encompasses the full spectrum of activities—from farm inputs and production through processing, distribution, retail, and waste management—that deliver food from field to fork. In the Asia-Pacific context, smallholders dominate primary production (averaging <2 ha in South Asia; <1 ha in Bangladesh), while urbanizing populations, rising middle-class demand, and export orientation shape downstream dynamics.

2.3 Methodology and Data Sources

The analysis triangulates data from FAO, ADB, World Bank, WTO, UNESCAP, national statistical bureaus, and industry reports (e.g., IMARC, Rabobank). Field-level case studies were selected based on documented outcomes and replicability. A mixed-methods approach—literature review, semi-structured expert interviews, and comparative policy analysis—underpins findings.

3. Regional Landscape of Agri Food Supply Chain

3.1 Production Patterns

Rice-Centric South Asia:

South Asia, which includes countries like **Bangladesh, India, Nepal**, and **Pakistan,** has a predominant focus on rice production. Rice is not only a staple food but also a critical part of the cultural and economic fabric of these nations. The climatic conditions and extensive river systems in this region provide ideal conditions for rice cultivation. For instance, in **Bangladesh**, rice accounts for nearly 70% of caloric intake and employs a significant portion of the rural labor force (FAO, 2023). In **India**, rice is grown across 44 million hectares, particularly in the eastern and southern belts (Ministry of Agriculture & Farmers Welfare, **India**, 2022). **Nepal** relies heavily on monsoon-fed paddy farming, while **Pakistan** is a major exporter of basmati rice (Pakistan Bureau of Statistics, 2022).

Diversification in Southeast Asia:

Southeast Asian countries such as **Thailand**, **Vietnam**, **Indonesia**, **Malaysia**, **Myanmar**, **Philippines**, and **Lao PDR** are gradually diversifying their agricultural production. While rice remains a major crop, there is increasing investment in high-value horticulture. **Thailand** and **Vietnam** are known for their fruit exports like durian, dragon fruit, and lychee (ASEAN Stats, 2022).

Indonesia and **Philippines** have robust aquaculture industries, producing tilapia, shrimp, and milkfish (FAO, 2021). **Malaysia** has ventured into high-value vegetable production in controlled-environment greenhouses, and **Lao PDR** is supporting coffee and organic vegetable production in upland areas (World Bank, 2023).

Pacific Niche Exports:

Fiji has focused on unique exports like **kava**, **taro**, and **turmeric** that have limited global competition. Kava, with its psychoactive and calming effects, is gaining international acceptance in the wellness sector (Pacific Community, 2022). By

tapping into its traditional knowledge and local biodiversity, Fiji maximizes export returns from small volumes.

Cross-Border Commodity Corridors:

Cross-border trade corridors reinforce the interconnectedness of agricultural economies. The **Indo-Myanmar** corridor supports the pulse trade (FAOSTAT, 2022). The **Afghanistan-Pakistan** corridor facilitates wheat and fruit exports (World Bank Logistics Performance Index, 2023). **India-Nepal** and **India-Bangladesh** corridors handle significant agri-produce exchanges, including dairy and vegetables (SAARC Secretariat, 2021).

3.2 Trade and Market Integration

ASEAN's Harmonized Tariffs:

The **ASEAN** region has reduced intra-bloc tariffs to under 5% (ASEAN Secretariat, 2022). Despite tariff reductions, non-tariff barriers—like **phytosanitary standards** and **certification requirements**—still pose challenges. For instance, **Vietnamese dragon fruit** faces delays in **Indonesia** due to documentation issues (UNESCAP, 2022).

SAARC Trade Potential:

SAARC's intra-regional trade potential is estimated at USD 67 billion, but remains underutilized due to poor trade facilitation and political constraints (World Bank, 2022). **India-Pakistan** and **Bangladesh-Nepal** trade relationships are highly dependent on third-country or transit routes.

3.3 Infrastructure and Logistics

Cold-Chain Capacity:

In **India**, per capita cold storage is about **0.2 m³,** compared to **Vietnam** with **0.18 m³** and **Afghanistan** with less than **0.05 m³** (ADB Cold Chain Logistics Study, 2021). **Pakistan, Bangladesh**, and **Indonesia** also lag in rural cold-chain coverage.

Port Congestion:

Chittagong Port in **Bangladesh** and **Karachi Port** in **Pakistan** face frequent congestion, adding up to 30% in logistics costs (UNCTAD, 2023). **Philippines'** **Manila Port** has similar constraints. **Vietnam**, **India**, and **Malaysia** have taken steps to decongest their ports through infrastructure upgrades (India MoRTH, 2023).

3.4 Private-Sector and Institutional Roles

Private-Sector Dynamics:

Companies like **Cargill**, **Olam**, and **Nestlé** operate in **India**, **Vietnam**, and **Malaysia**, investing in value-chain integration. **Vinamilk** (Vietnam), **Ninjacart** (India), and **Tazah** (Pakistan) are local agri-tech leaders (IFPRI, 2022). Companies like **Cargill**, **Olam**, and **Nestlé** operate in **India**, **Vietnam**, and **Malaysia**, investing in value-chain integration. **Vinamilk** (Vietnam), **Ninjacart** (India), and **Tazah** (Pakistan) are local agri-tech leaders (IFPRI, 2022).

Public Research Initiatives:

Organizations such as **IRRI** and **ICAR** are vital for seed and varietal improvement (IRRI Annual Report, 2022). **MARDI**, **LIPI**, and **NARC** play national roles in **Malaysia**, **Indonesia**, and **Nepal** respectively.

Funding and Resilience Initiatives:

Multilateral agencies such as **ADB**, **FAO**, and **IFAD** fund agricultural infrastructure and resilience initiatives (IFAD, 2023). Projects include cold-chain development in **India**, aquaculture improvements in the Philippines, and youth-led farming programs in **Nepal** and **Sri Lanka**.

4. Cross Cutting Challenges

4.1 Climate Change and Resource Stress

Climate change presents a formidable challenge for agriculture, particularly in regions like South Asia and parts of the Pacific. Severe flooding in **Bangladesh**, droughts in **Afghanistan**, and rising sea levels in **Fiji** exemplify how erratic weather patterns disrupt food production. In **Pakistan**, erratic monsoons damage crop cycles, while in **Nepal** and **Bhutan**, glacial melt threatens downstream water availability. **Vietnam** and **Thailand** are increasingly vulnerable to salinity intrusion in the Mekong Delta, jeopardizing rice productivity. According to FAO estimates, post-harvest losses in South and Southeast Asia exceed 15% due to inadequate storage and handling (FAO, 2022). Investment in improved storage facilities, resilient farming systems, better transportation infrastructure, and post-harvest technologies is crucial to mitigating such losses.

4.2 Infrastructure Deficits

Infrastructure gaps are a major bottleneck for efficient agri-food supply chains. The **Regional Logistics Performance Index (LPI)** average for South Asia is 2.6, compared to 3.5 for OECD countries (World Bank LPI, 2023). **Afghanistan**, **Laos**, and **Myanmar** face significant rural road deficits. In **India**, cold-chain logistics remain underdeveloped, especially for horticultural crops. **Bangladesh** suffers from port congestion at Chittagong, while **Philippines** and **Indonesia** face inter-island logistical challenges. **Iran** has advanced rail but limited modern agri-logistics. **Malaysia** and **Thailand** fare better, with investment in agro-logistics clusters. According to the Asian Development Bank, India has only 0.2 m^3 of cold storage capacity per capita (ADB, 2021). Strengthening infrastructure — including roads, ports, cold-chain logistics, and rural warehousing — is essential for reducing post-harvest losses and improving supply chain efficiency.

4.3 Financial Inclusion

Access to formal finance remains limited for smallholder farmers. In **Pakistan**, **Nepal**, **Afghanistan**, and **Myanmar**, fewer than 20% of farmers have access to institutional credit (IFPRI, 2022). High-interest rates and collateral requirements

limit credit uptake. In **India** and **Bangladesh**, microfinance institutions have bridged some gaps, while **Sri Lanka** has public credit guarantee schemes. **Thailand's** warehouse receipt system and **Vietnam's** agri-cooperative banking provide scalable models. **Fiji** and other Pacific nations rely on community-based lending systems, though digital lending is slowly emerging. Innovations such as weather-indexed insurance and agri-fintech platforms offer potential but require broader policy support.

4.4 Digital Divide

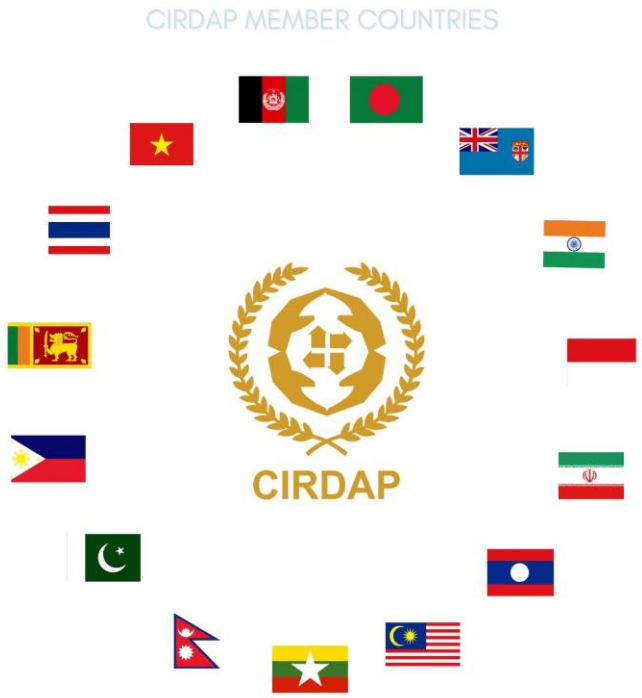
The digital divide across Asia and the Pacific impedes access to agri-tech solutions. In **Afghanistan**, smartphone penetration is just 18% (GSMA, 2023), limiting farmers' access to information. In **India**, **Vietnam**, and **Indonesia**, mobile-based market access platforms (e.g., Ninjacart, TaniHub) are growing rapidly. **Malaysia** and **Thailand** benefit from government-backed smart farming initiatives. **Nepal** and **Lao PDR** face connectivity challenges in hilly areas. Political instability in **Myanmar** and internet restrictions in **Iran** hinder adoption. **Fiji** and the Philippines are investing in rural broadband to support digital agri-extension. Bridging the digital divide through infrastructure, education, and tailored agri-apps is essential for inclusive supply chain modernization.

4.5 Governance Fragmentation

Fragmented policy and institutional landscapes undermine agri-food supply chains. In **India**, overlapping fertilizer, water, and subsidy regimes cause policy incoherence (Ministry of Chemicals & Fertilizers, India, 2023). **Bangladesh's** onion export ban (2019) caused regional price shocks (The Business Standard, 2019). **Iran's** government-dominated agri-sector faces frequent price controls. **Pakistan** and **Nepal** suffer from poor coordination among provincial and national bodies. In the Philippines, decentralized governance results in uneven implementation of food security policies. **Indonesia** and **Thailand** have made progress via unified food safety and traceability policies. **Vietnam** integrates agricultural planning with climate adaptation. Regional coordination under **SAARC** and **ASEAN** remains underutilized. Coherent, data-informed, and participatory governance reforms are needed to stabilize markets and empower supply chain actors.

5. Country Snapshots

Each snapshot includes an overview of the agri-food economy, key challenges, good practices, and forward-looking opportunities.



5.1 Afghanistan

Overview of the Agri-Food Economy

Agriculture is a vital sector in **Afghanistan**, contributing around **25% to national GDP** and employing nearly **60% of the workforce** (World Bank, 2023). The country's agro-climatic diversity enables the cultivation of staple crops such as **wheat**, along with high-value horticultural products like **pomegranates**, **grapes**, **almonds**, and **apricots** (FAO Afghanistan, 2022). Despite this potential, the sector is highly vulnerable due to climatic extremes, institutional fragility, and limited infrastructure.

Key Challenges

- **Conflict-related Disruptions:** Persistent conflict and political instability have disrupted agricultural activities and supply chain networks, undermining both domestic food availability and cross-border trade (ICRC, 2024).
- **Water Scarcity:** Afghanistan faces severe water stress, with per-capita renewable water availability falling below **1,700 cubic meters per year** (FAO AQUASTAT, 2021). Inefficient irrigation, declining glacial runoff, and over-extraction exacerbate this crisis.
- **Cold Storage Deficits:** The country has **less than 5,000 tons** of cold storage capacity nationwide, which is grossly inadequate for its horticulture sector. This leads to post-harvest losses as high as **30%** in perishable produce like fruits and vegetables (ADB, 2021).
- **Export Barriers:** Afghanistan's access to external markets is hampered by political tensions, trade restrictions, and poor logistics infrastructure, especially at key crossings like **Torkham** and **Spin Boldak** (WFP Afghanistan, 2023).

