Advancing Shared Prosperity: Best Practices in Productivity Gainsharing in Asia's Agrifood Sector

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ADVANCING SHARED PROSPERITY: BEST PRACTICES IN PRODUCTIVITY GAINSHARING IN ASIA'S AGRIFOOD SECTOR

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Advancing Shared Prosperity: Best Practices in Productivity Gainsharing in Asia's Agrifood Sector

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FOREWORD

The agrifood sector has long been served as a cornerstone of economic development, food security, and rural livelihoods in Asia. In recent years, however, the sector has faced mounting challenges – including fragmented supply chains, rising production costs, market volatility, and the impacts of climate change. These issues have increased the need for innovative mechanisms that not only improve agricultural productivity but also ensure that the resulting benefits are shared fairly among all stakeholders. One such approach is productivity gainsharing, which aims to create more equitable and sustainable agrifood systems by aligning incentives across farmers, workers, cooperatives, agribusinesses and policymakers.

In this context, it has become increasingly important to identify and promote best practices in productivity gainsharing. As many APO member economies still rely heavily on smallholder and subsistence farming systems, producers often struggle to capture a fair share of the value they help to create. Addressing this imbalance is critical not only for improving farm-level incomes and motivation but also for strengthening food systems' resilience, competitiveness, and social cohesion. A better understanding of how gainsharing can be implemented in different settings offers valuable insights for designing inclusive and sustainable agricultural policies across the region.

This research, conducted by national experts from ten APO members, provides a comprehensive comparative analysis of successful productivity gainsharing models in diverse agrifood sub-sectors ranging from fisheries and horticulture to poultry farming, cashmere production, and low-carbon rice cultivation. The report highlights practical mechanisms, such as cooperative-based frameworks, public-private partnerships, and digital tools that enhance transparency, efficiency, and equitable profit distribution. By synthesizing these experiences, the report offers actionable policy recommendations and strategic interventions to guide stakeholders in scaling effective gainsharing approaches tailored to local needs and contexts.

The APO extends its gratitude to the experts who prepared this report, led by Chief Expert Dr. Nazrul Islam, Visiting Professor and Director of NSU-UWA Agribusiness Centre of Excellence, North South University, Bangladesh, and national experts from Bangladesh, India, Lao PDR, Mongolia, Nepal, Pakistan, the Philippines, Thailand, Turkiye, and Vietnam. It is hoped that *Advancing Shared Prosperity: Best Practices in Productivity Gainsharing in Asia's Agrifood Sector* serves as a meaningful resource in building more inclusive, sustainable, and resilient agrifood systems across the Asia-Pacific region.

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BEST PRACTICES IN PRODUCTIVITY GAINSHARING IN ASIA'S AGRIFOOD SECTOR

Executive Summary

The agrifood sector is a critical driver of economic development, food security, and rural livelihoods across Asia. As agricultural productivity continues to evolve, gainsharing models have emerged as effective mechanisms for promoting equitable profit distribution, enhancing efficiency, and fostering sustainability among stakeholders. This executive summary consolidates best gainsharing practices from 10 countries (Bangladesh, India, Lao PDR, Mongolia, Nepal, Pakistan, Philippines, Thailand, Turkiye, and Vietnam), highlighting key findings, challenges, and strategic recommendations.

Bangladesh's Daudkandi floodplain aquaculture model exemplifies inclusive profit sharing, sustainable resource use, and local community ownership. This community enterprise approach is the best practice for integrating smallholders into gainsharing frameworks within the agrifood sector.

India's farmer producer organizations mitigate market fragmentation in tomato farming, reducing reliance on intermediaries and enhancing price negotiations. Best practices include contract farming and digital marketplace integration (open network for digital commerce) within cooperative frameworks.

In Lao PDR, public–private partnerships (PPPs) are being promoted in the rice production sector. Key best practices include strengthening farmer cooperatives by improving irrigation systems and processing infrastructure.

In Mongolia, the cashmere wool sector faces market volatility due to fluctuating fiber quality and income instability among herders. Cooperative gainsharing models are regarded as the most effective approach to ensuring fair revenue distribution, performance-based pricing, and traceability using digital tracking systems.

Nepal's beekeeping industry maintains high producer profit retention (85%), yet market access remains challenging. Direct marketing models through cooperative trade networks are found to be successful gainsharing solutions.

Pakistan's apricot and cherry farming faces certification barriers, weak infrastructure, and market isolation. Besides the fruit sector, tunnel farming and off-season vegetable production provide a good revenue base for sustainable livelihoods. Quality input supplies, value addition, packaging, branding, and certification are suggested to be prioritized for better economic growth in fragile small farm communities. Farmer cooperatives, digital trade hubs, sustainable irrigation systems, and PPP models are effective gainsharing solutions.

In the Philippines, the broiler chicken industry benefits from cash-based incentives and IoT-driven production tracking; however, the sector continues to face challenges related to price volatility. Performance-based profit distribution through process improvement frameworks is suggested as a best practice.

Thailand's shrimp industry suffers from fragmented supply chains, limiting profit distribution efficiency. Expanding blockchain-based traceability, financial commitment, and standardization are suggested solutions.

Turkiye's aquaculture sector exhibits gaps in producer-level efficiency yet maintains strong technological innovations in wholesale and export. Cold chain management improvements and direct-to-market digital trade are regarded as best practices.

Vietnam's Mekong River Delta prioritizes low-carbon rice farming, which has cut production costs by 16% while boosting sustainability. Alternate wetting and drying irrigation, organic fertilization techniques, and training farmers to leverage resources are considered effective solutions.

The aforementioned summary suggests that while fragmented supply chains, price instability, and infrastructure limitations persist, cooperative models, digital innovations, and policy-driven frameworks present scalable solutions for long-term agricultural growth, equitable market access, and environmental sustainability and effective gainsharing.

Introduction

Background and Importance

In the post-COVID-19 period, disruptions to global food supply chains and food price inflation affected all countries, heightening concerns about food insecurity. With ongoing changes in terms of trade issues, the threat of climate change, depleting natural resources, flood and drought hazards, and tight macroeconomic conditions, the pressure to improve agricultural productivity and ensure the equitable distribution of its gains across the agrifood supply chain stakeholders is crucial for the development of rural, regional, and national economies.

Against this backdrop, it becomes essential to assess best practices in productivity gainsharing within the agrifood sector (Barrett, 1996; Goldsmith, 2016; Cook, 2018). APO member countries typically have small-scale individually operating farmer structures; thus, such assessment is essential for driving productivity improvements, fostering collaboration, motivating employees, enhancing performance, and promoting sustainable growth and competitiveness in the agriculture and food industry (Cook & Iliopoulos, 1999; Nilsson et al., 2009). Historically, subsistence farming prevailed in Asian countries for several reasons, resulting in small-scale, individually operating farming structures. Consequently, farmers are often deprived of a fair share of the productivity enhancement gains resulting from their labor and efforts in agrifood sectors (Stringer et al., 2008; Deininger, 1995).

Failure to secure better prices may lower farmers' productivity and negatively impact the agrifood sector by hindering economies of scale, restricting market access, and impeding access to extension services and shared resource facilities (Barrett, 1996; Hazell, 2005). Regarding farmers' gains, this small-scale structure is an issue of concern as farmers lack bargaining power, and intermediaries win a large share of the consumers' final prices. To address such issues, the governments of the APO member countries have introduced different price controls and hedging techniques by forming farmer organizations/cooperatives. Assessing the effectiveness of these measures in productivity gainsharing and comparing them across countries can yield important policy insights.

The agrifood sector is complex, diverse, and vulnerable to weather-related risks and market volatility, with products being susceptible to perishability (Islam, 2011). Globally, this sector is rapidly evolving as it must adapt to the ever-increasing demand for food and changing market and weather conditions. It primarily relies on weather conditions, uses a wide range of technology, is intimately connected to natural resources, and has a global reach. When people eat, they get involved in the agrifood sector as consumers of its final products. Farmers are involved as producers of the raw materials that ultimately make their way to the end consumer. This vast and dynamic system has complex, local, regional, and global dimensions in food production and marketing. When people walk through a local village market or a grocery store in a city, they can observe the wide range of activities involved in growing, harvesting, transporting, processing, and distributing various types of foods and food products nationally and globally.

Interestingly, the activities ranging from primary food production to marketing are highly complex, yet they occur daily within the food production chain and marketing systems. At various stages of these processes, some form of gainsharing is practiced among the people and organizations involved. This food production and marketing system comprises thousands of businesses, ranging from small subsistence farms raising livestock such as baby goats in rural, remote villages to some of the largest retail corporations in the world. The definition of a "worldclass food system"[1] posits that in a food system, firms, farms, and food companies come together in the food production and marketing system; within and across the supply chain, stakeholders have a person or group responsible for ensuring that things get done and that participants receive a fair share of gains for their contributions.

Study Objectives

This study evaluates the best practices in productivity gainsharing within the agrifood sectors in APO member countries, with the aim of identifying challenges and prospects and suggesting appropriate policy and implementation strategies to enhance productivity across the supply chain.

Key objectives are:

- Identify economically, socially, and environmentally important agrifood sectors in APO member countries.
- Explore best practices in farm productivity gainsharing across stakeholders within the identified agrifood sectors.
- Assess the effectiveness of these productivity gainsharing approaches.
- Provide policy recommendations based on the lessons learned from member countries.

Rationale

Other things remaining constant, an increase in farm-level productivity will likely improve value gains for producers (primarily farmers) in agrifood sectors and support the implementation of gainsharing mechanisms throughout the supply chain. This situation, in turn, leads to poverty reduction among farmers and improves the country's local, regional, and national living standards and food security.

However, the literature reveals that different incentives exist to measure organizational productivity in terms of who is measuring and who is being measured (Doyle & Ridout, 1985). Theoretically, such individuals should invest in productivity, for which they can be held responsible. Policymakers, in practice, place a high value on ambiguity and vagueness. In any event, personnel within an organization may have little incentive to initiate or accept measurement unless the reward system is proactive and fair (Chowdhury & Hoque, 1998). Employees tend to suspect measurement is part of cutting back, downsizing, or controlling efforts. Similar theories and practices may also be applicable in the agrifood sector, where several combinations of stakeholders exist, ranging from individually operated and scattered small subsistence farms to large corporate business enterprises. Many of these stakeholders may lack the incentive and ability to measure productivity gainsharing across the value chain; however, such information is important from a policy-making perspective.

Research Scope

This research covers a diverse range of agrifood sectors to capture the variety of production systems, distribution mechanisms, gainsharing practices, and economic conditions in 10 APO member countries: Bangladesh, India, Lao PDR, Mongolia, Nepal, Pakistan, the Philippines, Thailand, Turkiye, and Vietnam. It includes small-scale farmers and large agribusiness operations and focuses on key components of the agrifood sector, such as agricultural production, food processing, and supply chain management.

1 Worldclass food system is a complex and diverse system "providing a well-managed process that includes the production, processing, distribution, and consumption of high quality safe and secure food and well management of waste, contributing to a growing, competitive and market oriented agriculture and to the wellbeing of the rural community, farm security, environmental sustainability, and economic diversification while responding to the domestic and international changing food needs with a secured high quality and nutritious food supply" (Islam, *et. al.*, 2011).