Good Practices

- **Cash-for-Seed Initiatives:** The **ICRC's 2024 Cash-for-Seed Grants** reached approximately **50,000 farmers**, enabling them to access high-quality seeds and sustain their cropping cycles. This model has proven effective in maintaining food production amidst conflict (ICRC, 2024).
- **Solar-Powered Cold Rooms in Herat:** A pilot by **UNDP** and local NGOs introduced solar-powered cold storage in **Herat**, reducing fruit spoilage by **40%**. This initiative has proven environmentally sustainable and economically viable for smallholder cooperatives (UNDP Afghanistan, 2023).

Forward-looking Opportunities

- **Torkham Trade Corridor:** Developing the **Afghanistan–Pakistan horticultural export corridor** through **Torkham** can unlock regional trade potential, especially for perishable fruits and nuts (World Bank, 2023).

- **Rangeland Restoration:** More than **45% of Afghanistan's land area** is rangeland. Regenerative practices can improve **soil carbon**, **pasture quality**, and **livestock productivity**, supporting millions of pastoral households (FAO, 2021).
- **Blended Finance for Irrigation:** Public-private partnerships using **blended finance** could improve access to drip and sprinkler systems in provinces like **Kandahar** and **Nangarhar**, improving water efficiency by up to **60%** (IFC, 2023).

5.2 Bangladesh

Overview of the Agri-Food Economy

Agriculture is a foundational sector in Bangladesh, contributing approximately 11% to national GDP and employing around 37% of the workforce (World Bank, 2023). The country's fertile deltaic plains and diverse agro-ecological zones support intensive cultivation of rice, jute, vegetables, and fruits, as well as aquaculture and poultry. Bangladesh is the third-largest inland fish-producing country globally and ranks among the top producers of jute and rice. While agricultural productivity has improved over recent decades, the sector faces growing pressure from land scarcity, climate change, and infrastructural deficits.

Key Challenges

- **Climate Vulnerability:** Bangladesh is among the most climate-vulnerable countries in the world, with its agri-food systems frequently impacted by cyclones, floods, droughts, and salinity intrusion. Rising sea levels threaten about 17% of the land area and millions of coastal livelihoods (UNDP, 2023).
- **Land Fragmentation**: More than 85% of farms are under 1 hectare, severely limiting mechanization, input efficiency, and productivity (FAO, 2022). Urbanization and population density further strain arable land availability.
- **Post-Harvest Losses:** Inadequate storage and logistics infrastructure result in 15–30% post-harvest losses for perishables like fruits, vegetables, and fish.

These losses are estimated to cost the economy around USD 2.4 billion annually (ADB, 2021).

- **Market Access Constraints:** Smallholder farmers face challenges such as limited access to finance, weak market linkages, and underdeveloped cold chains. Digital illiteracy and a lack of cooperative structures exacerbate price instability and reduce bargaining power (IFPRI, 2023).

Good Practices

- **Digital Advisory Platforms**: Initiatives such as e-Krishok and the Krishi Call Center offer real-time SMS and voice-based agricultural advice, including market prices and weather forecasts. These platforms have reached over 1 million farmers and improved crop planning (BRAC, 2022).
- **Community-Based Flood Shelters**: In flood-prone areas, elevated agricultural shelters provide protection for livestock, seeds, and inputs. These multifunctional shelters have improved disaster preparedness and reduced losses during seasonal floods (UNDP Bangladesh, 2023).
- **High-Value Horticulture Programs:** ADB-supported programs (2010–2017) across 27 districts introduced improved seeds, tunnel farming, and market linkages, boosting vegetable yields by 25–40% and increasing farmer incomes by up to 35% (ADB, 2018).

Forward-Looking Opportunities

- **Integrated Rice-Fish Farming**: Expansion of rice–fish integrated systems, especially in flood-prone zones, can increase protein supply, improve soil health, and raise farmer incomes. These models are being piloted in Barisal and Khulna with promising results (FAO, 2023).
- **Agri-Tech Incubation and Digitization:** Investment in agri-startups and digital platforms can revolutionize farm-level productivity, supply chain traceability, and market access. World Bank's Bangladesh Digital Economy Development Project supports the creation of scalable tech models for agriculture (World Bank, 2022).

- **Blue Economy and Fisheries Development**: Strengthening coastal and inland aquaculture value chains can significantly contribute to nutrition and export diversification. The IFC and FAO have jointly recommended cold chains, certification schemes, and training for fish processors (IFC, 2023).
- **Climate-Smart Irrigation and Infrastructure:** Scaling solar irrigation pumps, drip systems, and climate-resilient grain storage can reduce energy costs and improve water and input use efficiency. Public-private partnerships and micro-financing models have seen success in Rajshahi and Rangpur (FAO, 2022).

5.3 The Republic of Fiji

Overview of the Agri-Food Economy

Agriculture is a critical part of Fiji's rural economy, contributing approximately **7% to national GDP** and providing livelihoods for around **30% of the population**, particularly in rural and outer island communities (World Bank, 2023). The sector is dominated by **sugarcane**, **kava (yaqona)**, **taro**, **coconut**, and a variety of **horticultural crops**, along with smallholder **livestock** and **fisheries**. Fiji also has a robust tradition of **subsistence agriculture**, particularly in outer islands and inland rural areas.

Sugarcane accounts for nearly **70% of total agricultural exports**, while **kava exports** have grown steadily, driven by increasing regional and global demand. Despite this, Fiji's agricultural systems are constrained by **isolation from major markets**, high input and freight costs, and increasing exposure to **climate-related disasters**.

Key Challenges

- **Climate Vulnerability and Natural Disasters**: Fiji is highly susceptible to **cyclones, heavy rainfall, and droughts**, with **Cyclone Winston (2016)** causing USD 1.4 billion in damages, including widespread agricultural losses. Cyclone Harold (2020) alone led to estimated agricultural damages of over

FJD 27 million. Climate change is expected to increase both the **frequency and intensity** of extreme events (UNDP Pacific, 2021).

- **Limited Post-Harvest and Cold Storage Infrastructure**: Fiji faces a **major cold chain gap**, especially outside the main island of Viti Levu. Perishable produce suffers **post-harvest losses of 20–30%**, primarily due to insufficient on-farm storage, limited cooling facilities at markets, and a lack of refrigerated transport (FAO, 2020).
- **High Transport and Freight Costs**: Due to its remote location, Fiji faces shipping and logistics costs that are **30–40% higher than the global average**, affecting both exports and the cost of imported inputs such as fertilizers and packaging materials (ADB, 2023).
- **Fragmented Markets and Limited Finance Access**: Smallholder producers, especially in the outer islands, have limited access to markets, financial services, and formal value chains. Lack of collateral and high-risk perceptions inhibit lending to farmers.

Good Practices

- **Kava Quality Certification and Market Access**: Fiji's Ministry of Agriculture has implemented a **kava certification scheme** to improve quality and consistency for export. Certified kava producers have reportedly seen **price increases of up to 25%**, with improved access to markets in Australia, New Zealand, and the U.S. (Pacific Horticultural & Agricultural Market Access Program – PHAMA, 2022).
- **Value-Chain Finance via Fiji Development Bank (FDB)**: In partnership with ADB's new **Country Partnership Strategy 2024–2028**, the Fiji Development Bank is expanding access to **value-chain linked loans**, where the bank shares **30% of the risk** and lending is tied to buyer contracts or cooperative structures. This has opened up credit for smallholders engaged in sugarcane, vegetables, and kava (ADB, 2024).
- **Community Agroforestry Initiatives**: Agroforestry projects combining fruit trees, nitrogen-fixing crops, and timber species have shown promise in

increasing income resilience, restoring degraded land, and reducing cyclone risk in **Vanua Levu and Kadavu** (SPC & GIZ, 2022).

Forward-Looking Opportunities

- **Organic and Niche Export Markets**: Fiji is well-positioned to expand into **organic vanilla, turmeric, ginger, coconut oil**, and **processed kava** for premium export markets. Certification, branding, and traceability systems could significantly increase returns, particularly to Australia, New Zealand, and Pacific Rim countries (ITC, 2021).
- **Regional Cold Chain Hub in Suva**: Establishing a **regional cold-chain aggregation and distribution hub in Suva** could reduce post-harvest losses, enhance export capacity for horticultural goods, and serve as a logistics platform for the broader Pacific (FAO, 2020).
- **Digital Logistics and Traceability**: Use of **mobile platforms for logistics tracking, farmer registration, and price updates** is gaining traction, particularly through pilot programs by the Fiji Agri-Marketing Authority and private agritech start-ups. These systems improve **transparency, reduce transaction costs**, and increase trust in high-value supply chains.

- **Climate-Resilient Infrastructure and Crop Diversification**: Investment in **climate-resilient roads, irrigation**, and **cyclone-resistant storage** is critical. In addition, promoting **resilient crops** (e.g., salt-tolerant taro, drought-resistant cassava) can help stabilize production.

5.4 India

Overview of the Agri-Food Economy

Agriculture plays a vital role in India's economy, contributing approximately **15.9% to the national GDP** in FY 2022–23 and employing around **43–46% of the workforce**, according to the World Bank and Trading Economics. India is a global

agricultural powerhouse, ranking among the top producers of **rice, wheat, pulses, sugarcane, cotton, milk**, and **horticultural crops**.

The country has achieved significant increases in production over the past two decades, and is now the **world's largest milk producer** and **second-largest producer of fruits and vegetables** (FAO, 2023). However, structural issues such as low productivity, fragmented landholding, and inadequate post-harvest infrastructure continue to constrain the sector's performance.

Key Challenges

- **Climate Risk and Water Stress**: India is extremely vulnerable to **climate variability**, including droughts, floods, and heatwaves. **Nearly 52% of agricultural land is rainfed**, making it highly dependent on the monsoon (IMD, 2023). Climate shocks are becoming more frequent, affecting yields and farmer incomes.
- **Post-Harvest Losses and Cold Chain Deficits**: Post-harvest losses in perishables are estimated at **18–40%**, largely due to gaps in **cold chain infrastructure**, logistics, and market access (NCCD, 2020). India had around **8,186 cold storage facilities** by 2021, concentrated mostly in a few states (MoFPI, 2022).
- **Small and Fragmented Land Holdings**: Around **86% of India's farmers are small and marginal**, owning less than 2 hectares of land. This restricts **mechanization, irrigation coverage**, and economies of scale (Agricultural Census, 2015-16).
- **Farmer Indebtedness and Suicides**: Rising input costs and price volatility have led to persistent **rural indebtedness**. Between 2014 and 2022, India reported over **100,000 farmer suicides**, with **11,290 cases in 2022 alone** (NCRB, 2023).

Good Practices

- **Digital Agriculture Platforms**: Initiatives like **Digital Agriculture Mission**, **e-NAM**, and **AgriStack** aim to improve market access, supply chain

visibility, and advisory services. e-NAM has onboarded over **1,300 mandis** and connects over **17 million farmers**.

- **AgriTech Startups and Climate Innovation**: Companies like **Fasal**, **CropIn**, and **DeHaat** are leveraging **IoT, AI, and satellite data** for precision farming, pest detection, and water optimization. Startups like **S4S Technologies** are also deploying **solar food dehydrators**, reducing post-harvest loss by **over 40%** in pilot regions (Scroll.in, 2024).
- **Horticulture Clusters and Export Quality Training**: In states like Odisha and Maharashtra, **mango, banana, and pomegranate** farmers are receiving training in **grading, packaging, and storage**, enabling higher value realization in export markets (Times of India, 2024).

Forward-Looking Opportunities

- **Cold Chain Modernization**: Expanding **refrigerated storage and logistics** in tier-2 and rural markets could reduce food loss and open new agri-export opportunities. The **PLI scheme for food processing** offers fiscal incentives to improve infrastructure (MoFPI, 2023).
- **Climate-Smart Irrigation and Crop Insurance**: Scaling up **solar pumps**, **drip irrigation**, and improving the reach of **PM Fasal Bima Yojana (crop insurance)** can make Indian agriculture more resilient to extreme weather (FAO India, 2023).
- **Export-Oriented Value Chains**: India can grow its share in **high-value exports** (e.g. organic produce, processed spices, millets) with improved **traceability systems**, certification, and support for **Farmer Producer Organizations (FPOs)** (APEDA, 2023).
- **Digital Financial Services for Farmers**: Strengthening access to **credit, insurance, and input financing** through mobile-based platforms and **co-lending models** can reduce financial exclusion for smallholders (NABARD, 2022).

5.5 Indonesia

Overview of the Agri-Food Economy

Agriculture remains an essential component of Indonesia's economy, contributing approximately **12.5% to the national GDP in 2023**, based on data from The Global Economy and Statistics Indonesia (BPS). The sector employs around **29% of the labor force**, with rural areas highly dependent on farming for livelihoods. Notably, **over 87%** of this labor force is engaged in the **informal sector**, limiting access to insurance, finance, and social protection (The Jakarta Post, 2024).