This study explores the implementation and impact of gainsharing models, which involve distributing cost savings or performance gains among employees. Furthermore, it analyzes different models such as profit sharing, bonus systems, and performance incentives and assesses their economic outcomes such as productivity improvements, cost reductions, and profitability emerging from social impacts, including employee motivation, job satisfaction, and community development.

Significance

The study aims to (a) help agrifood businesses enhance competitiveness through efficient production and better workforce engagement and (b) encourage practices that boost economic performance and ensure environmental sustainability and social equity. We also aim to (c) provide policymakers with insights into effective incentive structures promoting agricultural innovation and fair labor practices and (d) equip agrifood sectors with adaptable gainsharing models tailored to local circumstances and innovation needs. Finally, this study aims to (e) strengthen collaboration between stakeholders in agrifood sectors, including governments, businesses, and communities. Researching gainsharing's impact in these settings can contribute to more sustainable and equitable growth in the agrifood sector across Asia.

Structure of the Report

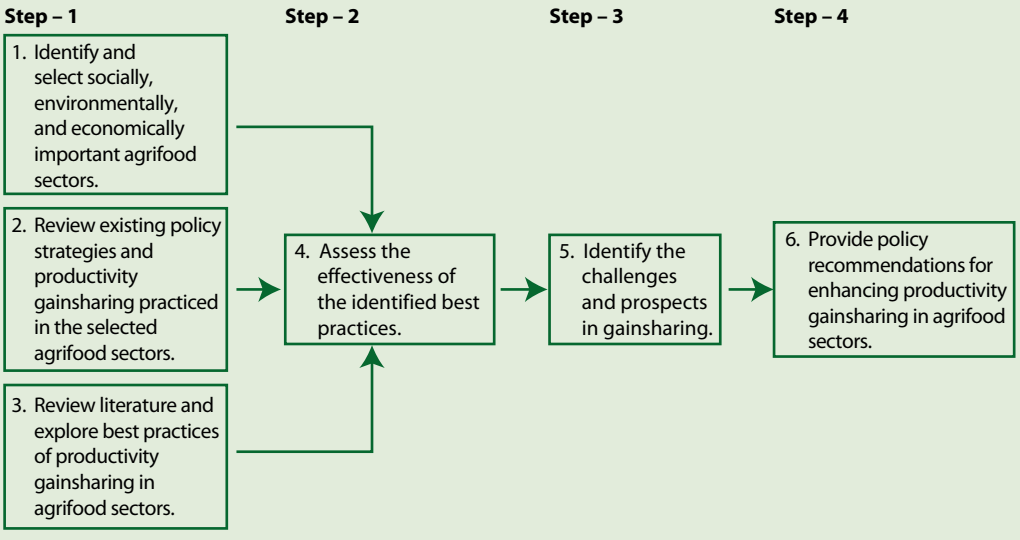
This report is structured into nine sections. Section 2 describes the research methodologies, whereas Section 3 presents the definition and theoretical foundation of productivity gainsharing and its role in the agrifood value chains. Section 4 outlines the comparative analysis of productivity gainsharing models across the 10 APO countries. A country-specific summary of the best practices is described in Section 5. The key findings and best practices regarding common themes, cross-sectoral lessons, and innovations in the successful gainsharing model are synthesized in Section 6, whereas Section 7 discusses the challenges and barriers to effective implementation. The key policy recommendations and strategic interventions are highlighted in Section 8, and Section 9 provides conclusive comments with potential future research directions.

Methodologies

This research was conducted by the respective national experts (NEs) of the 10 APO member countries (Bangladesh, India, Lao PDR, Mongolia, Nepal, Pakistan, Philippines, Thailand, Turkiye, and Vietnam) following a four-step process (Figure 1). Step 1 primarily involved extensive desk research to identify

FIGURE 1

THE RESEARCH PATH



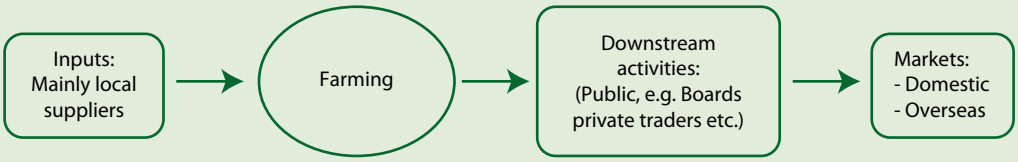
and select an agricultural sector and/or sub-sector of local and regional importance in terms of the economic, social, and environmental context of the participating APO countries. Furthermore, it involved reviewing public documents on existing policies and strategies for productivity gainsharing practices and reviewing research papers related to studies on productivity gainsharing methods and practices in agrifood sectors.

In Step 2, the effectiveness of productivity gainsharing practices in the selected sectors/sub-sectors is assessed using a mixed methods approach; qualitative assessment and/or quantitative measurement are conducted using various analytical methods. The assessment identifies the challenges and opportunities associated with the implementation of gainsharing practices in the agrifood sector, focusing on legal and regulatory issues, effectiveness of measurement approaches, financial implications, governance and coordination challenges, technological barriers, and sustainability concerns.

In this study, an "agrifood sector" is defined as encompassing primary farm commodity production, secondary processing of those commodities, creation of final consumable products, and all other stakeholders (backward and forward linked) involved in the supply chain. Figure 2 illustrates a typical and simple agrifood supply chain structure representing the backward and forward connectivity of primary farm commodity production regarding resource use, processing, transporting, and marketing to final consumers.

FIGURE 2

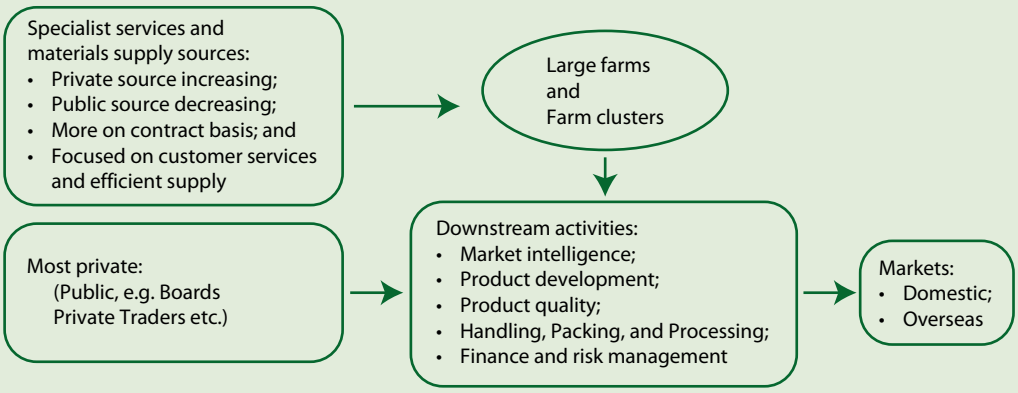
TYPICAL AGRIFOOD SUPPLY CHAIN STRUCTURE



Given the size, diversity, and complexity of production, processing, distribution, and marketing activities, the supply chain structure of an agrifood supply chain may significantly vary and become increasingly complex. Figure 3 presents an example of such complex variations. The sources of services and material supplies to farms are shifting from public to private sectors, farm size and structures are evolving, and downstream activities are becoming increasingly dependent on private outsourcing. A systematic approach is required to assess productivity gainsharing and best practices among the diverse stakeholders across the complex agrifood supply chain.

FIGURE 3

VARIATIONS IN AGRIFOOD SUPPLY CHAIN STRUCTURE



After identifying and selecting the respective country's important sector, NEs primarily applied the value chain modeling approach (Islam, 1997, 2003, 2012) to measure the total value-added and share distribution across the stakeholders under varied supply chains and production systems. They also assessed the best practice models that drive productivity improvements, foster collaboration, motivate employees, enhance performance, and promote sustainable growth and competitiveness in the agriculture and food industry. In Step 3, the challenges and prospects for best practices are identified, and in Step 4, recommendations for policy and implementation strategies are suggested.

Conceptual Framework

Productivity gainsharing is defined as "the distribution of wealth generated as a result of productivity improvement between the organisation and its employees" (SPRING Singapore, 2011). Productivity gainsharing is a performance-based compensation model where improvements in productivity, efficiency, or financial gains are shared among stakeholders, including farmers, agribusinesses, workers, and supply chain actors (Islam, 1997). It incentivizes collaboration, innovation, and shared responsibility by ensuring that those contributing to productivity growth receive a fair portion of the financial benefits.

The concept of productivity gainsharing is founded on economic, organizational, technological, innovative, social, ethical, and environmental considerations (Nayavich, 2013; Hunt, 2012; Fivaz, 2008; Fakhfakh & FitzRoy, 2018; Carrigan et al., 2020; Gao & Zong, 2024; Schoneveld & Weng, 2023; Campos et al., 2021; dos Santos, & Guarnieri, 2021; Sannou et al., 2023). The economic foundation of gainsharing lies in aligning incentives for efficiency that motivate higher productivity by directly linking rewards to measurable improvements. It enhances profit distribution fairness, ensuring producers and workers benefit alongside corporations, and encourages cost reduction strategies, such as optimized resource use, waste minimization, and operational efficiency. The organizational foundation strengthens collaboration and workforce engagement. Cooperative models such as farmer producer organizations (FPO) and community-owned enterprises foster stakeholder alignment, ensuring collective progress instead of competitive fragmentation. Productivity gainsharing encourages knowledge-sharing and best practice adoption, leading to long-term productivity improvements (Jaffee, 1992; Khan & Soverall, 2007; JA ZEN-NOH, 2022;). Technological and innovative foundations support the adoption of modern practices such as precision agriculture, automation, IoT-based tracking, and digital trade platforms that enhance traceability, data-driven decision-making, and transparency in profit distribution. Furthermore, it accelerates sustainable farming practices, such as low-carbon agriculture and climate-resilient models. The social and ethical foundation regarding fair employment and inclusivity in decision-making ensures equitable income distribution, particularly for smallholder farmers (Lyon, 2010; Moyo, 2000). Moreover, productivity gainsharing strengthens livelihood security, reduces economic disparities in rural communities, and aligns with CSR and ethical trade commitments. Environmental foundation in sustainable resource management can lead to practicing low-emission farming models, promoting efficient water use, organic inputs, and regenerative agriculture. It also supports climate adaptation strategies for fostering long-term ecological balance.

Therefore, productivity gainsharing in the agrifood sector is not just about financial distribution; it is a holistic framework combining economic efficiency, organizational collaboration, technological innovation, social equity, and environmental sustainability. Productivity gainsharing can transform agrifood value chains when properly implemented to ensure fairness, resilience, and sustainable growth for all stakeholders.

Given the concept and theoretical foundations, productivity gainsharing plays a crucial role in agrifood value chains by ensuring fair profit distribution, efficiency optimization, and sustainability improvements across stakeholders. It catalyzes efficiency, fairness, and sustainability, ensuring equitable market participation, strengthened supply chain resilience, and improved environmental stewardship. When effectively implemented, gainsharing can drive inclusive economic growth and transform agrifood systems.

It aligns the interests of farmers, processors, distributors, and retailers by promoting shared financial benefits, reduces income disparities between smallholders and larger agribusiness players, and encourages cooperative frameworks where farmers receive a fairer share of final market prices.

Comparative Analysis

A comparative analysis of the study reports from the 10 countries reveals that productivity gainsharing is essential for ensuring fair profit distribution, efficiency improvements, and sustainability across various agrifood sectors. This section evaluates the best practices implemented in 10 APO countries across Asia and highlights key findings, challenges, opportunities, and strategic recommendations for enhancing productivity across supply chains.

Regional Overview

Bangladesh: Community-Based Fisheries Gainsharing: Bangladesh's agrifood sector, particularly in fisheries, has demonstrated success through community enterprise approaches (CEA) such as the Daudkandi floodplain aquaculture model, which fosters equitable profit sharing, resource management, and sustainability. This study recommends successful models such as Daudkandi and emphasizes the need to strengthen policy frameworks and increase infrastructure investments for improved gain distribution.

India: Organized Supply Chains for Horticulture: India's horticulture sector, especially in tomato farming, suffers from fragmented supply chains; however, it is shifting toward FPOs to enhance productivity and profit distribution among smallholders. For improved gainsharing, the study suggests reducing intermediaries by encouraging contract farming and digital market access through expanding farmers' training programs aimed at improving market efficiency.

Lao PDR: Public–Private Partnerships in Rice Production: Lao PDR's rice sector, which accounts for 20% of the country's GDP, relies on public–private partnerships (PPPs) to improve value chain efficiency and market competitiveness. The study recommends policies aimed at strengthening cooperatives to increase farmer bargaining power and leveraging private investment in infrastructure development, irrigation systems, and sustainability programs.

Mongolia: Cashmere Industry Gainsharing: Mongolia's cashmere industry has transitioned from centralized Soviet-era control to a free-market system that struggles with price volatility and inconsistent fiber quality. Strategic solutions include introducing cooperative gainsharing models to ensure fair revenue distribution and investing in capacity building and technological tracking systems to enhance quality assurance.

Nepal: Value Chain Optimization in Beekeeping: Nepal's beekeeping sector in Chitwan demonstrates strong producer profit retention (85%) but requires market access expansion and cooperative strengthening. Best practices include enhancing direct marketing channels for beekeepers to optimize value addition and strengthen cooperative networks for better financial returns.

Pakistan: Value Addition in Gilgit-Baltistan's Fruit Industry: Pakistan's agricultural sector (24% of GDP) faces market isolation in fruit farming, particularly apricots and cherries in the Gilgit-Baltistan region, due to high input costs and lack of certification compliance. The most effective gainsharing practices involve increasing productivity through improved irrigation efficiency and adopting sustainable pest control methods. Moreover, for better price negotiation, farmer cooperatives and digital trade platforms should be introduced.

The Philippines: Performance-Based Gainsharing in Poultry: The broiler chicken industry in the Philippines benefits from cash-based incentives; however, supply chain inefficiencies and price volatility continue to hinder further productivity gains. Recommended growth strategies include expanding profit-sharing and performance-based programs to stabilize incomes alongside investing in precision farming and IoT-based disease monitoring systems.

Thailand: Value Chain Collaboration in Shrimp Farming: Thailand's shrimp industry is characterized by complex supply chains, facing challenges related to traceability and securing financial commitments necessary for effective gainsharing programs. Expanding blockchain-based traceability is suggested to encourage sector-wide adoption of gainsharing, strengthen financial investments, and ensure transparency in revenue distribution.

Turkiye: Efficiency Optimization in Aquaculture: Turkiye's aquaculture industry, particularly in sea bream, sea bass, and trout farming, exhibits efficiency gaps at the producer level but maintains strong technological innovations in wholesale and retail. For best gainsharing practices, this study recommends improved financial accessibility for infrastructure investment, optimized domestic market logistics, and expanded digital e-commerce platforms.

Vietnam: Low-Carbon Rice Farming for Sustainable Gainsharing: Vietnam's Mekong River Delta (MRD), which contributes 90% of the country's rice exports, has benefited from a low-carbon rice farming initiative that has reduced production costs by 16% while boosting environmental sustainability. For sustainable gainsharing practices, it is recommended to scale up low-carbon rice programs to other provinces and improve farmers' training for improving resource use efficiency.

Regional Synthesis and Comparative Insights

Common Challenges across Countries: Common challenges across the 10 APO countries include limited infrastructure and market access. Many smallholders lack processing, storage, and distribution facilities. Price volatility and fragmented supply chains, dominated by intermediaries, further reduce producers' earnings. Regulatory barriers and slow policy implementation delay certification, thereby hindering international competitiveness. Moreover, resistance to technology adoption is also prevalent, largely due to inadequate farmer training and insufficient financial incentives to integrate precision farming, blockchain technologies, and digital trade tools.

Best Practices in Productivity Gainsharing: Best practices in productivity gainsharing could be classified into three categories.

a. Cooperative and community-based models where Bangladesh, Nepal, Pakistan, and India use FPOs and cooperatives to strengthen their market presence. Similar categories of practices are found in previous studies (Manaswi et al., 2018; Shree & Vaishnavi, 2022; Pathania, 2020;).

b. PPP and policy-driven innovations where Lao PDR, Vietnam, Turkiye, and Thailand promote government-backed gainsharing initiatives. Studies by Imam and Ohida (2025) and Smyth et al. (2021) focus on similar practices.

c. Technology-enabled transparency and efficiency in the Philippines, Mongolia, and Thailand emphasize digital monitoring, blockchain adoption, and precision farming. Several papers presented in the Proceedings of the National Conference on "Corporate Governance and Sustainable Competitiveness in Agriculture Collectives" are supportive of such practices (Yadav et al., 2022):

Productivity gainsharing presents substantial opportunities for sustainable agrifood sector development in Asia. While fragmented supply chains, price volatility, and infrastructure limitations remain challenges, cooperative models, digital innovation, and public–private partnerships offer scalable solutions for fair profit distribution and efficiency improvements. By integrating regional expertise, Asia's agrifood industries can optimize resource use, enhance smallholder income, and ensure long-term agricultural sustainability.

Country Reports-Specific Best Practices

Bangladesh: *Community-Enterprize-Based Fisheries Gainsharing*

The agrifood sector in Bangladesh faces a declining GDP share due to the rise of industry and services; however, it remains vital for employment, poverty reduction, and food security. This study identifies key segments within the sector and explores productivity gainsharing and best practices to enhance equitable benefit sharing across supply chains. It highlights the fisheries sector as a standout area for productivity gainsharing. The CEA, exemplified by the Daudkandi floodplain aquaculture model, effectively promotes community ownership, equitable profit sharing, and sustainable resource management. Nonetheless, several challenges, such as fragmented ownership, lack of formal agreements, and resource over-exploitation, warrant systemic solutions.

This study underscores gainsharing's potential in fostering innovation, boosting productivity, increasing farmer incomes, and enhancing resilience to climate and market shocks. Recommended strategies for expanding these practices include scaling up successful models, strengthening policy frameworks, building local capacity, improving infrastructure, and incentivizing innovation.

Productivity gainsharing in Bangladesh's agrifood sector holds significant potential for inclusive economic growth, sustainability, and resilience. The Daudkandi aquaculture model is a flagship case study, demonstrating how community based enterprise frameworks can drive positive social, economic, and environmental outcomes. Addressing systemic challenges through policy enhancement, institutional support, and capacity-building initiatives can ensure long-term success, contributing to national development and rural sustainability.

India: *Organized Supply Chains and FPOs in Horticulture*

India's horticulture sector contributes approximately 30% to the agricultural GDP, despite occupying only 13.1% of the gross cropped area. Challenges such as postharvest losses, inadequate infrastructure, and market inefficiencies hinder sectoral growth despite its economic importance. Efforts are underway to shift from traditional fragmented supply chains to value-based systems, emphasizing quality management, safety, storage improvements, and export potential.

Key challenges in the traditional tomato supply chain include fragmentation and lack of coordination. Farmers sell produce individually, leading to inefficiencies. Multiple intermediaries are also involved, reducing farmers' profit margins. Perishable crops such as tomatoes suffer severe losses due to poor logistics. Farmers struggle with price realization, facing high input costs and marketing constraints.

For better gainsharing solutions, India promotes FPOs, farmer cooperatives, and direct marketing channels to strengthen supply chain efficiency and fair profit distribution. Gainsharing models in horticulture include (a) contract farming arrangements, where farmers engage in agreements with buyers to ensure stable prices; (b) collaborative supply chain frameworks, where stakeholders align incentives for mutual benefits; (c) revenue-sharing agreements to ensure fair distribution of profits among supply chain participants; (d) development of digital platforms and market data to improve price negotiations; and (e) aligning production practices with environmental goals to advance sustainability initiatives.

India's horticulture sector and tomato supply chain must evolve from traditional fragmented models to organized cooperative-driven systems, ensuring higher price realization for farmers, sustainable resource use, and reduced losses. The success of FPOs such as Sahyadri Farms demonstrates effective gainsharing, offering better logistics, direct market access, and inclusive growth opportunities. Strengthening training programs, digital infrastructure, and policy frameworks will ensure equitable gains distribution, boosting agricultural productivity and economic resilience.

Lao PDR: *Public–Private Partnerships (PPPs) in Rice Production*

Rice is a cornerstone of food security, economic development, and poverty reduction in Lao PDR, with over 70% of the population relying on agriculture for their livelihood. Despite its significance, the sector experiences limited access to modern farming methods, inadequate infrastructure, and low export competitiveness, hindering growth. The government has promoted PPPs to address these challenges to enhance productivity, sustainability, and economic resilience.

Although harvested areas have declined, PPP initiatives have contributed to productivity improvements. However, challenges such as weak export positioning, infrastructure deficits, and unequal profit distribution persist. Strengthening cooperatives, attracting private investment, integrating digital platforms, and implementing fair profit-sharing models are critical strategies to boost rice productivity, drive sustainable agricultural expansion, and foster inclusive economic growth.

Effective productivity gainsharing in Lao PDR's rice sector requires government and private sector collaboration to ensure equitable profit distribution, operational efficiency, and sustainability. The government must provide policy stability, expand infrastructure, and support farmer education,

whereas the private sector should invest in technology, improve market access, and develop transparent financial models. By aligning incentives, both sectors can build a resilient, competitive, and inclusive agrifood economy.

Mongolia: *Cooperative Models in the Cashmere Industry*

Although Mongolia plays a vital role in global cashmere production, its supply chain has evolved significantly from the Soviet-era centralized system to a modern competitive free-market environment. While the state-controlled approach (1950–70) ensured price stability and standardized processing, the contemporary model faces challenges such as price volatility, fiber quality inconsistencies, and herder economic instability.

Key challenges and opportunities in Mongolia's cashmere supply chain can be addressed by comparing modern market issues with the Soviet-era model, which was characterized by controlled pricing, consistent quality, and government-backed infrastructure. In the modern market, herders face income insecurity due to fluctuating prices, inconsistent fiber quality, and limited domestic processing. However, significant gainsharing potential exists through (a) aligning incentives for herders, processors, manufacturers, and exporters to reward efficiency and productivity improvements; (b) providing higher compensation for herders producing premium cashmere; (c) optimizing efficiency in processing facilities; (d) strengthening global market positioning through ethical sourcing and sustainability branding; and (e) establishing industry-wide agreements to ensure fair profit sharing based on measurable improvements in fiber quality and efficiency.