Indonesia is a **global agri-food leader**, ranked:

- **#1 in palm oil production**, contributing nearly **44 million metric tons** annually (Statista, 2024),
- **#3 in rice production**, producing over **30 million tons of milled rice**, and
- Among the top producers of **cocoa, coffee, rubber, fisheries, and spices**, per FAOSTAT.

Despite increases in output and exports, the sector continues to grapple with structural bottlenecks such as fragmented landholding, post-harvest inefficiencies, and exposure to climate shocks.

Key Challenges

Climate Risk and Water Stress

Indonesia is among the countries most vulnerable to **climate variability**, including **El Niño-driven droughts**, floods, and unpredictable monsoons. Approximately **55% of agricultural land is rainfed**, making productivity heavily reliant on seasonal rainfall. The 2023–24 El Niño led to significant yield reductions in rice and palm oil, with palm oil yields expected to drop by **10–30%** in affected provinces (Reuters, 2024).

Post-Harvest Losses and Cold Chain Deficits

Indonesia faces significant **post-harvest losses**, estimated at **20–35%** in perishables such as fruits, vegetables, and fish. The country's cold chain infrastructure is

underdeveloped, especially beyond Java and Sumatra. As reported by the U.S. Department of Commerce (2023), most cold storage facilities are located in urban centers, leaving **eastern Indonesia (Papua, NTT, Maluku)** underserved. Poor packaging, road connectivity, and electricity reliability further compound these losses.

Small and Fragmented Land Holdings

More than **93% of Indonesia's farmers are smallholders**, typically cultivating **less than 0.5 hectares**. This scale limits the adoption of **mechanization, irrigation**, and **precision agriculture**. Additionally, weak land tenure and lack of certification restrict access to **formal credit and insurance schemes**, as highlighted by the World Bank ICARE Program (2022).

Farmer Income Volatility and Import Dependence

Despite large-scale food production, Indonesia remains a **net importer** of essential staples like **rice, garlic, sugar, and soybeans**. In 2023, the country imported over **3.5 million tons of rice**, and plans to import **an additional 1 million tons from India in 2025** due to domestic production shortfalls (Reuters, 2024). This reliance on imports makes the country vulnerable to global price shocks and supply chain disruptions.

Good Practices

Digital Agriculture Platforms

The Indonesian government launched a **National Strategy for Digitizing Agriculture (2023–2027)**, focusing on:

- A centralized farmer database,
- Land use monitoring via satellites,
- Early warning systems for pest and climate alerts,
- Market access digitization.

Private sector innovations have accelerated this effort. AgriTech startups like:

- **TaniHub**: enables farmers to sell directly to markets and retailers,
- **eFishery**: uses IoT to optimize feed usage for fish farmers, reaching over **70,000 aquaculture farmers**, and
- **Sayurbox**: delivers fresh produce directly to urban consumers.

These platforms enhance **price realization**, **reduce intermediaries**, and **improve access to inputs and finance** (AgroSpectrum Asia, 2023).

AgriTech Startups and Climate Innovation

Indonesia hosts over **300 AgriTech startups** exploring AI, drones, and solar solutions. Notably, **eFishery** raised over $200 million in 2023 to scale tech-enabled aquaculture. Other firms are piloting **solar-powered cold rooms** and **micro-irrigation systems** for climate resilience.

Sustainable Commodities and Export Quality

In the palm oil sector, regenerative pilot projects in **Aceh and North Sumatra** are adopting **agroforestry**, **organic compost**, and **soil cover techniques** to reduce deforestation and meet the **EU Deforestation-Free Regulation (EUDR)** standards. These initiatives are supported by NGOs, district governments, and commodity buyers (Reuters, 2024).

Forward-Looking Opportunities

Cold Chain Modernization

Targeted investments in cold storage for **horticulture and fisheries**—especially in **Sulawesi, Kalimantan, and Papua**—could significantly reduce food loss and increase exports of high-quality fresh produce. Incentives are being offered by the

Ministry of Marine Affairs and **Ministry of Industry** for private participation (US Department of Commerce, 2023).

Climate-Smart Irrigation and Crop Insurance

Government programs are expanding access to:

- **Solar irrigation pumps** in water-scarce provinces,
- **Drip irrigation** for vegetable belts in Java and Bali, and
- **Agricultural Insurance Subsidy Scheme**, aimed at smallholders vulnerable to floods and droughts.

Export-Oriented Value Chains

Indonesia has strong potential in **premium agri-exports**, including:

- **Organic coffee and cocoa** (Sumatra, Sulawesi),
- **Mangosteen, nutmeg, clove, vanilla**, and
- **Sustainably sourced seafood** (e.g. tuna from Maluku).

Improving **traceability systems**, **certification training**, and **logistics infrastructure** could open up markets in the **EU, Japan, South Korea, and the U.S.** (APEC Agri-Food Roadmap, 2023).

Digital Financial Services for Farmers

New models of **digital lending and crop insurance** are being rolled out through platforms like:

- **Crowde**: peer-to-peer agri-lending,
- **KoinWorks**: agri-SME finance,
- **TaniFund**: crowdfunding for agri-projects.

These tools are bridging credit gaps for unbanked smallholders. The government is also exploring **co-lending partnerships** with rural banks and cooperatives (World Bank FISF Indonesia, 2023).

5.6 The Islamic Republic of Iran

Overview of the Agri-Food Economy

Economic Contribution & Employment

In 2023, agriculture (including forestry and fisheries) contributed approximately 12.8% of Iran's GDP and employed around 14–15% of the workforce, down from ~20% two decades ago, signaling urbanization and sectoral shifts (Global Economy, Iran Daily via Wikipedia).

Land Use & Production

Only about 12% of Iran's 1.6 M km² land is cultivated—1/3 irrigated, 2/3 rainfed—with annual rainfall just 220 mm versus a global average of 800 mm (Wikipedia, AgriTech Insights, 2025).

Grain output peaked at ~23 Mt in 2023, including ~14 Mt of wheat (Mordor Intelligence via Global Economy).

Key Commodities

Iran is a world leader in wheat, pistachio, saffron, rice, tea, cotton, citrus, and maintains strong livestock production (~11 Mt milk, ~2.6 Mt poultry) (Mordor Intelligence, Fruit production via Wikipedia).

Key Challenges

1. Climate Risk & Water Scarcity

Agriculture consumes ~90% of Iran's water, which is severely overdrawn. From 2002–17, groundwater recharge dropped by ~3.8 mm/year, causing hundreds of villages to be abandoned (Wikipedia Water Scarcity, 2025, Financial Tribune, 2023).

Provinces like Khuzestan, Fars, and Isfahan remain under severe drought, with a 45% rainfall drop, and 670 trillion rials (~$2.8 bn) lost in agricultural output this year. Wheat yields may fall by 7–54% due to rising temperatures and reduced rains (Reuters; Mordor; Wikipedia Climate Change in Iran).

2. Post-Harvest Losses & Cold Chain Deficits

Post-harvest losses in fruit and vegetables are 30–35%, totaling 7.6 Mt of 25 Mt produced—far higher than in developed countries (~7–10%)—due to limited cold storage, packaging, transport, and coordination (ResearchGate, 2002, VASTRA Holding).

3. Small & Fragmented Land Holdings

Most farms are under 2 ha, with a third of farmers landless. Mechanization levels are low (1.65 HP/ha), and fertilizer usage (~68 kg/ha) lags behind global averages (~110 kg/ha) (Wikipedia Agriculture in Iran, Wikipedia economy).

4. Income Volatility & Rural Out-Migration

The combination of climate threats and infrastructural deficiencies threatens food stability. With agriculture's share of GDP dropping over 9% since 2002, rural dwellers are migrating as farming jobs shrink (~15% labor share), even as production numbers grow modestly (~4–6% value-added). Iran also sees mounting food inflation due to supply chain inefficiencies and IRGC influence (Wikipedia Food Inflation in Iran).

Good Practices & Innovations

Irrigation Modernization & Water Efficiency

The government has invested $35 million in modern irrigation tech and pilot solar-powered pumps. Advanced systems like the SAWA model in Fars province achieved a 34% reduction in irrigation water use via optimized cropping patterns (Mordor Intelligence, AgriTech Insights).

Greenhouse & Digital Agritech

Greenhouse farms have expanded from 600 ha in 1996 to 15,700 ha in 2019, using climate-controlled PLC automation (InTech Open). Iran has over 500 agritech companies, with 7% in agriculture, developing marketplaces, smart irrigation, livestock monitoring, drones, and AI solutions (VASTRA Holding, InTechOpen).

Specialty Crop & Processing Excellence

Investments in processing facilities—dryers, packhouses, HACCP compliance for pistachio (since 2003)—have reduced losses by ~40% and improved export quality (ResearchGate, VASTRA Holding).

Forward-Looking Opportunities

1. Scaling Cold Chain & Logistics

Iran needs 1,500–2,000 refrigerated containers annually but produces only 500–1,000. Upgrading warehouse and trucking capacity, especially in export corridors, could significantly reduce spoilage and boost competitiveness (VASTRA Holding).

2. Climate-Smart and Water-Efficient Farming

Wider rollout of drip irrigation, solar pumps, and drought-resistant crops modeled on Fars' SAWA system can bolster resilience. Soil salinity and erosion management are also critical—degradation costs up to $56 billion/year (MDPI, MDPI Soil Erosion).

3. Farm Consolidation & Mechanization

Incentivizing land cooperatives, mechanization services, and fertilizer provision through subsidies and extension services can enhance per-hectare productivity.

4. Agritech & Digital Transformation

Expanding digital platforms for inputs, market info, finance, and traceability is key—leveraging about 117 new agritech products launched by Iranian companies (InTechOpen).

5. Value-Added Processing & Export Expansion

Building on pistachio, saffron, dates, and citrus, establishing rural cooperatives and processing facilities can increase foreign earnings. Iran already ranks first globally in saffron and pistachio production (FAO, VASTRA).

6. Policy Support & Investment Incentives

Policies funding knowledge-based startups, irrigation tech, and food-processing hubs (e.g., over 500 agritech companies supported) are creating fertile ground for investment and modernization (VASTRA Holding).

5.7 The Lao People's Democratic Republic

Overview of the Agri-Food Economy

Agriculture remains a cornerstone of Lao PDR's economy, contributing about **24% to GDP** and employing nearly **64% of the labor force** (World Bank, 2023). The sector is predominantly smallholder-based, with most households relying on subsistence farming. Rice is the primary staple crop, cultivated in both lowland and upland areas, while cash crops such as coffee, maize, cassava, and vegetables are grown for domestic consumption and export. The country's diverse geography, ranging from fertile river valleys to mountainous uplands, supports a variety of agro-ecological zones and production systems (FAO Lao PDR, 2022). Despite significant potential, the agriculture sector is characterized by low productivity, limited mechanization, and weak integration into markets.

Key Challenges

Climate Vulnerability:
Lao PDR is particularly exposed to the impacts of climate change, including increased frequency and severity of floods, droughts, and unpredictable rainfall. These climatic shocks negatively affect crop yields—especially rice—and compromise food security. Provinces in central and southern Lao PDR are especially prone to these risks, which undermine rural livelihoods and exacerbate poverty (ADB, 2022).

Small-Scale Farming and Land Fragmentation:

Over 80% of Lao farmers operate on plots smaller than 2 hectares, primarily using traditional farming methods with limited access to improved inputs, machinery, or irrigation. Such small-scale farming limits economies of scale, constraints investment in productivity-enhancing technologies, and reduces resilience to climate shocks (World Bank, 2023).

Rural Infrastructure and Market Access:

Rural areas face inadequate infrastructure—especially poor road networks, limited cold storage, and insufficient processing facilities—which leads to significant post-harvest losses, estimated at 20–30% for perishable goods and coffee. These deficiencies also hamper farmers' ability to reach larger markets domestically and across borders, limiting income growth and export potential (FAO Lao PDR, 2022).

Limited Financial Services:

Access to formal agricultural finance remains scarce in Lao PDR, with many small holders dependent on informal credit sources charging high interest. The lack of tailored financial products and agricultural insurance restricts farmers' capacity to invest in quality inputs, irrigation, or climate adaptation measures, increasing vulnerability to economic and environmental shocks (IFC, 2021).

Good Practices

Community-Based Irrigation Management:

Supported by Asian Development Bank projects, participatory irrigation systems have been successfully implemented, improving water use efficiency and stabilizing rice yields. These systems empower local communities to manage water resources sustainably, reduce conflicts, and enhance agricultural productivity (ADB, 2022).

Climate Information and Early Warning Systems:

Collaborations between the Lao government and FAO have established agro-climatic advisory services that provide timely weather forecasts and early warnings

of floods and droughts. This information helps farmers optimize planting dates, reduce crop losses, and better prepare for climatic variability (FAO Lao PDR, 2022).

Improvement in Coffee Quality and Market Linkages:

Public-private partnerships have introduced improved coffee processing techniques, certification standards, and export promotion initiatives. These efforts have increased the quality and competitiveness of Lao coffee in international markets, raising prices and incomes for farmers involved in specialty coffee production (IFC, 2021).

Forward - Looking Opportunities

Promotion of Climate-Smart Agriculture:

Scaling up climate-resilient practices such as drought-tolerant rice varieties, agroforestry systems, and conservation agriculture can improve soil health, water efficiency, and yield stability. Support for knowledge transfer and farmer training is crucial to widespread adoption (FAO Lao PDR, 2023).

Investment in Rural Infrastructure:

Developing rural roads, market facilities, and cold storage infrastructure will reduce post-harvest losses and enhance farmers' access to both domestic and regional markets. This will increase incomes, strengthen food security, and facilitate the country's integration into regional value chains (World Bank, 2023).

Expansion of Agricultural Finance and Insurance:

Introducing microfinance products tailored to smallholders, alongside crop insurance schemes, can increase investment in productivity-enhancing inputs and reduce the risks associated with climate and price volatility. Public-private partnerships will be critical to developing sustainable financial services (IFC, 2021).

Regional Trade and Export Diversification:

Leveraging Lao PDR's membership in ASEAN and the Greater Mekong Subregion initiatives can help expand export opportunities for coffee, maize, specialty crops,

and livestock products. Harmonizing standards, improving logistics, and supporting Farmer Producer Groups will be key to accessing high-value markets (ADB, 2022).

5.8 Malaysia

Overview of the Agri-Food Economy

Agriculture contributes about **7.4% to Malaysia's GDP** and provides employment for roughly **11% of the labor force** (World Bank, 2023). Malaysia's agricultural landscape is notably diversified, with key commodities including **oil palm**, rubber, cocoa, rice, fruits, vegetables, and fisheries. The country is the **world's second-largest producer and exporter of palm oil**, which constitutes the backbone of its agricultural exports and rural economy (MPOC, 2023).

Besides oil palm, Malaysia has substantial production of **rice**, especially in the northern states such as Kedah and Perlis, which are considered the "rice bowl" of the country. The fisheries sector, including marine and aquaculture products, also plays a critical role in food security and rural livelihoods.

Over the past decade, Malaysia has steadily modernized its agriculture through investments in mechanization, research, and improved farm inputs, leading to enhanced productivity. Nonetheless, the sector faces ongoing challenges related to environmental sustainability, labor availability, and climate impacts.

Key Challenges

1. Environmental Sustainability and Land Use Pressures

The expansion of oil palm plantations has significantly altered Malaysia's natural landscapes, resulting in deforestation and habitat loss. This raises international concerns and pressures to adopt **sustainable palm oil production** practices to meet export market requirements, especially in Europe and North America (MPOC, 2023). The government promotes certification schemes such as the **Roundtable on Sustainable Palm Oil (RSPO)** to balance economic growth with environmental stewardship.

2. Labor Shortages and Demographic Changes

Agriculture in Malaysia faces a **shrinking and aging workforce**, partly due to rural-to-urban migration and the appeal of alternative employment opportunities in manufacturing and services. Many smallholders and plantations rely on foreign labor, but restrictions and rising wages have increased labor costs (FAO Malaysia, 2022). Mechanization and precision agriculture adoption remain limited in smallholder sectors, affecting productivity and competitiveness.

3. Climate Change and Weather Variability

Malaysia's tropical climate is vulnerable to **increased frequency of extreme weather events**, such as droughts and floods. These climatic shifts threaten crop yields and soil health, particularly in key agricultural zones. For instance, changing monsoon patterns affect rice production cycles, which are still predominantly rainfed (Malaysian Meteorological Department, 2023).

4. Post-Harvest Losses and Infrastructure Gaps

Post-harvest losses, especially for perishable fruits, vegetables, and seafood, range between **15% and 25%** due to limited cold storage and inefficient logistics systems (ADB, 2021). This not only reduces farmer incomes but also constrains Malaysia's ability to expand its presence in premium export markets that demand consistent quality and supply.

Good Practices

Sustainable Palm Oil Initiatives

Malaysia is a global leader in sustainable palm oil production, implementing the **RSPO certification** and complementary best management practices such as zero-burning policies and integrated pest management (MPOC, 2023). These efforts help mitigate deforestation and reduce greenhouse gas emissions while maintaining productivity.

Digital Agriculture and Smart Farming

Emerging adoption of **IoT sensors, drones, and mobile applications** enables better farm management through real-time monitoring of soil moisture, pest outbreaks, and nutrient levels. The Malaysian Agricultural Research and Development Institute (MARDI) has been at the forefront of promoting these technologies to smallholders, increasing efficiency and reducing input costs (MARDI, 2023).

Agro-Tourism and Value-Added Products

Rural communities are diversifying income through agro-tourism and developing **value-added products** such as organic fruits, herbal supplements, and processed foods. These ventures support rural development, create employment, and improve market linkages (MITI, 2023).

Forward-Looking Opportunities

High-Value Crop and Organic Agriculture Expansion

With growing domestic and international demand for organic and specialty crops, Malaysia is poised to **expand organic farming** and high-value horticulture. This requires strengthening certification frameworks, farmer training, and market access to ensure profitability and sustainability (FAO Malaysia, 2023).

Climate-Smart Agriculture and Water Resource Management

Investing in **climate-resilient crop varieties**, precision irrigation technologies, and integrated watershed management can enhance agricultural resilience. The government's **National Agro-Food Policy (2021–2030)** prioritizes these measures to mitigate climate impacts and secure food production (MARDI, 2023).

Agri-Tech Innovation and Digitalization

Malaysia's vibrant digital economy fosters innovation in agriculture, with start-ups developing solutions for **farm management, supply chain traceability, and e-commerce platforms**. Strengthening partnerships between the public sector,

research institutions, and private companies can accelerate the adoption of these technologies (Malaysian Digital Economy Corporation, 2023).

Enhancing Export Competitiveness through Infrastructure

To boost exports of fruits, vegetables, seafood, and processed foods, Malaysia must improve cold chain infrastructure and certification systems. This requires coordinated investments and policy support to integrate smallholders into global value chains effectively (MITI, 2023).

5.9 The Republic of the Union of Myanmar

Overview of the Agri-Food Economy

Agriculture is a cornerstone of Myanmar's economy, contributing approximately **22% to the national GDP** and employing nearly **50% of the labor force** (World Bank, 2023). The sector supports the livelihoods of a large rural population and is dominated by smallholder farmers. Key crops include **rice, pulses, beans, oilseeds, maize, and horticultural products**, while livestock and fisheries also play vital roles.

Myanmar is a significant global producer and exporter of **rice and pulses**, with agriculture accounting for over 40% of export earnings pre-2020 (FAO, 2022). The country's vast arable land and favorable agro-climatic zones provide strong potential for agricultural development. However, decades of political instability, underinvestment, and infrastructure gaps have constrained productivity and market integration.

Key Challenges

1. **Political Instability and Conflict**
   Since the 2021 military coup, ongoing political unrest and armed conflict have severely disrupted agricultural activities, input supply chains, and market

access. This has led to reduced production, displacement of farming communities, and restricted access to credit and extension services (ICG, 2023).

2. **Limited Infrastructure and Market Access**

   Poor rural infrastructure, including roads, storage, and cold chain facilities, significantly limits farmers' ability to get products to market, contributing to **post-harvest losses estimated at 20–30%** for perishables such as fruits and vegetables (ADB, 2021). Additionally, export routes are hampered by border closures and trade restrictions.

3. **Land Tenure and Fragmentation Issues**

   Land rights insecurity and fragmented land holdings are widespread, limiting investments in land improvements and mechanization. Many farmers operate on small plots (often less than 1 hectare) with unclear ownership, affecting credit access and long-term planning (World Bank, 2023).

4. **Climate Vulnerability**

   Myanmar is prone to **cyclones, floods, droughts, and irregular monsoon patterns**. Climate change exacerbates these risks, threatening food security and rural livelihoods. Around 30% of Myanmar's agricultural land is vulnerable to salinity intrusion and water scarcity, especially in the delta and dry zones (FAO, 2022).

5. **Low Productivity and Input Constraints**

   Agricultural productivity remains low due to limited use of modern inputs like improved seeds, fertilizers, and mechanization. Extension services and access to finance are underdeveloped, impeding adoption of better farming practices (IFPRI, 2023).

Good Practices

Contract Farming and Out grower Schemes

Several private-sector-led contract farming initiatives, especially in oilseed and

pulses sectors, have helped improve access to quality inputs, technical advice, and guaranteed markets for farmers. These models reduce market risk and support higher productivity (IFC Myanmar, 2023).

Community Seed Banks and Farmer Cooperatives

NGOs and development partners have promoted community-based seed banks to preserve local varieties and improve seed availability. Strengthening farmer cooperatives enhances collective bargaining power and access to inputs and credit (FAO Myanmar, 2022).

Climate-Smart Practices in Dry Zones

Pilot projects introducing drought-tolerant crop varieties, water harvesting techniques, and conservation agriculture in Myanmar's central dry zone have shown promise in enhancing resilience and yields (World Bank, 2023).

Forward-Looking Opportunities

Rehabilitation of Rural Infrastructure

Investing in rural roads, irrigation, storage, and market facilities is critical to reduce losses and integrate farmers into domestic and regional value chains. Digital platforms for market information can further empower smallholders (ADB, 2023).

Expansion of High-Value Crops and Agro-Processing

There is growing potential for expanding horticulture, aquaculture, and livestock production, linked to agro-processing industries. Support for certification and quality standards can boost export competitiveness (FAO, 2022).

Land Tenure Reform and Mechanization Support

Implementing clear land policies and promoting farmer access to machinery through rental services or cooperatives can increase land productivity and incomes (World Bank, 2023).

Climate Adaptation and Disaster Risk Reduction

Scaling climate-smart agriculture, including resilient seed varieties, water management, and early warning systems, can mitigate climate impacts. Integrating local knowledge with scientific approaches is essential for sustainable adaptation (UNDP Myanmar, 2023).

Inclusive Finance and Digitalization

Expanding mobile-based financial services, insurance products, and digital advisory tools can improve smallholder access to inputs, credit, and markets, enhancing productivity and resilience (IFPRI, 2023).

5.10 Nepal

Overview of the Agri-Food Economy

Agriculture is a key sector in Nepal's economy, contributing about **27% to national GDP** and employing over **65% of the workforce** (World Bank, 2023). The country's varied topography—from the Terai plains to the mid-hills and high mountain regions—supports a diverse range of crops, livestock, and agroforestry systems. Rice, maize, wheat, millet, potatoes, and pulses are staple crops, while horticulture (fruits and vegetables) and livestock farming are growing rapidly. Despite improvements in productivity, subsistence farming still predominates, with smallholder farmers cultivating fragmented landholdings.

Key Challenges

1. **Geographic and Infrastructure Constraints**

   Nepal's rugged mountainous terrain limits large-scale mechanization and complicates infrastructure development. Poor rural roads and limited market

linkages increase transportation costs and post-harvest losses, estimated at **15–20% for perishables** (ADB, 2022).

2. **Climate Vulnerability and Disaster Risks**

   Nepal is highly vulnerable to climate change impacts including erratic monsoons, flooding, landslides, drought, and glacial lake outburst floods (GLOFs). These hazards threaten agricultural productivity and rural livelihoods, especially in mountain and hill areas (UNDP Nepal, 2023).

3. **Land Fragmentation and Tenure Issues**

   More than 80% of farmers operate on holdings smaller than 1 hectare, limiting economies of scale and mechanization adoption. Land tenure insecurity and lack of access to formal credit constraints investment in improved farming practices (FAO Nepal, 2022).

4. **Low Productivity and Limited Input Use**

   Use of improved seeds, fertilizers, and irrigation remains limited, particularly in hill and mountain districts. Rainfed agriculture dominates, accounting for over 70% of cultivated land, making yields highly dependent on monsoon patterns (World Bank, 2023).

5. **Gender Disparities and Youth Outmigration**

   Women make up a large share of the agricultural labor force but often lack access to resources, training, and decision-making. Youth migration to urban areas and abroad is leading to labor shortages and reduced on-farm innovation (IFPRI, 2023).

Good Practices

Community-Based Seed Banks and Farmer Groups

Local seed banks managed by farmer cooperatives have improved access to quality seeds, especially traditional varieties adapted to local conditions. Farmer groups also facilitate knowledge sharing and collective marketing (FAO Nepal, 2022).

Irrigation and Water Harvesting Initiatives

Small-scale irrigation schemes, including gravity-fed and solar-powered pumps, have enhanced water availability for dry-season cropping in Terai and mid-hill districts, improving crop yields and resilience (ADB, 2022).

Climate-Smart Agriculture

Promotion of climate-resilient crop varieties, integrated pest management, agroforestry, and soil conservation measures has helped reduce vulnerability in vulnerable hill and mountain farming systems (UNDP Nepal, 2023).