Digital traceability can significantly enhance productivity gainsharing in Mongolia's cashmere industry by ensuring transparent transactions, fair pricing, and efficiency in profit sharing. Herders can obtain fair compensation using blockchain-based traceability, tracking the quality and origin of cashmere and ensuring that they receive premium pricing for high quality fibers. Digital traceability can transform Mongolia's revenue distribution, ensuring herders, processors, and exporters receive fair earnings while boosting transparency, efficiency, and market trust in the cashmere supply chain. Mongolia can enhance industry-wide profitability and strengthen global positioning by integrating blockchain technology and digital tracking tools.

Integrating gainsharing models into Mongolia's cashmere industry can enhance sustainability, improve global competitiveness, and ensure fair compensation for all supply chain participants. Transparent pricing structures, stakeholder cooperation, and government-backed initiatives will be key to fostering long-term economic stability in the sector.

Nepal: *Value Chain Optimization in Beekeeping*

Beekeeping in Nepal has been practiced for centuries, supporting rural and marginalized farmers. The commercialization of beekeeping has grown significantly over the last three decades, contributing to the national economy and rural livelihoods. This study focuses on productivity gainsharing best practices through a survey conducted in the Chitwan district, Nepal's hub for commercial beekeeping of Apis mellifera.

The key challenges and opportunities in the honey value chain are that marketing channels are diverse, ensuring broader consumer access but with varying efficiency. Beekeepers handle multiple roles, including processing, packaging, and retailing, indicating potential for value addition and improved profitability. Despite strong market potential, challenges such as climate impacts, limited infrastructure, and lack of advanced beekeeping techniques persist. To enhance productivity gainsharing, it is essential to strengthen collaboration between beekeepers, traders, wholesalers, and retailers to improve supply chain efficiency. Moreover, establishing direct sales channels and integrating digital marketing approaches should be prioritized to reduce intermediary costs. On the technology side, innovative beekeeping techniques, such as modern hive management and sustainable honey harvesting practices, should be adopted to boost production.

Beekeeping in Nepal presents a high-profit, low-cost investment opportunity for farmers, making it a viable livelihood option. Suitable market strategies, cooperative models, and technological interventions can help Nepal increase honey production, ensure fair profit distribution, and strengthen rural economic development.

Pakistan: *Value Addition in Gilgit-Baltistan's Fruit Industry*

Pakistan is a predominantly agrarian economy, with agriculture contributing 24% to the national GDP, employing approximately 44% of the labor force, and generating 60% of foreign exchange earnings. The diverse geography and climate favor various crops, with fruits (especially apricots and cherries in Gilgit-Baltistan [GB]) playing a crucial economic role. While subsistence farming remains dominant, commercial farming is gradually expanding, driven by government initiatives, private sector investments, and international development partnerships (AKRSP, USAID, and IFAD).

Pakistan's agrifood sector in GB is evolving; however, market isolation, limited infrastructure, and quality control issues remain barriers to broader commercial success. Strengthening agribusiness networks, increasing investment in value chain efficiencies, enhancing policy frameworks, and integrating digital platforms can help maximize productivity gains, improve economic returns, and ensure food security. The cooperative-led processing and certification models exhibit strong potential in GB.

In GB, cooperative-led processing and certification models can ensure fair revenue distribution, improve market access, and enhance quality standards in cherry and apricot farming. These models enable smallholder farmers to pool resources, strengthen their bargaining power, and establish structured mechanisms for productivity gainsharing. Cooperative groups invest in cold storage and dehydration units, reducing postharvest losses and improving fruit shelf life. Farmers pool their produce for bulk processing, ensuring standardized grading and quality control. It can add value through the processing, drying, and packaging of fresh fruits into high value processed apricots and cherries to expand product diversity and increase profitability. Moreover, cooperatives can negotiate better rates with exporters and domestic buyers, reducing reliance on intermediaries.

GB province's cooperative-led processing and certification models drive profitability, sustainability, and global market access in cherry and apricot farming. By leveraging shared infrastructure, organic certification, and productivity-based gainsharing agreements, farmers can increase their incomes, enhance quality assurance, and contribute to the development of a more competitive agrifood sector.

The Philippines: *Performance-Based Gainsharing in Poultry*

The Philippines' chicken broiler industry is a vital component of the country's agrifood sector, contributing significantly to food security and agricultural employment. Although the sector has experienced consistent growth, several challenges hinder effective productivity gainsharing, such as supply chain inefficiencies, rising production costs, import competition, and lack of integration between small-scale producers and commercial players.

The key challenges and opportunities in the poultry sector include (a) supply chain deficits, where local production fails to meet growing demands, leading to pricing disparities between smallholders and large integrators. Additionally, (b) feed price fluctuations and market instability impact profitability, as do (c) insufficient coherent market oversight, high transport costs, and inadequate disease control due to weak compliance with regulatory and infrastructure issues. Fair and effective productivity gainsharing can be promoted by expanding performance-based incentives and profit-sharing programs, while also strengthening pricing mechanisms through the integration of small-scale farmers to reduce disparities. Furthermore, digital solutions could be leveraged by applying IoT-based disease monitoring, automated feed optimization, and data-driven farming techniques to help reduce inefficiencies.

Policy reforms should be strengthened to support smallholders by facilitating direct market access, streamlining regulatory processes, and providing financial incentives for the sustainable growth of this sector. Such reforms should also encourage cross-training, the use of digital tools, and continuous improvement initiatives to ensure long-term resilience.

This study emphasizes that the Philippines' poultry industry must bridge gaps between small and large-scale producers while adopting technological advancements and transparent gainsharing models. With support from the Department of Science and Technology (DOST-III) and collaborative initiatives, the

sector can enhance productivity, improve food security in terms of access to affordable sources of protein, and build a sustainable agricultural economy.

Thailand: *Traceability and Financial Commitments in Shrimp Farming*

The Thai shrimp industry (TSI) is a complex and technologically intensive sector that plays a crucial role in Thailand's economy. This study highlights the value chain approach used to measure and evaluate best practices for improving stakeholder productivity, efficiency, and fair profit distribution.

The key challenges and opportunities in the TSI productivity gainsharing include the following. (a) The TSI features a complex value chain involving multiple market actors, such as retailers, intermediaries, wholesalers, and exporters, each of whom influences resource distribution. (b) The lack of transparent supply chain traceability systems undermines operational efficiency and stakeholder trust within the industry. (c) Many gainsharing practices fail due to insufficient financial commitment and inadequate incentives for producers and employees. (d) A skilled labor shortage exists at the farm level and in the retail and export markets, requiring specialized training.

Although the TSI supply chain exhibits gainsharing potential, sector-wide cooperation remains limited due to profit-driven decision-making and insufficient integration. Standardizing accountability, expanding financial commitments, investing in technological upgrades, and strengthening government regulations will be essential for sustainable productivity growth and economic resilience.

Turkiye: *Aquaculture Efficiency Optimization*

Turkiye is a major agricultural player, ranking first in Europe and eighth globally in terms of agricultural GDP. Turkiye's agrifood sector has undergone modernization, driven by technological innovation and sustainability shifts; however, persistent challenges remain, including the effects of climate change, increasing market competition, and concerns over food. This study focuses on best practices in productivity gainsharing, particularly the aquaculture sector, one of the world's largest animal protein sources.

Turkiye has a vast coastline (8,333 km), enabling fishing and aquaculture production. This study used Porter's value chain model and a network DEA efficiency assessment to analyze sea bream, sea bass, and trout, which are key aquaculture products. Regarding efficiency scores, fresh sea bream/sea bass (0.852) and trout (0.865) scored more or less equally in the domestic market. Processed trout exhibited higher efficiency than processed sea bream/sea bass in the export market, indicating that efficiency improvements are needed in use of producer-level inputs, particularly energy, labor, transportation, and storage.

Strategies for enhancing productivity gainsharing within Turkiye's aquaculture sector include: (a) Reducing energy, transportation, and labor costs by implementing targeted training programs focused on workforce planning, energy management, and feed optimization at the producer level. (b) Improving domestic value chain efficiency by promoting processed trout and sea bass consumption, educating local consumers on nutritional benefits, and enhancing cold chain management, logistics, and market access. (c) Strengthening fair trade and revenue distribution, ensuring that fish farmers receive a fair revenue share through cooperative models and the expansion of blockchain-based traceability to improve transparency. (d) Expanding market access and digital solutions to facilitate direct e-commerce for farmers, while integrating stock exchange and auction systems for aquaculture product movements. (e) Supporting financial accessibility for infrastructure development and research and development to improve aquaculture efficiency by encouraging investment and collaboration.

Turkiye's agrifood sector remains a global force, and aquaculture plays a pivotal role in promoting economic sustainability. Optimizing input efficiency, improving domestic market structures, enhancing fair-trade practices, and leveraging digital advancements can ensure long-term productivity growth and fair revenue distribution for all stakeholders.

Vietnam: *Low-Carbon Rice Farming and Profit Distribution*

Rice production is a critical agricultural sub-sector in Vietnam, ensuring food security and export earnings. The MRD is the primary rice-producing region, comprising 55% of rice-growing areas, 56%

of national production, and 90% of rice exports. This study examines best practices in productivity gainsharing to enhance supply chain efficiency and promote low-carbon rice farming models. The study's findings indicate that several agricultural cooperatives lack essential infrastructure, such as warehouses, irrigation stations, processing, and packaging facilities. While successful cooperatives provide essential services such as water pumping, clean water provision, and supply chain input management, the overall share of resources costs and productivity gains remains weak.

Pilot programs under the "Sustainable Development of One Million Hectares of High-Quality Low-Carbon Rice" initiative were launched in the Soc Trang, An Giang, and Tra Vinh provinces (100 hectares per province). These programs demonstrate the positive impacts of low-carbon rice farming in terms of profit-sharing, economic, and environmental benefits. The profits are shared across cooperative-linked farming households, agricultural cooperatives, and fertilizer and seed dealers. The production costs for seeds, fertilizers, and pesticides have remarkably reduced compared with conventional farming methods. Additionally, environmental benefits have been realized through the decreased use of these inputs and the adoption of efficient irrigation techniques that optimize water usage.

Vietnam's low-carbon rice farming model demonstrates promising results, yielding economic savings, environmental benefits, and productivity gains. To ensure long-term sustainability and competitiveness in the global rice trade, it is essential to scale up these initiatives, provide targeted training for cooperatives, and strengthen market linkages for certified low-carbon rice products.

Synthesis of Key Findings and Best Practices

Common Themes in Successful Gainsharing Models

Based on studies from the 10 Asian countries on productivity gainsharing in the agrifood sector, several common themes emerge across successful models. These themes highlight the key factors that drive efficiency, fairness, and sustainability in agricultural value chains, which can be classified into six clusters.