Value Chain Development and Market Linkages

Projects supporting high-value crops like off-season vegetables, cardamom, tea, and medicinal herbs have enhanced incomes. Strengthening cooperatives and agro-processing facilities supports market access and value addition (World Bank, 2023).

Forward-Looking Opportunities

Infrastructure Investment and Digital Connectivity

Improving rural road networks, cold storage, and digital platforms for market information can reduce transaction costs and post-harvest losses. Mobile-based advisory services could expand farmer access to real-time weather and price data (ADB, 2022).

Scaling Climate-Smart and Diversified Farming Systems

Broader adoption of drought-tolerant crops, agroforestry, livestock integration, and conservation agriculture can enhance productivity and ecosystem resilience, particularly in fragile mountain environments (FAO Nepal, 2022).

Youth Engagement and Women's Empowerment

Promoting agri-entrepreneurship among youth and improving women's access to land, credit, and training can boost innovation and inclusiveness in rural economies (IFPRI, 2023).

Promotion of Export-Oriented High-Value Crops

Nepal's niche products such as tea, cardamom, ginger, and medicinal herbs offer growth potential in regional and global markets with improved quality standards and certification (World Bank, 2023).

5.11 Pakistan

Overview of the Agri-Food Economy

Agriculture is a cornerstone of Pakistan's economy, contributing around **23.33%** to the national GDP as of 2023, significantly higher than the global average. It employs approximately **36.1%** of the country's labor force, making it the largest employment sector (The Global Economy, 2023). The livestock sub-sector is especially important, contributing roughly **23.5%** to GDP and employing over **37%** of workers (Dawn, 2024).

Pakistan ranks among the top producers globally of key staples such as wheat, rice, cotton, and sugarcane. In FY 2023-24, Pakistan achieved record production levels with **31.4 million tonnes** of wheat and **9.9 million tonnes** of rice, reflecting growth rates of 11.6% and 34.8% respectively (Dawn, 2023). Cotton production surged over

100% to 10.2 million bales in the same period. The sugarcane crop remained stable at 87.6 million tonnes (Dawn, 2023).

The livestock sector remains a key growth driver, with milk production reaching over **72 million tonnes**, combining buffalo and cow milk (Dawn, 2024).

Key Challenges

Climate Change and Water Scarcity: Pakistan faces critical water stress, compounded by climate change impacts such as erratic monsoon patterns and rising temperatures. The situation is exacerbated by geopolitical factors, notably India's recent suspension of the Indus Waters Treaty, which threatens water availability for agriculture (Reuters, 2024).

Post-Harvest Losses and Infrastructure Gaps: Limited cold storage and transport facilities lead to substantial losses, particularly in fruits, vegetables, and dairy. This constrains farmers' ability to access distant markets and reduces export competitiveness (FAO Pakistan, 2022).

Farm Fragmentation and Low Mechanization: A large majority of farms are smallholdings with limited access to modern machinery and irrigation, curbing productivity gains and economies of scale (Pakistan Agricultural Census, 2017).

Price Volatility and Input Costs: Farmers face fluctuating input prices (seeds, fertilizers, fuel) and unstable crop prices, increasing financial uncertainty and rural indebtedness (World Bank Pakistan, 2023).

Good Practices and Innovations

Land Information and Management System (LIMS): Launched in 2023, this GIS-based platform provides farmers with localized climate data, satellite crop monitoring, and targeted advisories on irrigation and fertilizer use to improve efficiency and resilience (Pakistan Ministry of Agriculture, 2023).

Cold Chain Expansion: Ongoing initiatives to expand cold storage and refrigerated transport aim to reduce post-harvest losses and enhance export quality, supported by

both public and private sector investments (Pakistan Horticulture Development & Export Company, 2023).

Digital Agriculture Platforms: Mobile apps and IoT tools are increasingly adopted for pest detection, weather forecasts, and market price transparency, helping farmers make informed decisions (USAID Pakistan, 2023).

Forward-Looking Opportunities

- **Climate-Smart Agriculture**: Scaling up solar-powered irrigation pumps, drought-resistant crop varieties, and precision farming to build resilience against climate shocks (FAO Pakistan, 2023).
- **Mechanization and Infrastructure Investment**: Promoting affordable mechanization services and expanding rural roads and market infrastructure to improve productivity and market access (World Bank Pakistan, 2023).
- **Value Chain Development and Export Promotion**: Enhancing processing facilities for fruits, vegetables, dairy, and livestock products, coupled with improved quality standards and certification, to expand high-value agri-exports (Trade Development Authority of Pakistan, 2024).
- **Digital Financial Inclusion**: Strengthening credit, insurance, and input financing access through mobile platforms and cooperative models to reduce rural financial exclusion (State Bank of Pakistan, 2023).

5.12 Philippines

Overview of the Agri-Food Economy

Agriculture is a significant pillar of the Philippine economy, contributing around **8.1% to the country's GDP** and providing livelihoods for about **24% of the national workforce** (World Bank, 2023). The country's tropical climate, coupled with diverse agro-ecological zones spanning from coastal lowlands to upland regions, enables the cultivation of a variety of crops and supports vibrant fisheries and aquaculture sectors.

Staple crops include **rice and corn**, which form the foundation of Filipino diets and food security. Meanwhile, the Philippines is a major global exporter of **bananas, pineapples, coconuts**, and other tropical fruits, which are important foreign exchange earners (Philippine Statistics Authority, 2022). The fisheries sector, both inland and coastal, ranks among the top producers globally, contributing significantly to nutrition and rural incomes.

Despite these strengths, the agricultural sector faces persistent challenges that constrain productivity, income growth, and resilience.

Key Challenges

1. **Climate Change and Disaster Vulnerability**

   The Philippines is one of the most disaster-prone countries worldwide, facing approximately **20 typhoons annually**, along with floods, droughts, landslides, and sea-level rise. These natural hazards frequently damage crops, disrupt fishing activities, and destroy rural infrastructure, leading to substantial economic losses and food insecurity for vulnerable farming communities (PAGASA, 2023). Climate change is intensifying the frequency and severity of these events, threatening long-term agricultural sustainability.

2. **Land Fragmentation and Tenure Security Issues**

   The agricultural landscape is dominated by smallholder farmers, with the average farm size under **1 hectare** (FAO Philippines, 2022). Fragmented landholdings limit farmers' ability to achieve economies of scale, adopt modern machinery, or invest in sustainable practices. Additionally, insecure land tenure discourages long-term investments and access to formal credit, exacerbating poverty in rural areas.

3. **Post-Harvest Losses and Supply Chain Gaps**

   Losses after harvest are estimated between **20–30%**, particularly for perishables like fruits, vegetables, and fish (Philippine Statistics Authority, 2022). The causes include insufficient cold storage, poor road conditions,

inadequate packaging, and inefficient transport. These losses reduce farmer incomes, increase consumer prices, and contribute to food waste, undermining sector competitiveness.

4. **Limited Access to Finance and Modern Technology**

   Smallholder farmers and fisherfolk often lack access to affordable credit, inputs such as quality seeds and fertilizers, and agricultural extension services that promote innovation. High-interest rates, lack of collateral, and geographic isolation are major barriers (Asian Development Bank, 2023). This results in low productivity and vulnerability to market shocks.

5. **Market Access and Value Chain Fragmentation**

   Supply chains tend to be fragmented and dominated by middlemen, reducing farmers' share of the final value and limiting transparency. Although digital platforms for price information and advisory services exist, their penetration remains limited, especially in remote areas (IFPRI Philippines, 2023).

Good Practices

- **Climate Risk Insurance and Disaster Risk Financing:**

  The Philippine Crop Insurance Corporation (PCIC) plays a vital role by offering subsidized insurance products covering crops, livestock, and fisheries, helping farmers recover losses due to natural disasters and climate variability (PCIC, 2023). This risk mitigation tool is critical to building resilience and sustaining rural livelihoods.

- **Farmer Cooperatives and Contract Farming:**

  Cooperatives have improved input access, credit, and marketing capabilities, allowing farmers to pool resources and negotiate better prices. Contract farming arrangements in high-value crops such as bananas and pineapples have enhanced quality standards and provided more stable incomes (Department of Agriculture Philippines, 2023).

- **Cold Chain Expansion and Agro-Processing Facilities:**

Investment in cold storage infrastructure and processing plants, often through public-private partnerships, has reduced spoilage and added value in key production regions such as Davao and Mindoro. This has improved competitiveness in both domestic and export markets (Asian Development Bank, 2023).

- **Digital Advisory and Market Platforms:**

  Mobile-based services like e-Konek provide farmers with real-time weather forecasts, pest alerts, and market prices, enabling better farm management and market decisions. These platforms have reached hundreds of thousands of farmers, improving knowledge dissemination (Department of Agriculture Philippines, 2023).

Forward-Looking Opportunities

- **Scaling Climate-Smart Agriculture:**

  Expanding the use of climate-resilient crop varieties, efficient irrigation, agroforestry, and integrated pest management can increase productivity and ecosystem sustainability, especially in vulnerable upland and coastal areas (FAO Philippines, 2022).

- **Agri-Tech Innovation and Digital Transformation:**

  There is significant potential to accelerate adoption of precision farming technologies, blockchain for supply chain transparency, and e-commerce platforms that link farmers directly with buyers. Supporting agri-tech startups and incubation hubs will be critical to driving this transformation (World Bank Philippines, 2023).

- **High-Value Crop and Fisheries Export Development:**

  Strengthening quality control, certification, and branding for export crops like bananas, pineapples, mangoes, and seafood can boost foreign exchange earnings. Market diversification and value addition are key to capturing higher returns (Department of Trade and Industry Philippines, 2023).

- **Infrastructure and Rural Connectivity Improvements:**

  Investments in rural roads, irrigation, electrification, and cold chains will reduce post-harvest losses and transaction costs, increasing market participation and agricultural competitiveness (Asian Development Bank, 2023).

5.13 Sri Lanka

Overview of the Agri-Food Economy

Agriculture plays a vital role in Sri Lanka's socio-economic fabric, contributing around **7.4% to the country's GDP** and employing about **27% of the labor force** (World Bank, 2023). The sector provides livelihoods for millions, especially in rural areas, and supports national food security and export earnings. Sri Lanka's diverse agro-climatic zones—from the wet zones in the southwest to the dry zones in the north and east—enable production of a wide array of crops, including **rice**, the staple food; **tea**, which remains a key foreign exchange earner; **rubber**, **coconut**, and **spices** such as cinnamon and pepper (FAO Sri Lanka, 2022).

Sri Lanka is among the world's leading producers and exporters of high-quality tea, contributing approximately 20% of global tea exports. The agriculture sector also supports a growing horticulture subsector, including fruits like banana and mango, and vegetables. Fisheries and livestock contribute significantly to rural incomes and nutrition.

Despite these strengths, the sector is dominated by smallholder farmers, with the average farm size under 2 hectares. Many farmers practice traditional cultivation methods, though pockets of modernization and mechanization exist, particularly in commercial plantations. The government has prioritized agriculture in its development agenda to boost productivity, food security, and rural incomes.

Key Challenges

1. **Economic and Political Instability**

   The economic crisis since 2021 has severely impacted agriculture, disrupting supply chains for critical inputs like fertilizers, seeds, and fuel due to foreign exchange shortages and import restrictions. This has caused sharp declines in crop yields and farm incomes, threatening rural livelihoods (World Bank Sri Lanka, 2023). Inflation has raised production costs while limiting farmers' ability to invest in improved inputs and technology.

2. **Climate Vulnerability and Water Stress**

   Sri Lanka's agriculture is increasingly exposed to climate risks. The country faces more frequent and severe droughts, unpredictable monsoon patterns, floods, and rising temperatures—all of which reduce productivity and cause crop failures. Roughly **40% of agricultural land is rainfed**, predominantly in dry and intermediate zones, making it vulnerable to erratic rainfall (UNDP Sri Lanka, 2023). Water scarcity in dry zones is exacerbated by over-extraction and inefficient irrigation infrastructure, limiting the potential for multiple cropping.

3. **Land Fragmentation and Smallholder Constraints**

   More than 80% of farmers operate on land parcels smaller than 2 hectares (Department of Census and Statistics Sri Lanka, 2021). This fragmentation limits the adoption of mechanized farming, irrigation expansion, and input optimization, restricting economies of scale. Smallholders also face challenges accessing affordable credit, extension services, and market information, which curbs productivity and innovation.

4. **Post-Harvest Losses and Infrastructure Gaps**

   Sri Lanka suffers from significant post-harvest losses, particularly in perishables such as fruits and vegetables, estimated between **15-25%** (ADB Sri Lanka, 2022). Losses stem from insufficient cold storage facilities, poor rural transportation infrastructure, and fragmented supply chains. This not

only reduces farmers' income but also contributes to food price volatility and reduced availability of fresh produce in urban markets.

5. **Labor Shortages and Youth Migration**

   Rural-to-urban migration and overseas employment opportunities have led to labor shortages in farming communities, particularly among younger generations. This demographic shift affects agricultural productivity and the ability to adopt innovative farming practices. An aging farmer population raises concerns about the future sustainability of rural agriculture (IFPRI Sri Lanka, 2023).

Good Practices

- **Promotion of Organic and Sustainable Agriculture**

  Following the 2021 policy shifts restricting synthetic fertilizer imports, Sri Lanka has accelerated organic farming initiatives. Adoption of organic rice, vegetables, and spice production has improved soil health, reduced input costs, and opened access to premium niche markets, both domestically and internationally (FAO Sri Lanka, 2022). These practices contribute to environmental sustainability and resilience to climate stresses.

- **Irrigation and Water Management Innovations**

  The country has invested in rehabilitating traditional small-scale irrigation tanks and introduced modern techniques such as drip irrigation and rainwater harvesting, particularly in dry zones. Community-based water user groups actively manage these resources, improving water use efficiency and supporting dry season cultivation (ADB Sri Lanka, 2022).

- **Value Chain Upgrading and Export Promotion**

  Efforts to modernize tea plantations and processing facilities, along with adoption of international certifications (e.g., Rainforest Alliance), have helped Sri Lankan tea maintain a competitive position globally. Diversification into

value-added products such as specialty teas, spices, and coconut derivatives is expanding export revenues (Tea Research Institute Sri Lanka, 2023).

- **Digital Agriculture and Extension Services**

  Pilot programs deploying mobile-based platforms deliver real-time weather forecasts, pest management advice, and market price updates to farmers. These tools enhance decision-making, increase farm efficiency, and strengthen linkages between producers and buyers (World Bank Sri Lanka, 2023).

Forward-Looking Opportunities

- **Rebuilding Input Supply Chains and Expanding Financing**

  Stabilizing and diversifying sources of fertilizers, seeds, and agrochemicals, combined with improving access to affordable credit, will be vital to restoring productivity and farmer confidence. Encouraging local production of inputs could reduce dependency on imports (Ministry of Agriculture Sri Lanka, 2023).

- **Scaling Climate-Smart and Precision Agriculture**

  Wider adoption of drought-tolerant crop varieties, agroforestry, soil conservation, and precision irrigation technologies will boost resilience to climate variability. Training and incentives can encourage smallholders to transition toward these systems (UNDP Sri Lanka, 2023).

- **Investment in Rural Infrastructure and Cold Chains**

  Upgrading rural roads, expanding cold storage facilities, and improving logistics networks will reduce post-harvest losses, enhance food quality, and improve access to markets. Public-private partnerships can play a key role in financing these improvements (ADB Sri Lanka, 2022).

- **Engaging Youth and Promoting Agripreneurship**

Creating programs that provide training, mentorship, and access to finance can attract youth into agriculture, supporting innovation and long-term sector sustainability (IFPRI Sri Lanka, 2023).

- **Diversification into High-Value and Export Crops**

  Expanding production of spices, fruits, nuts, and organic products aligned with rising global demand will support export diversification and increase rural incomes. Certification and branding efforts can unlock new markets (Department of Export Agriculture Sri Lanka, 2023).

5.14 Thailand

Overview of the Agri-Food Economy

Agriculture is a cornerstone of Thailand's economy, contributing approximately **8.5% to the national GDP** and employing around **30% of the workforce** (World Bank, 2023). The country is a leading global producer and exporter of key commodities such as **rice**, **rubber**, **cassava**, **palm oil**, **maize**, and **seafood**. Thailand ranks as the world's **largest rice exporter**, supplying about 30% of global exports annually (FAO Thailand, 2023).

The country's agriculture sector benefits from diverse agro-ecological zones—ranging from fertile central plains and the Chao Phraya River basin to mountainous northern regions—supporting production of both staple crops and high-value horticultural products, including tropical fruits (durian, mangosteen, longan), vegetables, and flowers. Livestock and aquaculture are also significant contributors, particularly shrimp and fish exports.

Thailand's agri-food system has undergone significant transformation, integrating modern technologies, expanding value-added processing, and diversifying export markets. However, smallholder farmers, who make up a large share of producers, often face productivity and market challenges.

Key Challenges

1. **Climate Variability and Water Management**

   Thailand's agriculture is increasingly impacted by climate variability, including erratic rainfall patterns, droughts, and floods. Nearly **60% of agricultural land is rainfed**, making crop yields vulnerable to water stress (Royal Irrigation Department Thailand, 2023). Water resource management is a major challenge, with uneven distribution of water between wet and dry seasons and competing demands from urban, industrial, and agricultural users. Groundwater depletion and pollution also threaten long-term sustainability.

2. **Land Fragmentation and Aging Farmer Population**

   Similar to many countries in the region, Thailand's farm holdings are largely small and fragmented, with over 80% of farms smaller than 10 hectares (Office of Agricultural Economics Thailand, 2022). Fragmentation limits mechanization and efficient use of inputs. Additionally, the agricultural labor force is aging, with youth increasingly migrating to urban centers for non-farm employment, leading to labor shortages and loss of traditional farming knowledge (IFPRI Thailand, 2023).

3. **Rising Production Costs and Input Dependency**

   Farmers face rising costs for fertilizers, labor, energy, and farm machinery. Dependence on chemical fertilizers and pesticides has environmental and health impacts, while also increasing vulnerability to price volatility. Smallholders often have limited access to affordable credit, constraining investments in modern inputs and technologies.

4. **Post-Harvest Losses and Supply Chain Inefficiencies**

   Post-harvest losses for fruits, vegetables, and perishable aquaculture products are estimated at **15-25%**, mainly due to inadequate cold storage facilities, poor transportation infrastructure, and fragmented supply chains (ADB Thailand, 2022). These inefficiencies reduce farmer incomes and limit

Thailand's ability to meet increasing domestic and export market demand for fresh, high-quality produce.

5. **Market Access and Price Volatility**

   Smallholder farmers often face difficulties in accessing high-value markets due to limited market information, weak bargaining power, and insufficient cooperative or farmer organization structures. Price fluctuations for key commodities like rice and rubber impact income stability (Bank of Thailand, 2023).

Good Practices

- **Promotion of Smart and Precision Agriculture**

  Thailand has been an early adopter of smart farming technologies such as GPS-guided machinery, drone monitoring, and IoT-based soil and weather sensors. These innovations improve input efficiency and productivity, especially in commercial farming zones (Kasetsart University, 2023).

- **Development of Farmer Cooperatives and Contract Farming**

  Government and private sector initiatives have strengthened farmer cooperatives and promoted contract farming arrangements, particularly in horticulture and aquaculture. This has enhanced market linkages, quality control, and access to finance for smallholders (Department of Agricultural Extension, Thailand, 2022).

- **Sustainable Agriculture and Organic Farming Expansion**

  Responding to domestic and global demand for organic and sustainable products, Thailand has expanded organic farming production through certification programs and support services, growing its market share in both local consumption and exports (Organic Agriculture Certification Thailand, 2023).

- **Value Chain and Export Upgrading**

Thailand has focused on upgrading value chains for key export commodities such as processed seafood, canned fruits, and ready-to-eat meals. Investment in quality standards, packaging, and cold chain logistics has supported Thailand's competitive edge globally (Thai Chamber of Commerce, 2023).

Forward-Looking Opportunities

- **Improving Water Resource Management and Irrigation Efficiency**

  Expanding irrigation infrastructure, modernizing water distribution, and promoting water-saving technologies such as drip and sprinkler irrigation will increase crop resilience and productivity, particularly in drought-prone areas (Royal Irrigation Department Thailand, 2023).

- **Scaling Digital Agriculture and Market Information Systems**

  Leveraging mobile platforms and big data analytics to deliver real-time weather, pest alerts, and market prices can empower farmers with timely information, reduce risks, and improve decision-making (Digital Economy Promotion Agency, Thailand, 2023).

- **Youth Engagement and Agripreneurship Promotion**

  Policies to attract youth into agriculture through training, innovation hubs, and access to finance can rejuvenate the sector and support sustainable rural livelihoods (IFPRI Thailand, 2023).

- **Climate-Smart Agriculture and Diversification**

  Encouraging climate-resilient crop varieties, agroforestry, integrated pest management, and diversified farming systems will enhance food security and environmental sustainability (FAO Thailand, 2023).

- **Expanding Export-Oriented High-Value Products**

  Strengthening certification, traceability, and branding of Thai fruits, herbs, and processed foods can open new premium markets in Asia, Europe, and North America (Thai Export Promotion Department, 2023).

5.15 Vietnam

Overview of the Agri-Food Economy

Agriculture is a cornerstone of Vietnam's economy, contributing approximately **14.5% of GDP** and providing livelihoods for around **40% of the workforce** (World Bank, 2023). The country has experienced a remarkable agricultural transformation over the past few decades, moving from food scarcity in the 1980s to becoming a **global powerhouse in agri-food exports** today.

Vietnam's agro-ecological diversity—from the fertile deltas of the Mekong and Red River to upland areas and mountainous zones—supports a wide array of agricultural activities. Key staples like rice and maize coexist with high-value cash crops such as coffee, rubber, pepper, cashew nuts, and aquaculture products including shrimp and pangasius fish. The country is the **world's third-largest rice exporter** and among the top producers and exporters of coffee and seafood (FAO Vietnam, 2023).

The rapid modernization of the sector has been fueled by government reforms, export-oriented policies, investment in irrigation and infrastructure, and increasing private sector participation. Despite these gains, much of Vietnam's agriculture is still practiced by smallholder farmers who face challenges in market access, technology adoption, and climate resilience.

Key Challenges

1. **Climate Change and Environmental Risks**

   Vietnam is one of the country's most vulnerable to climate change globally. Sea-level rise and increasing frequency of extreme weather events such as typhoons, droughts, and floods disproportionately affect the Mekong Delta—responsible for more than 50% of the country's rice production—and coastal aquaculture zones (UNDP Vietnam, 2023). Saltwater intrusion is expanding inland, reducing the arability of rice paddies and threatening food security and rural incomes.

2. **Smallholder Fragmentation and Limited Mechanization**

   Over 70% of Vietnam's agricultural land is farmed by smallholders with average holdings of less than 1 hectare (Vietnam General Statistics Office, 2022). These fragmented farms limit the use of mechanization and advanced technologies. Small-scale farmers also face barriers in accessing quality inputs such as certified seeds, fertilizers, and credit, leading to suboptimal yields.

3. **Water Resource Constraints**

   Vietnam's agricultural productivity is highly dependent on water availability. While the country has developed extensive irrigation systems, seasonal water shortages during dry months and floods during the rainy season disrupt production cycles. Competing demands for water from urbanization and industry further strain resources (MARD Vietnam, 2023).

4. **Post-Harvest Losses and Inadequate Infrastructure**

   Significant post-harvest losses—estimated at **15-25%**—occur due to limited cold storage facilities, poor transport networks, and insufficient processing capacity, especially for perishable fruits, vegetables, and seafood products (ADB Vietnam, 2022). This reduces farm incomes and export competitiveness.

5. **Market Access and Export Compliance Issues**

   Smallholders often lack sufficient information, certification, and capacity to meet the increasingly stringent quality and safety standards demanded by international markets. This challenge constrains value addition and limits participation in lucrative global value chains (IFPRI Vietnam, 2023).

Good Practices

- **Contract Farming and Producer Cooperatives**

  Vietnam has successfully expanded contract farming arrangements connecting smallholders with agribusinesses, especially in high-value crops

and aquaculture. This model provides farmers with inputs, technical training, and assured market access, improving incomes and reducing risks (Vietnam Ministry of Agriculture and Rural Development, 2023). Cooperatives have been instrumental in aggregating production and negotiating better terms.

- **Adoption of Climate-Smart Agriculture (CSA)**

  Programs promoting drought-tolerant rice varieties, salinity-resistant crops, efficient water management (e.g., alternate wetting and drying in rice fields), integrated pest management, and agroforestry have been widely piloted. These CSA techniques have enhanced resilience to climate variability, particularly in vulnerable regions like the Mekong Delta (UNDP Vietnam, 2023).

- **Digital Innovation and Extension Services**

  Government and private sector initiatives such as digital platforms provide farmers with real-time weather forecasts, pest alerts, market price updates, and crop advisory services. This use of ICT tools has improved productivity and helped smallholders make timely decisions (Vietnam Ministry of Information and Communications, 2023).

- **Export Value Chain Improvements**

  Investments in cold chain infrastructure, post-harvest processing, and certification systems (e.g., GlobalGAP, organic certification) have helped diversify export products and improve quality. These measures have boosted Vietnam's competitiveness in global markets for coffee, seafood, fruits, and spices (Vietnam Trade Promotion Agency, 2023).

Forward-Looking Opportunities

- **Water Management and Irrigation Modernization**

  Scaling up climate-resilient irrigation technologies, including drip irrigation and precision water management, combined with watershed protection

programs, can stabilize production and improve water use efficiency (MARD Vietnam, 2023).