1. ***Cooperative and Community-Based Gainsharing Models:*** Bangladesh (fisheries), India (horticulture), Nepal (beekeeping), and Pakistan (fruit farming) demonstrate strong farmer-led cooperative frameworks. FPOs in India and community enterprise models in Bangladesh empower smallholders with collective bargaining, direct market access, and fair profit distribution. Nepal's beekeeping sector and Pakistan's small fruit producers benefit from shared processing and packaging facilities, reducing reliance on intermediaries.

2. ***Public–Private Partnerships Driving Productivity Gains:*** Lao PDR (rice farming) and Vietnam (low-carbon rice) successfully leverage government–private sector collaboration to enhance productivity. PPPs increase infrastructure-related investments, improve irrigation systems, and expand financial access, ensuring long-term resilience in value chains. Vietnam's low-carbon rice initiative further advances climate-smart agriculture, integrating policy-backed environmental benefits into gainsharing models.

3. ***Digital Innovations and Market Access Expansion:*** The Philippines (poultry), Thailand (shrimp), Turkiye (aquaculture), and Mongolia (cashmere) embrace technology-driven gainsharing. IoT-based monitoring in poultry, blockchain-powered traceability in shrimp, and e-commerce integration in aquaculture improve efficiency, transparency, and revenue distribution. Furthermore, Mongolia's digital tracking of fiber quality ensures premium pricing and fair gain distribution among herders.

4. ***Value Chain Optimization and Fair Profit Distribution:*** Vietnam (rice farming), Bangladesh (fisheries), and Thailand (shrimp) exhibit value chain efficiency improvements that maximize farmer earnings. Vietnam's low-carbon rice farming reduces production costs by 16%, improving profit margins for producers. Thailand's blockchain-based shrimp farming introduces transparent pricing structures, ensuring fair income distribution.

5. ***Sustainability and Climate-Resilient Farming Models:*** Vietnam (rice farming), Turkiye (aquaculture optimizations), and Pakistan (fruit farming) integrate eco-friendly approaches into gainsharing structures. Vietnam's alternate wetting and drying irrigation techniques reduce water consumption, boosting farmer profits and soil health. Turkiye's energy-efficient aquaculture reduces waste, cost inefficiencies, and improves processing yields.

6. ***Incentivized Performance-Based Rewards and Shared Risk Models:*** The Philippines (poultry) and Mongolia (cashmere) embrace productivity-based incentives that reward efficiency improvements. Mongolia's premium pricing for high quality fibers ensures herders benefit from improvements in production standards. The Philippines' cash-based poultry gainsharing model increases participation and operational performance.

Overall, successful gainsharing models across countries seem to rely on (a) strong cooperatives and farmer-led networks for market access and fair revenue distribution and (b) government and private sector collaboration to further advance sustainable agribusiness models. They also require (c) digital innovations and technology adoption to reduce inefficiencies and enhance transparency, (d) fair value chain optimization ensuring shared economic benefits across stakeholders, and (e) climate-smart farming approaches that integrate environmental sustainability with financial incentives. By leveraging these themes, Asia's agrifood sector can optimize productivity gainsharing, improve smallholder livelihoods, and ensure long-term agricultural sustainability.

Cross-Sectoral Lessons and Innovations

Several cross-sectoral lessons and innovations emerge from across the 10 countries, providing valuable insights for enhancing productivity gainsharing models across different agrifood sectors in Asia. These lessons showcase scalable approaches that transcend individual industries, fostering efficiency, sustainability, and equitable profit distribution. The cross-sectoral lessons from productivity gainsharing models are classified below.

1. ***Strengthening Cooperative and Collective Market Access Models:*** Bangladesh (fisheries), India (horticulture), Nepal (beekeeping), Pakistan (fruit farming), and Vietnam (rice farming) highlight the success of farmer cooperatives in enhancing bargaining power, resource pooling, and implementing profit-sharing mechanisms. FPOs in India, community aquaculture models in Bangladesh, and low-carbon rice cooperatives in Vietnam demonstrate how collective market participation improves price negotiation and facilitates equitable revenue distribution. Pakistan's "One Village, One Product" model strengthens market access for smallholder fruit farmers, demonstrating how regional branding can improve profitability.

2. ***Public–Private Partnerships for Infrastructure and Policy Support:*** Lao PDR (rice farming), Vietnam (low-carbon rice), and Thailand (shrimp) demonstrate effective government–industry collaboration, ensuring long-term investment, sustainability, and efficiency improvements. PPPs in Lao PDR provide financial and technical assistance to farmers, whereas Vietnam's government-backed rice program integrates sustainable practices with economic incentives. Turkiye's aquaculture models leverage public–private funding for improving cold chain logistics and market access, thereby optimizing sector-wide productivity.

3. ***Digital Trade and Technology-Enabled Innovations for Transparency:*** Thailand (shrimp), Mongolia (cashmere), the Philippines (poultry), and Turkiye (aquaculture) integrate blockchain, IoT, and digital platforms into productivity gainsharing models. In Thailand's shrimp industry, blockchain traceability ensures fair profit sharing and transparent revenue tracking. Mongolia's cashmere industry uses digital fiber tracking to incentivize high quality production, ensuring premium pricing for herders. The Philippines' IoT-driven poultry monitoring optimizes feed efficiency, disease management, and performance-based gainsharing.

4. ***Value Chain Optimization for Fair Profit Distribution:*** Vietnam (rice farming), Bangladesh (fisheries), and Thailand (shrimp farming) showcase efficient value chain restructuring to maximize

producer earnings. Vietnam's alternate wetting and drying irrigation methods cut costs by 16%, boosting farmer profits while improving sustainability. Bangladesh's community-led aquaculture improves gain distribution through shared ownership models. Thailand's integrated shrimp farming models increase producer revenue retention by eliminating redundant intermediaries.

5. ***Sustainability-Driven Productivity Innovations:*** Vietnam (rice farming), Turkiye (aquaculture), and Pakistan (fruit farming) integrate eco-friendly farming models into gainsharing frameworks. Vietnam's low-carbon farming reduces the need for seeds, fertilizers, and pesticides, thereby lowering costs and improving farmer profitability. Turkiye's aquaculture sector implements energy efficiency measures that reduce resource waste, ensuring greater financial and environmental sustainability. Similarly, Pakistan's transition toward sustainable irrigation and organic fruit farming improves long-term resilience to climate change.

6. ***Performance-Based Gainsharing and Incentivized Profit Models:*** The Philippines (poultry) and Mongolia (cashmere) employ productivity-based rewards encouraging efficiency improvements. Mongolia's premium pricing mechanism for high quality fibers ensures fair revenue distribution among herders. The Philippines' cash-based gainsharing model incentivizes poultry farmers to adopt better operational practices for cost reduction.

In addition to the above lessons, the following 4 groups of cross-sectoral innovations emerge from productivity gainsharing models across the 10 countries.

1. ***Blockchain Traceability and Digital Verification Systems:*** Thailand (shrimp) and Mongolia (cashmere) are leading in the adoption of blockchain-powered traceability systems to ensure transparent revenue distribution. Turkiye's seafood industry is exploring digital tracking technologies to prevent market inefficiencies.

2. ***Climate-Smart Agriculture and Eco-Friendly Productivity Models:*** Vietnam's rice sector is pioneering large-scale low-carbon farming, reducing input costs while improving yields. Similarly, Pakistan's adoption of green technologies in fruit farming enhances climate resilience.

3. ***Technology-Led Value Chain Automation and Market Optimization:*** IoT-driven poultry farming in the Philippines improves precision farming and operational efficiency. Turkiye's aquaculture market optimization models ensure cost-efficient logistics and direct market access.

4. ***Digital Trade and E-Commerce Platforms for Smallholders:*** India's Open Network for Digital Commerce (ONDC) integrates farmers into digital marketplaces, ensuring better pricing and direct consumer access. Pakistan and Turkiye explore farmer-led e-commerce models to bypass intermediaries.

Lessons for Regional Replication and Policy Adaptation

The cross-sectoral lessons and innovations highlighted above across the 10 countries demonstrate how gainsharing models can improve fairness, efficiency, and sustainability in agrifood sectors. The core insights include the following.

- Cooperative and community-based enterprise frameworks ensure equitable profit sharing for smallholders.
- Public–private partnerships provide long-term stability and investment backing.
- Digital innovations drive market transparency and producer empowerment.
- Sustainability models align climate resilience with financial incentives.
- Performance-based gainsharing motivates sector-wide improvements.

Policymakers and agribusiness leaders can leverage these insights to optimize value chains, improve farmer incomes, and enhance environmental sustainability for fair productivity gainsharing across Asia's agrifood sector.

Challenges and Barriers to Effective Implementation

Despite the success of productivity gainsharing in various agrifood sectors, several challenges and barriers hinder their effective implementation. These obstacles often relate to structural inefficiencies, financial limitations, policy constraints, and technological adoption issues across different countries and industries. The challenges and barriers are listed below.

1. ***Market Fragmentation and Weak Supply Chain Integration:*** Intermediary-dominated markets (India, Nepal, and Pakistan) limit farmers' direct earnings. Insufficiently organized supply chains lead to price volatility and inconsistent profit sharing. Cross-border trade inefficiencies prevent regional scalability of successful gainsharing models.

2. ***Limited Infrastructure and Processing Facilities:*** Weak cold chain logistics (Bangladesh, Turkiye, and Mongolia) affect storage, transportation, and quality control. Insufficient mechanization and modern processing units restrict value addition and market competitiveness. The absence of cooperative-led processing hubs compels smallholders to rely on intermediaries, limiting profits.

3. ***Financial Constraints and Low Investment in Smallholder Gainsharing:*** Limited access to credit and investment funds can prevent farmers from expanding operations (Pakistan, Lao PDR, and Thailand). High operational costs associated with cooperatives and PPPs present significant barriers to scaling without sustained financial backing. Moreover, insufficient structured loan programs for agricultural producers hinder innovation and infrastructure expansion.

4. ***Policy and Regulatory Barriers:*** Weak policy enforcement impacts fair trade and revenue distribution (Thailand and Philippines). A lack of government support for cooperative-led gainsharing models (Mongolia and Turkiye) remains an issue, while certification gaps and trade restrictions prevent farmers from benefiting from international markets (Pakistan and Bangladesh).

5. ***Technological Adoption Challenges:*** Resistance to digital trade platforms and blockchain models slows progress toward market transparency (Thailand and Mongolia). Limited knowledge and training in precision farming and IoT-driven agriculture restrict efficiency improvements (Philippines and Turkiye). Additionally, weak digital literacy among smallholder farmers prevents participation in gainsharing platforms.

6. ***Sustainability and Environmental Risks:*** Scaling climate-smart farming models is resource-intensive, requiring government and private sector collaboration (Vietnam and Lao PDR). The adoption of low-carbon agricultural practices remains limited among smallholders due to cost constraints and knowledge barriers. Additionally, water scarcity and climate change-related disruptions threaten long-term gainsharing profitability in rice and fruit sectors (Pakistan and Vietnam).

Successful gainsharing models require long-term structural reforms, technological adoption, policy adjustments, and investment mobilization to overcome implementation barriers. The following recommendations could address these barriers, enabling Asia's agrifood sector to fully adopt fair gainsharing practices, ensuring economic inclusivity, supply chain resilience, and long-term sustainability.

- Strengthen cooperative structures to reduce reliance on intermediaries and prevent exploitative practices.

- Expand digital tools and blockchain traceability to increase transparency.

- Enhance government-backed financial programs to improve investment accessibility.

- Encourage regional policy harmonization to facilitate cross-border trade.
- Scale climate-smart innovations while ensuring affordability for smallholders.

Policy Recommendations and Strategic Interventions

This section attempts to synthesize the key policy recommendations and strategic interventions based on the analyses of the 10 countries. These approaches could enhance productivity gainsharing, improve market inclusivity, and ensure sustainable agricultural growth across Asia's agrifood sector.

Policy Recommendations

1. ***Institutional Support for Cooperative and Community-Based Gainsharing Models:*** (a) Expansion of FPOs and cooperatives, supported by government initiatives that ensure legal recognition and financial backing for farmer-led cooperatives (e.g., Bangladesh, India, and Nepal). (b) Encourage aggregation models such as "One Village, One Product" (e.g., Pakistan) to enhance market access. (c) Strengthen the governance and regulation of cooperative networks by promoting direct trade mechanisms to protect farmers from exploitation by intermediaries. (d) Develop transparent pricing and revenue-sharing frameworks to optimize profit distribution.

2. ***Public–Private Partnerships for Infrastructure and Investment Support:*** (a) PPPs should be promoted to facilitate the expansion of agricultural infrastructure through targeted investments in facilities such as cold storage, irrigation, transportation, and market connectivity (e.g., Lao PDR, Pakistan, and Vietnam). (b) Postharvest processing facilities must be subsidized to reduce losses and improve profitability. (c) The private sector and foreign direct investment should be leveraged through the provision of tax incentives for agribusinesses supporting gainsharing practices (e.g., Thailand and Turkiye) and by promoting joint ventures between cooperatives and international agribusiness firms to scale up rural productivity.

3. ***Financial and Credit Access for Smallholder Farmers***: (a) Microfinance and credit programs for cooperatives must be expanded by developing low-interest loans for farmer groups and SMEs to access modern equipment and production technologies. (b) Financial inclusion should be strengthened through agricultural cooperatives for better market negotiation and resource pooling (e.g., Nepal and Mongolia). (c) Performance-based financial incentives must be introduced to adopt cash-based gainsharing models for efficiency improvements (e.g., Philippines and Mongolia) and by offering tax breaks and grants for sustainable farming techniques (e.g., Vietnam and Turkiye).

4. ***Digital Innovation and Technology-Enabled Market Integration:*** (a) Blockchain-powered traceability and transparent pricing systems must be introduced (following the footsteps of Thailand's shrimp industry and Mongolia's cashmere sector). These can serve as models for traceability-driven gainsharing, ensuring fair pricing and profit-sharing accountability. (b) Smart contracts for cross-border trade can be introduced to reduce transaction inefficiencies. (c) E-commerce and digital trade platforms for smallholders can be extended following India's suggested ONDC model, which enables direct-to-consumer trade, reducing reliance on intermediaries. (d) Regional digital trade networks can be developed to connect farmers directly with international markets (e.g., Pakistan, Turkiye, and Vietnam).

5. ***Sustainability and Climate-Smart Agricultural Policies:*** (a) Climate-resilient farming practices should be expanded by scaling up Vietnam's low-carbon rice initiative to other rice-growing economies and promoting sustainable irrigation practices, water management, and organic input usage (e.g., Pakistan, Lao PDR, and Turkiye). (b) Sustainability standards should be integrated into gainsharing policies by encouraging eco-friendly farming practices in all gainsharing models in compliance with carbon reduction targets for government-supported agricultural programs.

Strategic Interventions for Scaling Productivity Gainsharing Models

1. ***Capacity Building and Training Programs for Farmers:*** (a) Provide digital literacy training for farmers to adopt blockchain and e-commerce platforms and harness the strategic use of the Internet and data science for more effective planning and coordination among stakeholders' activities,

thereby improving efficiency and profitability. (b) Invest in sector-specific training programs (e.g., aquaculture logistics in Turkiye and poultry automation in Philippines).

2. ***Expand Regional Investment Funds and Public Sector Financing for Sustainable Agriculture:*** (a) Create dedicated agricultural investment funds to scale successful gainsharing models. (b) Ensure subsidies for farmer cooperatives integrating climate-smart farming techniques.

3. ***Strengthen Policy Enforcement and Trade Protection Measures:*** (a) Introduce certification standards and trade protections for smallholder exports (Pakistan and Mongolia). (b) Increase regulatory oversight for profit-sharing transparency in agribusiness partnerships (Thailand and Vietnam).

4. ***Regional Policy Harmonization for Cross-Border Trade Efficiency***: (a) Standardize gainsharing frameworks to ensure consistency across export markets (Bangladesh, India, and Turkiye). (b) Develop regional agreements for fair pricing mechanisms to reduce disparities between producers and exporters.

Asia's agrifood sector can implement institutional, financial, technological, and sustainability-focused policy interventions to optimize productivity gainsharing, ensuring equitable market participation, profitability, and long-term sustainability. Governments, cooperatives, agribusiness firms, and financial institutions must collaborate to scale successful models and strengthen regional food security and farmer livelihoods.

Conclusions and Future Research Directions

This study assesses best practices in productivity gainsharing across 10 Asian countries, highlighting gainsharing's strategic role in enhancing efficiency, profitability, and sustainability in agrifood sectors. Despite market fragmentation, financial constraints, and technological adoption barriers, cooperative-led models, digital innovations, PPPs, and sustainability-focused strategies have proven effective in improving farmer incomes and long-term sectoral resilience.

Key takeaways from the study include the following.

- **Cooperative and community-based enterprise frameworks improve fair revenue distribution**, particularly in smallholder farming communities (Bangladesh, India, Nepal, and Pakistan).

- **Public–private partnerships drive sectoral modernization**, ensuring infrastructure investment and market expansion (Lao PDR, Vietnam, and Turkiye).

- **Technology-driven gainsharing enhances efficiency**, integrating blockchain technology, IoT, and digital trade platforms to optimize revenue distribution (Thailand, Mongolia, and Philippines).

- **Climate-smart agricultural models** align productivity incentives with sustainable practices, promoting long-term environmental and economic benefits (Vietnam, Turkiye, and Pakistan).

- **Performance-based financial incentives** encourage stakeholders to optimize operations for shared profitability (Philippines and Mongolia).

Governments, cooperatives, and agribusiness actors must scale successful frameworks, ensure policy harmonization, and expand investment support across agrifood value chains to fully leverage productivity gainsharing models. This study identifies key success factors and implementation challenges; however, future research could explore additional dimensions for enhanced policy recommendations and scalability strategies.

Some potential future research dimensions include the following.

1. ***Comparative Analysis of Gainsharing Models in Emerging and Developed Agricultural Markets:*** (a) Examine differences in gainsharing adoption between developed economies (Japan, South Korea)

and emerging markets (Bangladesh, Nepal, Mongolia). (b) Assess how regulatory frameworks and institutional structures shape gainsharing adoption globally.

2. ***Digital Transformation in Gainsharing and Traceability Innovations:*** (a) Explore blockchain-powered gainsharing applications for improved revenue tracking and fraud prevention. (b) Investigate AI-driven predictive analytics for optimizing gain distribution and performance incentives.

3. ***Sustainability and Low-Carbon Farming Models***: (a) Assess the long-term scalability of Vietnam's low-carbon rice farming model in other rice-producing countries. (b) Identify carbon pricing mechanisms that could integrate gainsharing into climate-smart agricultural policies.

4. ***Financial Mechanisms for Expanding Cooperative-Based Trade:*** (a) Evaluate the effectiveness of microfinance, cooperative-led investment funds, and subsidy programs for smallholder farmers. (b) Develop frameworks for regional agricultural financing, ensuring sustained capital access for productivity investments.

5. ***Policy Integration for Cross-Border Trade Efficiency in Agrifood Supply Chains:*** (a) Analyze how regional trade agreements could harmonize productivity gainsharing models across ASEAN and South Asia. (b) Develop strategies for reducing trade barriers in certification, pricing standardization, and logistics optimization.

Future research should prioritize empirical studies, data-driven policy evaluations, and scalable implementation frameworks to advance global productivity gainsharing adoption across agrifood sectors. By integrating economic, technological, and sustainability perspectives, researchers and policymakers can strengthen market resilience, promote fair income distribution, and ensure long-term food security.

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RESEARCH ON BEST PRACTICES IN PRODUCTIVITY GAINSHARING IN THE AGRIFOOD SECTOR OF BANGLADESH

Executive Summary

The agrifood sector in Bangladesh plays a crucial role in employment generation, poverty reduction, and food security; however, its contribution to the GDP has been gradually declining due to the increase in the shares of the industry and services sectors. This study identifies socially, economically, and environmentally significant segments within the sector, explores best practices in productivity gainsharing, and develops policy recommendations to enhance productivity while ensuring equitable benefit-sharing across the supply chain. Using a mixed-methods approach, the study combines expert interviews, literature review, and case studies to analyze gainsharing practices. The research identified the fisheries sector as an important subsector of agriculture, where the community enterprise approach, exemplified by the Daudkandi floodplain aquaculture model, is a standout example of effective productivity gainsharing practices. This model promotes community ownership, equitable profit sharing, and sustainable resource use, addressing key challenges such as fragmented ownership, lack of formal agreements, and resource overexploitation. Additionally, this study highlights gainsharing's potential to enhance productivity, foster innovation, increase incomes, and enhance resilience to climate and market shocks. It recommends scaling successful models such as Daudkandi, strengthening policy frameworks, building local capacity, improving infrastructure, and incentivizing innovation to ensure the sector's sustainability and inclusivity. These strategies can help the agrifood sector achieve long-term growth and resilience while contributing to national development.

Introduction

Background and Importance of the Agrifood Sector in Bangladesh

Over the past 20 years, Bangladesh's economy has experienced significant growth, leading to substantial changes in its structure and the role of agriculture in driving continued development, ensuring food security, and reducing poverty. The contribution of agriculture to the country's GDP decreased from approximately 18% to 13% between 2009–10 and 2018–19, as the industry and services sectors expanded (Asian Development Bank, 2023). Factors such as economic growth, diversification, and urbanization have transformed food demands and heightened expectations regarding dietary changes, quality and safety standards, sustainability and resource efficiency, supply chain and market linkages, and technology and innovation from the agriculture and natural resources (ANR) sector. However, addressing these new challenges has become increasingly difficult as factors such as seasonal climate shocks and market volatility continue to impact agricultural productivity and profitability performance.

Although the share of agriculture in Bangladesh's national GDP has been on the decline, the sector continues to employ over 40% of the country's workforce. Approximately 85% of the country's poor population resides in rural areas; thus, agricultural development is vital for enhancing rural livelihoods by creating jobs, boosting household incomes, and alleviating poverty. However, agriculture and rural communities face growing risks due to climate-related shocks. The sector is particularly vulnerable to increased flooding, droughts, and saltwater intrusion driven by rising sea levels. These climate changes pose serious threats to future agricultural output and development as well as the quality, resilience, and sustainability of natural resources. Furthermore, the COVID-19 pandemic and food-price inflation have adversely affected the sector, posing a risk of reversing the progress made in poverty reduction and food security over recent decades (Asian Development Bank, 2023).