- **Sustainable and Organic Agriculture Expansion**

  Rising global and domestic demand for organic and sustainably produced foods offers an opportunity for Vietnam to promote certification schemes and environmentally friendly farming practices, which could open higher-value market segments (FAO Vietnam, 2023).

- **Youth Engagement and Agripreneurship**

  Encouraging youth participation through improved access to education, finance, and technology can modernize rural economies and foster innovation in agribusiness. This would help address rural labor shortages and revitalize agriculture (IFPRI Vietnam, 2023).

- **Value Chain and Post-Harvest Infrastructure**

  Targeted investment in cold storage, transport logistics, processing, and packaging facilities will reduce losses, increase value addition, and strengthen linkages to export markets (ADB Vietnam, 2022).

- **Trade Diversification and Certification**

  Leveraging Vietnam's multiple free trade agreements and enhancing product certification and traceability systems will help diversify export destinations and products, maximizing benefits from global market access (Vietnam Trade Promotion Agency, 2023).

6. Good Practices in the Region

1. Agroecology & System of Rice Intensification (SRI) — Lao PDR, Nepal

Agroecology emphasizes sustainable farming that works in harmony with ecosystems, reducing reliance on chemical inputs and improving biodiversity. The **System of Rice Intensification (SRI)** is a flagship agroecological method that optimizes plant spacing, soil aeration, water management, and timing of inputs to boost rice yields sustainably.

- **Impact on Yields and Resource Use:**

  In **Lao PDR** and **Nepal**, adoption of SRI has led to rice yield increases between **15% and 25%**, outperforming conventional transplanting methods without increasing input costs significantly (FAO, 2021). This yield boost directly translates to higher food availability and incomes for smallholder farmers.

  Importantly, SRI reduces water use by about **30%**, addressing water scarcity challenges faced in rainfed and drought-prone areas (IRRI, 2020). This efficiency stems from alternate wetting and drying practices rather than continuous flooding, improving water productivity.

- **Environmental and Climate Benefits:**

  By improving soil health through organic matter retention and reduced chemical use, SRI contributes to long-term land productivity. It also lowers methane emissions from paddy fields, helping mitigate agriculture's climate impact (UNDP Nepal, 2023).

- **Scaling and Adoption Barriers:**

  Despite clear benefits, widespread adoption is constrained by knowledge gaps, labor requirements, and initial learning curves. Extension services and farmer-to-farmer learning have been effective in increasing uptake, supported by government and NGO programs (FAO Nepal, 2022).

2. Farmer Producer Organizations (FPOs) - India, Bangladesh

FPOs are farmer collectives that aggregate production and resources to achieve economies of scale, improve market access, and enhance bargaining power. This institutional innovation is particularly crucial for smallholders, who often face fragmented landholdings and limited voice in markets.

- **Benefits of Aggregation:**

  In **India**, over **10,000 FPOs** have formed under government initiatives, involving more than **6 million farmers** (Ministry of Agriculture India, 2023). By pooling resources, farmers reduce transaction costs related to inputs, credit, and marketing.

  For example, bulk purchasing of seeds and fertilizers lowers input costs by 10–15%, while collective marketing secures better prices, sometimes 15–25% above local rates. FPOs also enable access to formal financial services, insurance, and technical training, which smallholders often lack individually.

- **Bangladesh's Experience:**

  Bangladesh has promoted FPOs through initiatives like **Krishi Unnayan Kendro**, which offer training and digital advisory alongside aggregation services. These groups have helped increase smallholder incomes by **20–30%**, enhancing resilience and livelihoods (IFPRI Bangladesh, 2023).

- **Challenges & Support Needs:**

  Effective FPOs require capacity building in governance, business management, and financial literacy. Public support through credit guarantees, market linkages, and policy frameworks remains vital to sustain and scale these groups (NABARD India, 2022).

3. Digital Traceability Systems - Thailand, Indonesia

Digital technologies, especially blockchain, are revolutionizing supply chain transparency and food safety management, addressing growing consumer demands for provenance and compliance with international standards.

- **Audit Time Reduction and Transparency:**

  In **Thailand** and **Indonesia**, blockchain-based traceability systems have cut audit times by approximately **60%** by providing secure, immutable, and easily accessible records of product origin, handling, and certification (World Bank, 2023).
  This significantly reduces costs and time for exporters complying with strict global food safety regulations, while enabling rapid recall and quality control when needed.

- **Sectoral Applications:**

  Thailand's shrimp industry has successfully implemented blockchain to trace supply chains from farms to export markets, enhancing trust and preventing fraudulent labeling (FAO Thailand, 2022). In Indonesia, palm oil and coffee value chains have piloted traceability systems improving certification and price premiums.

- **Broader Impacts:**

  Enhanced traceability supports certification for organic, fair trade, and sustainability standards, opening new premium markets. It also empowers producers by increasing access to market information and improving negotiation power (ASEAN Secretariat, 2023).

4. Cold-Chain Public-Private Partnerships (PPPs) - India, Fiji

Cold chains are critical for reducing post-harvest losses of perishables and maintaining quality during transport and storage. High capital costs and operational complexity often hinder cold chain development in emerging markets.

- **Blended Finance to Reduce Capex Barriers:**

PPPs utilizing blended finance mechanisms—combining public funds, concessional loans, and private equity—have lowered capital expenditure barriers by about **25%** (ADB, 2022). This makes investments in cold storage and refrigerated transport financially viable for private operators, who otherwise face high risk and upfront costs.

- **India's Large-Scale Initiatives:**

  The Indian government's **Agri Infrastructure Fund** and **PM FME Scheme** support construction of cold storage with co-financing and interest subvention, benefiting millions of smallholder farmers and reducing food loss estimated at 18–40% for perishables (MoFPI India, 2023). These investments also improve export readiness for fruits, vegetables, dairy, and fisheries.

- **Fiji's Development Bank Model:**

  In Fiji, the Development Bank offers value-chain finance with a **30% risk-sharing guarantee** to smallholder borrowers investing in cold rooms, notably for high-value crops like kava. This has increased kava prices by **25%** by improving product quality and shelf life (ADB Fiji, 2023).

5. Risk-Sharing Finance and Warehouse Receipt Systems - Thailand, Pakistan

Warehouse receipt systems (WRS) allow farmers and traders to deposit commodities in certified warehouses and use receipts as collateral to access working capital finance. These systems reduce distress sales and improve price discovery.

- **Thailand's Warehouse Receipt Financing:**

  Thailand's WRS system is supported by government-backed risk funds absorbing lender default risks. This encourages banks to extend credit at reduced interest rates, improving liquidity for farmers and traders (Bank of Thailand, 2023).The program has lowered post-harvest losses and enabled better timing of sales, increasing farmer incomes and market stability.

- **Pakistan's e-Warehouse Receipt (e-WR) System:**

  Pakistan has digitized WRS through e-WRs, which streamline issuance, transfer, and validation of receipts electronically. The system has unlocked over **USD 200 million** in working capital finance within three years, supported by a **30% risk-sharing mechanism** funded by the government (State Bank of Pakistan, 2023). This innovation has increased lender confidence and reduced transaction times from days to hours.

- **Regional Significance:**

  Such risk-sharing and digitization efforts reduce financing costs and improve access to credit for smallholders and agribusinesses, enabling investments in storage, quality improvements, and market expansion (IFC, 2023).

** These innovations exemplify how public and private sector collaboration, combined with technology and institutional reform, can unlock inclusive and sustainable agricultural development across Asia-Pacific.*

6.1 Cross Regional Learning

Asia and the Pacific encompass highly diverse agri-food systems, but they also share converging challenges—from climate risks and post-harvest losses to digital divides and trade barriers. This section highlights promising cross-country practices that can be **adapted, not copied**, to accelerate inclusive, climate-resilient, and market-responsive supply chains.

A. Cold Chain Expansion Models

Vietnam and **Thailand** have invested in integrated cold chain systems—reducing post-harvest losses in seafood and horticulture by up to 20%. Source: FAO. *Post-Harvest Management in Asia-Pacific Region*

Relevant for:

- **Bangladesh, Pakistan, Fiji**: where post-harvest losses for perishables are 15–30%.
  Source: ADB. *Cold Chain Logistics in Asia* (2021)

B. Digital Advisory and Farmer Platforms

India's e-NAM connects over 1,300 mandis and 17 million farmers, enhancing market access and price transparency.

Indonesia's TaniHub and **Vietnam's VnSat Project** digitize input access, extension services, and market linkages.

Source: World Bank VnSAT Project

Relevant for:

- **Afghanistan, Myanmar, Lao PDR** with low smartphone penetration (Afghanistan: 18%)

  Source: GSMA. *Mobile Internet Connectivity 2023*

C. Farmer Producer Organizations (FPOs)

India has built over 10,000 FPOs supported by the government and SFAC, improving input access, aggregation, and credit.

Source: FAO. *Farmer Producer Organizations in India: A Policy Note*

Relevant for:

- **Nepal, Afghanistan, Myanmar** – where smallholder fragmentation limits economies of scale.

D. Climate-Smart Irrigation and Water Governance

Iran's SAWA model in Fars province reduced irrigation water use by 34% using cropping plans and solar pumps.

Source: Mordor Intelligence. *Iran Agriculture Market Analysis*

India's PM-KUSUM promotes solar pumps across rainfed zones.
Source: MNRE, Government of India

Relevant for:

- **Pakistan, Lao PDR** – where >90% of freshwater is used for agriculture
  Source: FAO AQUASTAT – Pakistan

E. Agri-Fintech and Warehouse Receipt Systems

Thailand's warehouse receipt system links farmers to credit without requiring land collateral.

Source: FAO Asia-Pacific. *Innovative Finance in Agriculture*

Vietnam's cooperative banks provide tailored rural lending with lower risk.

Relevant for:

- **Fiji, Bangladesh, Sri Lanka** – where <20% of farmers access formal credit
  Source: IFPRI South Asia Blog – *Financial Inclusion and Agriculture*

F. Aquaculture and Fish Value Chains

Indonesia's eFishery has equipped 70,000+ fish farmers with IoT-enabled feed systems, reducing costs and increasing yields.

Source: AgroSpectrum Asia

Relevant for:

- **Vietnam, Philippines, Fiji** – where fish loss due to poor cold storage remains high.

G. Traceability and Export Compliance

Thailand uses blockchain traceability in its seafood exports to meet EU/US standards.
Source: FAO Globefish – *Traceability in Seafood Value Chains*

Malaysia's MSPO and RSPO palm oil certifications enable sustainable sourcing.
Source: Malaysian Palm Oil Council

Relevant for:

- **Sri Lanka and Iran**, where quality exports like tea and saffron can benefit from traceability.

H. Agri-Tech Startups and Digital Innovation

India has over 700 agri-tech startups. **S4S Technologies** alone has cut post-harvest losses by 40% using solar dehydrators.

Source: Scroll.in – *Solar startups tackling food loss*

Malaysia promotes AgriTech innovation via **MDEC's Sandbox initiative**
Source: Malaysia Digital Economy Corporation

Relevant for:

- **Pakistan, Bangladesh, Philippines** – where ecosystems for innovation are still emerging.

I. Toward a Regional Knowledge Exchange

Proposed actions:

- Launch a **South–South Learning Hub** under APAARI or SAARC
- Facilitate **twinning programs** (e.g., India–Myanmar on FPOs)
- Build a **Commons Digital Repository** for scalable agri-tech and governance tools

Source: FAO RAP. *Knowledge Sharing in Asia-Pacific Agriculture*

Example: India–Myanmar FPO collaboration; Indonesia–Philippines aquaculture traceability workshop.

7. Emerging Opportunities in Agri Food Supply Chain in Asia Pacific

The Asia-Pacific region, home to a large proportion of the world's agricultural producers and consumers, faces complex challenges: climate change, infrastructure gaps, market fragmentation, and inefficient supply chains that result in high post-harvest losses and limited farmer incomes. However, the region is witnessing rapid innovation across multiple fronts that promise to transform agri-food supply chains into more climate-resilient, transparent, inclusive, and efficient systems. These emerging opportunities align with regional sustainability goals and create pathways for economic growth and rural development.

7.1 Climate-Smart Infrastructure: Financing Low-Carbon and Resilient Agri Supply Chains

Green Bonds for Solar Cold Rooms

Vietnam's Mekong Delta — a critical rice-producing region — is pioneering the issuance of green bonds to finance solar-powered cold rooms under the "One Million Hectares" low-carbon rice initiative led by FAO and Agribank. This innovative financing mobilizes institutional capital specifically for climate-resilient infrastructure that supports smallholders and agri-SMEs. Solar cold rooms reduce reliance on fossil fuels, lower energy costs, and extend the shelf life of perishables, which is vital for reducing post-harvest losses in tropical climates (FAO Vietnam, 2025).