Other things remaining constant, a farm-level increase in productivity is likely to improve value gains for producers (mainly farmers) in the agrifood sector, enabling such gainsharing along the supply chain and, in turn, leading to reduction in poverty among farmers and generally improving the local, regional and national living standards and food security of Bangladesh.

Research Objectives

This study evaluates best practices in productivity gainsharing in Bangladesh's agrifood sectors to identify challenges and prospects. Subsequently, appropriate policy strategies can be suggested for productivity enhancement across the supply chain within this sector. This approach requires a detailed review of the existing policy strategies within which productivity gainsharing approaches among the participating stakeholders are practiced and an analysis of their effects on enhancing productivity growth in the agrifood sector (Islam, 2025).

This study's key objectives include the following:

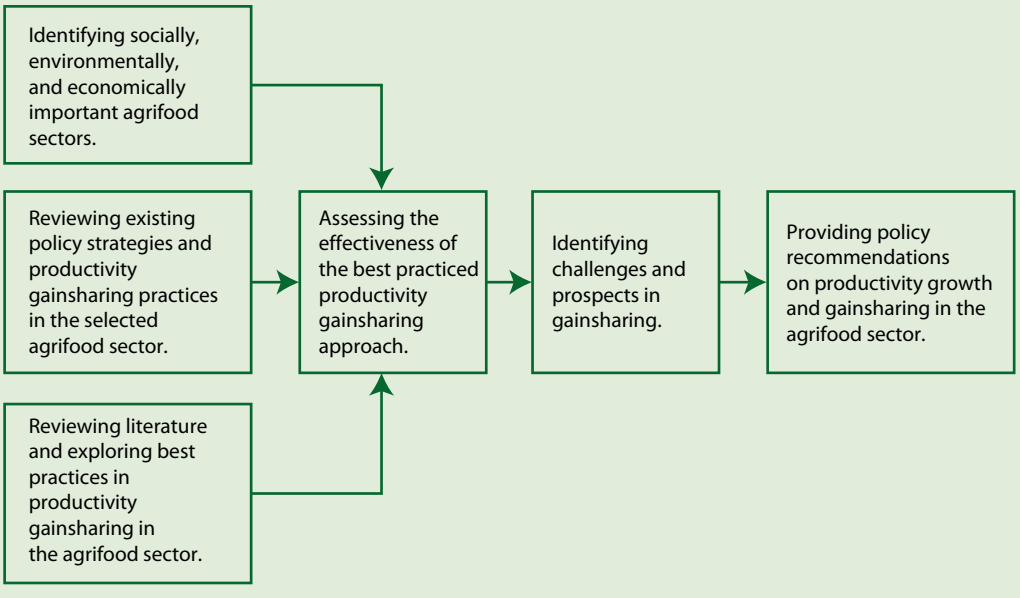
- Identifying socially, environmentally, and economically important agrifood sectors in Bangladesh (an APO member country);
- Exploring the best practices in farm productivity gainsharing among the stakeholders of the identified agrifood sector;
- Assessing the effectiveness of the best practiced productivity gainsharing approach;
- Providing policy recommendations based on the lessons learned from this study.

Research Framework

Figure 1 presents the structured approach followed to achieve the study objectives, focusing on improving productivity gainsharing in the agrifood sector by following a structured approach. We first identify agrifood sectors that are socially, environmentally, and economically significant, ensuring the study's relevance to sustainability and economic development. Existing strategies and productivity gainsharing practices in these sectors are then reviewed along with the policy environment influencing these practices.

FIGURE 1

RESEARCH FRAMEWORK



This framework incorporates a comprehensive literature review to explore global best practices, ensuring that recommendations are derived under diverse, relevant contexts, enabling evidence-based insights into effective strategies and the underlying reasons for their success. Challenges and opportunities in gainsharing are identified to provide a balanced understanding of barriers and prospects. Finally, the study concludes with actionable policy recommendations to enhance productivity growth and equitable gainsharing. While the framework is thorough and logical, it could be further strengthened by explicitly addressing stakeholder engagement, implementation strategies, and long-term monitoring of the proposed policies.

Scope of Assessing Gainsharing Best Practices in Agrifood Sectors in Bangladesh

The scope of gainsharing best practices in Bangladesh's agrifood sectors covers the study of employer-employee relations to increase productivity, profitability, and efficiency in agricultural and food processing industries. This approach includes soliciting views on how gainsharing models that compensate employees for output improvements or point load reductions can be introduced and developed across various levels of the agrifood value chain, from farming, processing, distribution, and retailing of products. Moreover, this research will assess the status, barriers, and feasibility of gainsharing initiatives in small and middle-sized enterprises and commercial agrifood businesses. Given local conditions and labor movements, this study also examines how such practices affect rural employment opportunities, income levels, diffusion of new technologies, and farming system sustainability.

The Significance of Assessing Best Practices in Gainsharing Within Bangladesh's Agrifood Sectors

It is important to appraise best practices in gainsharing within Bangladesh's agrifood sectors for several reasons.

Increase Productivity and Efficiency: Implementing gainsharing can motivate workers to increase productivity, optimize resource use, and reduce waste, leading to a more competitive agrifood sector.

Improve Incomes and Livelihoods: Gainsharing can increase the income of workers in agricultural and food industries by linking compensation to individual performance. This approach helps develop and enhance the earning capacity of an increasing number of low-income families, contributing to poverty reduction and sustaining a higher standard of living, particularly among rural populations.

Facilitate Innovation and Technology Adoption: The Bangladeshi agrifood sector can be technologically advanced by adopting gainsharing-based incentive mechanisms alongside the implementation of modern agricultural practices, thereby enhancing competitiveness in the global market.

Sustainability and Resource Management: With an orientation to promote efficiency and equilibria, gainsharing can contribute to sustainability in farming, focusing on the balanced and responsible use of natural resources while minimizing environmental impact.

Enhance Performance and Profitability in Agrifood Sectors: Enhancing productivity performance and profitability through gainsharing can contribute to overall economic growth, support rural development, and foster the growth of allied industries such as manufacturing and services.

Build Resilience: Employees and employers benefit from gainsharing strategies, which help the sector adapt to climate shocks and market volatility, thereby enhancing sector stability.

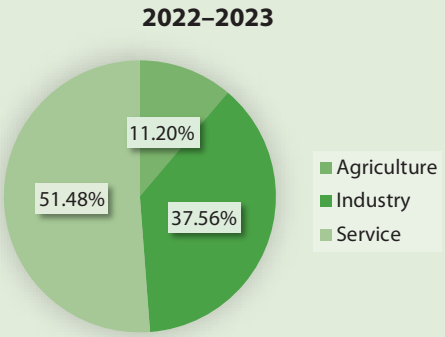
The Agrifood Sector in Bangladesh

Since the late 1990s, Bangladesh has transitioned from an agriculture-dependent economy to one undergoing significant transformation and progressing toward greater urbanization. As economies develop, the contribution of agriculture to GDP and employment typically decreases; however, the decline in agricultural employment often lags behind the decline in its GDP share. Moreover, variations in income levels across countries result in differing levels of structural transformation (Ahmed et al., 2021).

Sectoral Share of GDP: According to the Bangladesh Economic Review 2023, GDP for the agriculture, industry, and services sectors was 11.20%, 37.56%, and 51.48%, respectively, in FY 2022–23 (Figure 2).

FIGURE 2

SHARE OF GDP OF DIFFERENT SECTORS IN BANGLADESH

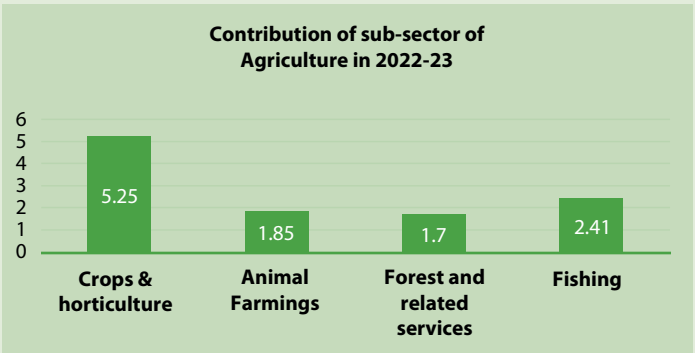


Source: Ministry of Finance, Bangladesh Economic Review (Ministry of Finance, 2025).

Contribution of Agriculture's Subsectors: There are four subsectors within Bangladesh's agricultural sector (Figure 3). According to Bangladesh Economic Review 2023, the crops and horticulture subsector has the highest GDP share (5.25%) and the forest and related services subsector has the lowest (1.70%). Fishing is the second largest and most important subsector, contributing about 2.41% to the sector's GDP.

FIGURE 3

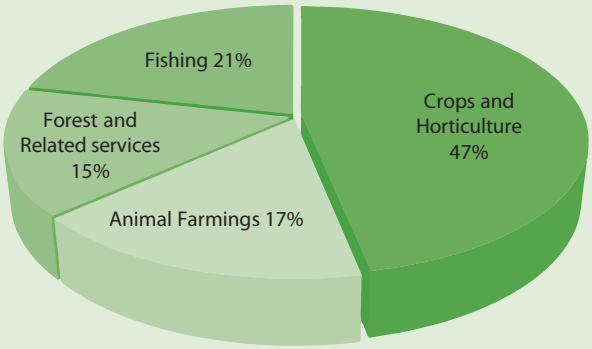
CONTRIBUTION OF BANGLADESH'S AGRICULTURAL SUBSECTORS TO THE GDP



Percentage of GDP Contribution from the Agriculture Sector: The pie chart in Figure 4 illustrates the contribution of different subsectors within Bangladesh's agricultural sector. Among these, the fisheries subsector (labeled as "Fishing") accounts for 21% of the total contribution, making it the second largest contributor after the crops and horticulture subsector, which dominates at 47%. This significant share highlights fisheries' vital role in the country's agricultural economy, employment, and food security. Compared with other subsectors such as animal farming (17%) and forest-related services (15%), fishing demonstrates a strong presence, reflecting its importance as a livelihood for millions and key investment and productivity improvement area. Therefore, targeted gainsharing initiatives such as fishing could substantially benefit agricultural growth and community well-being.

FIGURE 4

CONTRIBUTION OF DIFFERENT SUBSECTORS TO THE AGRICULTURAL SECTOR

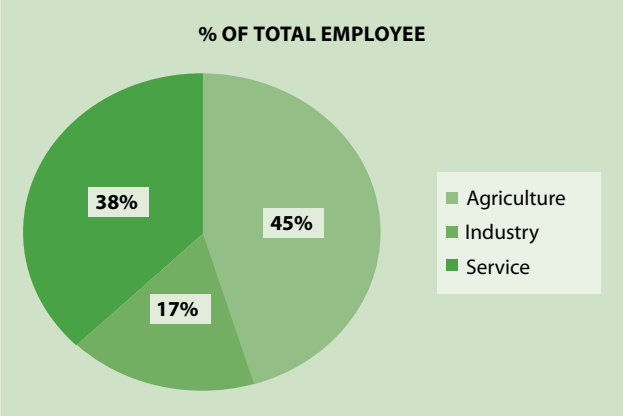


Source: Ministry of Finance, Bangladesh Economic Review (Ministry of Finance, 2025).