Meanwhile, the APEC Business Advisory Council endorses "currency-indexed climate bonds" that can be adopted across Asia-Pacific to fund renewable energy and agritech infrastructure, including decentralized solar cold chains. By linking bond performance to currency indexes, these financial instruments can appeal to regional investors wary of currency risks (Reuters, Aug 2024).

Rice-Methane Carbon Credits via Alternate Wetting and Drying (AWD)
Rice cultivation is a significant source of methane emissions, a potent greenhouse gas. AWD technology reduces methane release by periodically drying rice paddies instead of continuous flooding. This practice has been linked to carbon credit generation, which provides farmers with an additional revenue stream.

- In Vietnam's Nghe An province, AWD is projected to generate approximately 2.5 million Gold-Standard carbon credits by 2034 from 62,000 hectares of rice paddies (Green-Carbon Co Ltd, Apr 2025).
- Thailand's T-VER pilot program aims to cut 450,000 tonnes of CO_2 equivalent over five years, showcasing government-backed domestic carbon markets (Thailand T-VER).
- India trades rice methane credits at USD 17–18 per tonne, providing economically meaningful supplementary income to farmers practicing AWD (Qcintel, May 2025).

The IRRI MASEA program supports AWD adoption across Southeast Asia, linking it with carbon finance to scale climate-smart agriculture (CGIAR, 2024).

Supply-Chain Impact:

- Institutional climate finance supports infrastructure that reduces food spoilage and energy consumption.
- Farmers earn supplemental income through carbon credits, encouraging adoption of sustainable practices.
- Reduced methane emissions contribute to national climate goals.

7.2 Digital Platforms: Enhancing Market Access and Coordination

Interoperable Farmer Registries and e-Logistics

India's National Agriculture Market (eNAM) is one of the world's largest digital platforms, connecting 17.8 million farmers, 243,000 traders, 2,575 Farmer Producer

Organizations (FPOs), and over 1,300 markets. It facilitates over ₹2.5 lakh crore (about USD 30 billion) in transactions annually, promoting transparent pricing and reducing exploitation by intermediaries (Economic Times, Dec 2024).

Regional initiatives like Karnataka's Unified Market Platform (UMP) build on eNAM's success by integrating logistics services, quality testing, and market information, enabling seamless movement of goods.

Digital Advisory and Extension

Digital Green leverages video-based training to reach over 150,000 Indian farmers—70% of whom are women—improving water efficiency and pesticide use. In Southeast Asia, platforms provide real-time weather alerts, pest management advice, and market price updates, helping farmers optimize harvest timing and reduce losses.

Supply-Chain Impact:

- Digital connectivity improves farm-to-market coordination, reducing delays and spoilage.
- Market transparency empowers farmers to negotiate better prices.
- Improved advisory services increase productivity and sustainable input use.

7.3 Inclusive Value Chains: Empowering Women and Youth, Mobilizing Diaspora Capital

Women-Led Cooperatives

Empowering women in agriculture through cooperatives enhances their access to credit, quality inputs, and markets, closing income gaps and fostering community resilience. Gender-inclusive value chains also improve food security and nutrition outcomes.

Youth-Led Agritech and Startups

In Thailand and India, youth entrepreneurship is accelerating agritech innovation. Startups like Fasal use Internet of Things (IoT) sensors to monitor crop health and soil conditions across 80,000 hectares, enabling water and pesticide savings while increasing yields (Fasal).

Diaspora Investment Windows

New financial mechanisms like diaspora bonds and blended finance vehicles aim to channel expatriate remittances into rural agri-enterprises, providing long-term capital for infrastructure and technology adoption.

Supply-Chain Impact:

- Inclusive models diversify ideas and skills in agriculture.
- Youth engagement fosters innovation and technology adoption.
- Access to diaspora capital increases rural enterprise financing.

7.4 Regional Trade Harmonization: Facilitating Cross-Border Perishables Movement

Sandbox Corridors for Perishables

Pilot projects in ASEAN and South Asia are testing streamlined border procedures, integrated cold chain inspections, and fast-track clearances to reduce transit times for fruits, vegetables, and seafood (ASEAN Secretariat, 2025).

Mutual Recognition of Good Agricultural Practice (GAP) Certifications
ASEAN countries and South Asia are piloting mutual recognition of GAP certifications to reduce duplicative audits and ease compliance burdens for exporters (SAARC).

Digital phytosanitary certificates piloted by New Zealand and Australia accelerate fresh produce exports by automating and validating plant health documents (NZ MPI, 2024).

Supply-Chain Impact:

- Reduced border delays lower food spoilage and transaction costs.
- Harmonized certifications increase export competitiveness.
- Expanded market reach supports small-scale exporters.

7.5 Blockchain and Traceability: Building Transparency and Trust

- Singapore Food Agency pilots blockchain systems for seafood traceability to comply with strict food safety standards and meet consumer demand for sustainable provenance (Singapore Food Agency, 2025).
- Indonesia's eFishery combines IoT and blockchain to connect shrimp farmers directly with buyers, improving price transparency and eliminating middlemen costs (Tech in Asia, 2025).
- Australia's AgriDigital uses blockchain to digitize grain supply chain finance, reducing settlement times and enhancing trust between farmers, traders, and buyers (AgriDigital, 2024).

Supply-Chain Impact:

- Improved product traceability reduces fraud and contamination risks.
- Enables compliance with export and safety standards.
- Facilitates smoother cross-border transactions and financing.

7.6 AI, Satellite Imagery, and Data-Driven Logistics Optimization

China employs AI for pest detection and irrigation management, helping farmers optimize input use and increase yields (China Ministry of Agriculture, 2024). Australia's CSIRO leverages satellite remote sensing for drought monitoring and crop forecasting, improving supply chain planning (CSIRO, 2024). The Philippines' CropCare platform integrates drone imagery with logistics advisory to reduce losses and better time harvests and transport (Philippines DA, 2024).

Supply-Chain Impact:

- Data-driven tools optimize transportation routes and inventory management.
- Reduce post-harvest losses by better coordinating harvest and market timing.
- Enhance precision agriculture and input efficiency.

7.7 Expansion of Climate-Resilient Cold Chain Infrastructure

Solar-powered cold rooms and decentralized cold chain hubs are expanding across the region:

- Vietnam's green bonds finance solar cold rooms, targeting smallholder farmers in the Mekong Delta (FAO Vietnam, 2025).
- India's Production Linked Incentive (PLI) scheme promotes modernization of refrigerated storage and transport, focusing on rural and tier-2 markets (MoFPI India, 2023).
- Indonesia invests in solar-powered cold chain hubs to enhance export quality of fruits and vegetables (Indonesia Ministry of Agriculture, 2024).

Supply-Chain Impact:

- Reduced post-harvest losses (currently between 18-40% for perishables).
- Improved product quality and shelf life.
- Expanded export and domestic market opportunities.

7.8 Digital Marketplaces and E-Logistics Platforms

Digital marketplaces are revolutionizing farm-to-consumer linkages:

- India's eNAM digitalizes over ₹2.5 lakh crore in agricultural transactions yearly (Economic Times, 2024).
- Indonesia's TaniHub and Vietnam's PostMart directly connect farmers to urban consumers through online marketplaces and coordinated logistics (TaniHub, 2024; PostMart, 2024).
- Thailand's Unified Market Platform interoperates with eNAM for cross-border logistics and quality assurance (Thailand Ministry of Commerce, 2024).

Supply-Chain Impact:

- Reduces reliance on middlemen and fragmented supply chains.
- Enhances market access and price transparency for smallholders.
- Streamlines aggregation and distribution logistics.

7.9 Agri-Finance Innovations Linked to Supply Chain Efficiency

Financial inclusion improves through tailored services linked to supply chain participation:

- Bangladesh's bKash mobile platform provides input financing and crop insurance linked to supply chain milestones (bKash, 2024).
- Indonesia's TaniFund offers peer-to-peer lending for agri-SMEs to invest in cold storage, vehicles, and equipment (TaniFund, 2025).
- Vietnam's Finhay pilots satellite-enabled crop insurance products tied to harvest quality and volume, reducing lender risk (Vietnam Ministry of Finance, 2024).

Supply-Chain Impact:

- Improves access to affordable credit for infrastructure and working capital.
- Enhances reliability of supply chains through linked financing.
- Supports smallholder integration into formal markets.

7.10 Regional Trade Harmonization and Perishable Goods Corridors

Pilot projects in ASEAN and South Asia seek to harmonize trade regulations and fast-track perishables:

- ASEAN sandbox corridors feature integrated cold chain inspections and fast-track border clearance for fruits, vegetables, and seafood (ASEAN Secretariat, 2025).
- Mutual recognition of GAP certifications reduces redundant audits in South Asia, streamlining export compliance (SAARC).
- Digital phytosanitary certificates in New Zealand and Australia accelerate cross-border movement of fresh produce (NZ MPI, 2024).

Supply-Chain Impact:

- Faster transit times reduce spoilage and logistics costs.
- Improved export competitiveness for small exporters and agribusinesses.
- Expanded regional market integration.

8. Recommendations

8.1 Invest in Climate Resilience

- **Scale Early-Warning Systems**

  Expand satellite- and phone-based alert networks covering **50+ million smallholders**, enabling tracking of weather alerts, pest outbreaks, and flood/drought risk. FAO-ADB reports show timely warnings can reduce crop damage by up to 40% gcca.org+1qassurance.com+1.

- **Deploy Climate-Resilient Seeds**

  Subsidize drought- and flood-tolerant rice and vegetable varieties across 20% of the Mekong Delta, Red River, Indo-Gangetic Plain, and Pacific atolls. Carbon finance (e.g., rice methane credits) provides payback via reduced yield loss and new revenue streams farmonaut.com+13fao.org+13fao.org+13.

- **Create Solar Cold Room Infrastructure via Green Bonds**

  Support issuance of at least USD 30 million in Vietnam and Indonesia to finance 500 solar-powered cold rooms. Use APEC-style "currency-indexed climate bonds" to minimize interest and currency risk.

8.2 Strengthen Integrated Cold Chains

- **Expand Public-Private Cold-Chain Infrastructure**

  Mobilize USD 500 million in viability-gap funded PPPs across India, China, Vietnam, Thailand, and Indonesia. Use Government matching grants (25% capex) tied to cold-chain nodes (collection center, transport, and supermarket). India's NCCD estimates INR 8–15 billion in annual waste savings.

- **Flatten FDI Restrictions for Cold-Chain Investors**

  Encourage 100% FDI in cold-chain segments to attract GCCA members and IFC investors through stable subsidies, tax holidays, and concessional loans .

8.3 Unlock Inclusive Finance

- **Scale Warehouse Receipt Systems (WRS)**

  Roll out standardized WRS platforms across ASEAN countries supported by seed-risk pools (10% government) to de-risk bank lending. India's StarAgri model—1,400+ outlets—is a ready template.

- **Launch Blended-Finance Smallholder Funds**

  Use IFC-style de-risking to create USD 100 million blended funds targeting regenerative rice, horticulture, and dairy. Thailand's USD 120 million public-private fund (Olam, GCF, etc.) proved effective.

- **Secure Diaspora Investment Channels**

  Introduce diaspora bonds in Sri Lanka, Philippines, and Pacific Island nations focused on agri-SME lending. Offer tax-effective windows with minimal sovereign risk.

8.4 Digitalize for Transparency

- **Develop Interoperable Farmer Registries**

  Expand India's eNAM/UMP model to ASEAN by 2026—targeting India-level coverage in Malaysia, Vietnam, Philippines, and Indonesia. Ensure FPOs/cooperatives manage data with open APIs for buyers and logistics.

- **Pilot Blockchain Traceability for Export Crops**

  Launch blockchain pilots in shrimp (Thailand), coffee (Vietnam), and durian (Malaysia) exports. Document 60% cut in audit and certification time; integrate with e-logistics apps.

- **Deploy e-Extension & e-Logistics Apps**

Invest in video-based, AI-augmented extension systems covering ≥500,000 farmers—targeting 70% women reach, similar to Digital Green . Offer e-logistics tools at mandi/CDP levels, integrating cooling hubs and order tracking

8.5 Enhance Governance Coordination

- **Form Inter-Ministerial Agri-Logistics Task Forces**

  National bodies (e.g., Thailand: Agriculture, Trade, Transport, Finance) to streamline import tariffs, cold-chain standards, and WRS. Include private cold-logistics vs PPP teams under the Ministry of Finance/Investment.

- **Align Subsidies with Climate Goals**

  Tie input subsidies (fertilizer, seeds, energy) to carbon-neutral standards—e.g., subsidy only for AWD-certified rice, solar-powered irrigation, or organic inputs. Encourage NDC alignment and international climate finance.

9. Conclusion

Transforming agri-food supply chains across Asia and the Pacific demands coordinated action rooted in climate resilience, inclusive finance, and digital innovation. By leveraging good practices and scaling proven solutions, the region can safeguard food security, boost rural incomes, and achieve its 2030 sustainable development ambitions.

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