Share of Employed Labor Force: The agricultural sector plays a key role in the rural economy by reducing poverty, creating employment for the majority of the rural workforce, and providing substantial household income. Although its contribution to GDP is the lowest, agriculture accounts for the largest share of employment in the Bangladeshi economy. Approximately 45% of the total workforce is employed in this sector (Figure 5), indicating its vital role in supporting livelihoods through farming, forestry, and other related activities (Bangladesh Bureau of Statistics, 2025).

FIGURE 5

SHARE OF EMPLOYMENT ACROSS THE THREE SECTORS



Source: (Bangladesh Bureau of Statistics, Labour Force Survey (2025)).

Crops, Fisheries, and Livestock Subsectors

Major Cereals of Bangladesh: Table 1 shows the production data of various cereal food grains in Bangladesh from the years 2015–16 to 2022–23. The unit of measurement is in lakh metric tons (MT). The cereal food grains listed below are aus, amon, and boro (different types of rice), along with total rice, wheat, and maize. Production of grains such as aus, amon, and boro significantly contributed to the total rice production, demonstrating steady growth, with boro rice being the largest contributor to annual production. Conversely, wheat production remained relatively stable without any significant increase. Maize demonstrated the highest growth rate among all grains, reflecting increased cultivation or demand. Overall, food grain production steadily increased, reflecting improvements in agricultural productivity or possibly an expansion of cultivated areas.

TABLE 1

PRODUCTION OF MAJOR CEREALS IN BANGLADESH (IN LAKH MT)

Food Grains	2015–16	2016–17	2017–18	2018–19	2019–20	2020–21	2021–22	2022–23
Aus	22.89	21.34	27.09	27.20	30.12	32.85	32.45	36.90
Amon	134.83	136.56	139.94	140.55	155.02	144.38	149.58	163.45
Boro	189.38	180.16	195.76	203.89	201.81	198.85	209.77	215.34
Total Rice	**347.10**	**338.06**	**362.79**	**373.63**	**386.95**	**376.08**	**391.80**	**415.69**
Wheat	13.48	13.12	10.99	11.48	12.46	10.85	10.86	11.60
Maize	27.59	35.78	38.93	46.99	54.02	56.63	56.30	57.68
Total	**388.17**	**386.96**	**412.71**	**432.11**	**453.44**	**443.56**	**458.96**	**468.98**

Source: Ministry of Finance, Bangladesh Economic Review (2025)

Inland and Marine Fisheries: The contribution of the fisheries sector to food security, employment generation, export expansion, trade, and the socioeconomic development of Bangladesh is undeniable. Bangladesh has achieved fish production self-sufficiency through the adoption and implementation of timely plans for the production and management of inland open water bodies, inland closed water bodies, and marine water bodies. Moreover, the government is implementing various programs to ensure the supply of animal protein by increasing fish production. Initiatives such as fish farming in open water, conservation of endangered species, establishment of fish breeding and breeding sanctuaries, conservation of Jatka, and eco-friendly shrimp farming are currently underway. Furthermore, quality control activities have intensified to preserve and expand the export market for fish and fish products.

TABLE 2

ANNUAL FISH PRODUCTION IN BANGLADESH IN 2022–23

Types of Fisheries	Water Area (Hectare)	Production (Metric Ton)	% of Production	Productivity
A. Inland Fisheries				
I. Inland Open Water (Capture)				
River and estuary	853,863	389,035	7.92	456 kg/ha
Sundarbans	177,700	25,047	0.53	147 kg/ha
Beel	114,161	108,625	2.21	952 kg/ha
Kaptai Lake	114,161	108,625	0.35	248 kg/ha
Flood plain	2,646,757	842,520	17.14	318 kg/ha
Capture Total	**3,861,281**	**1,383,283**	**28.15**	
II. Inland Closed Water (Culture)				
Pond	415,872	2,272,667	46.24	5465 kg/ha
Seasonal cultural waterbody	1,444,513	231,582	4.71	1602 kg/ha
Baor	5,671	12,158	0.25	2144 kg/ha
Shrimp/prawn farm	261,833	301,103	6.13	1150 kg/ha
Crab	9,372	12,881	0.26	1374 kg/ha

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Types of Fisheries	Water Area (Hectare)	Production (Metric Ton)	% of Production	Productivity
Pen culture	9,080	16,402	0.33	1806 kg/ha
Cage culture	1.93 lakh cum	5,254	0.11	27 kg/ha
Culture Total	**846,341**	**2,852,047**	**58.03**	
III. Marine Fisheries				
Industrial (Trawling)		146,037	2.97	
Artisanal		533,348	10.85	

Source: Bangladesh Bureau of Statistics, Yearbook of Agricultural Statistics (2023)

Table 2 indicates that the fisheries sector in Bangladesh is divided into inland and marine categories, with inland fisheries further divided into open water (capture) and closed water (culture) systems. Inland closed water systems (culture) contributes the highest percentage (58.03%) of total fish production, with pond culture being the most productive, yielding 5,465 kg/ha. Among inland open waters, flood plains cover the largest area of over 2.6 million hectares. Despite a moderate productivity rate of 318 kg/ha, they contribute significantly to national fish production—producing approximately 842,520 MT, or 17.14% of the total. This situation makes flood plains a crucial component of the fisheries sector. They provide seasonal fishing opportunities during the monsoon season, supporting the livelihoods of millions of rural people with limited inputs or investments. In contrast, closed water systems such as ponds are highly productive due to controlled farming methods, contributing a larger share (46.24%) of fish production from a much smaller area. While marine fisheries also contribute to production, their share is comparatively lower. Overall, enhancing flood plain fisheries through sustainable practices and community-based management can further strengthen food security, rural income, and ecological balance (Bangladesh Bureau of Statistics, 2023).

Livestock

Production of Milk, Meat, and Eggs: The livestock sector plays a vital role in Bangladesh's economic development by supporting food and nutrition security, generating self-employment, and significantly reducing poverty. Due to ongoing government efforts, the country has become self-sufficient in meat and egg production and has made notable strides in milk production. A range of measures have been implemented to ensure sustainable milk output, including the improvement of cattle breeds, enhancement of milk marketing and quality control systems, increased accessibility to dairy products, and promotion of higher milk consumption.

TABLE 3

MILK, MEAT, AND EGG PRODUCTION

Product	Unit	Production							
		2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23*
Milk	Lakh MT	72.75	92.83	94.06	99.23	106.80	119.85	130.74	95.68
Meat	Lakh MT	61.52	71.54	72.60	75.14	76.74	84.40	92.65	66.70
Eggs	Crore	1191.24	1493.31	1552.00	1711.00	1736.00	2057.64	2335.35	1627.89

Source: Ministry of Finance, Bangladesh Economic Review (2025)

Table 3 shows the production trends of milk, meat, and eggs in Bangladesh between 2015–16 and 2022–23. Over the years, all three products have shown a steady increase in production, reflecting growth in the livestock and poultry sectors. Milk production rose from 7,275,000 MT in 2015–16

to 13,074,000 MT in 2021–22 before dropping to 9,568,000 MT in 2022–23. Similarly, meat production increased from 6,152,000 to 9,265,000 MT during the same period and then declined to 6,670,000 MT in 2022–23. Egg production exhibited a steady growth from 11.91 billion to 23.35 billion before falling to 16.28 billion in 2022–23. The decline in all three products from 2022 to 2023 may be attributed to challenges such as feed shortages, disease outbreaks, and economic disruptions.

Literature Review

Gainsharing is a company-wide initiative that uses a set formula to reward employees with a portion of the financial benefits resulting from improved organizational performance. Active employee participation is essential for the success of the program. The involvement is systematic, as employees are involved at all stages of implementation, including the design and periodic evaluation (Armstrong & Stephens, 2005).

Introduced as early as the 1930s, gainsharing is a system in which employees receive bonuses based on improvements in company performance, particularly in areas such as productivity, cost savings, and waste reduction. Early models of gainsharing, such as the Scanlon Plan, emphasized worker-management cooperation and cost reductions (Scanlon & Holthausen, 1948). Over time, these models have been adapted to suit various industries, including manufacturing, retail, and, more recently, agriculture and food production.

The agrifood sector has traditionally been slow to adopt gainsharing models owing to its structural characteristics, including high variability in production outcomes, seasonal labor demands, and fluctuating market prices (Parcell, 2002). However, technological advancements and a shift toward more sustainable and efficient practices have created new opportunities for implementing productivity-based incentive systems.

The agrifood sector is highly labor-intensive, particularly in regions that rely heavily on manual processes for planting, harvesting, and food processing. Productivity gainsharing can address labor inefficiencies by encouraging workers to identify waste, streamline processes, and adopt new technologies (Stewart et al., 2017). Studies have suggested that involving workers in productivity-related decision-making through gainsharing increases engagement and job satisfaction, leading to further productivity gains [c].

Harris et al. (2015) conducted an empirical study of gainsharing programs in food processing plants, finding that companies implementing gainsharing experienced an average productivity increase of 12% over two years. These improvements were linked to better team collaboration and a greater sense of ownership among workers. Similar results were found in agricultural settings where gainsharing was implemented in large-scale farming operations, particularly in the dairy and poultry sectors, where production efficiency is critical (Williams & O'Donnell, 2018).

Output variability is one of the key challenges in implementing gainsharing in the agrifood sector. Weather conditions, pests, and fluctuating market prices can significantly affect productivity, making it difficult to accurately measure gains attributable to employee effort (Gonzalez & Peréz, 2016). Additionally, the seasonal nature of agricultural work poses a challenge, as workers may not be present long enough to fully participate in or benefit from gainsharing programs (Clark & Harris, 2010).

To address these challenges, some companies have adapted the traditional gainsharing model to suit the agricultural context. For instance, Parcell (2002) proposed incorporating individual and group incentives to account for the fluctuating nature of agricultural work. This hybrid model rewards workers for their contributions while benefiting from overall productivity improvements.

Integrating technology into agriculture (often called "smart farming") creates new avenues for productivity gainsharing. Precision agriculture, data analytics, and automated machinery enable more accurate measurements of productivity and resource use (Stewart et al., 2017). These technologies enhance productivity and provide a clearer basis for distributing gainsharing rewards.

In the food processing sector, automation and digital tracking systems enable precise monitoring of labor inputs, waste reduction, and energy efficiency, all of which can be tied to gainsharing metrics (Milne et al., 2006). The future of gainsharing in the agrifood sector may rely heavily on integrating these technologies, enabling more consistent measurement and reward structures, even in highly variable environments.

Gainsharing Practices in the Agrifood Sector

Different types of productivity gainsharing approaches have been practiced in the agrifood sector, each employing distinct mechanisms for measuring productivity and distributing rewards. Table 4 shows some gainsharing practices in the agrifood sector.

TABLE 4

PRODUCTIVITY GAINSHARING APPROACHES (ISLAM, 2024)

1. Profit Sharing Programs and Schemes	This approach involves distributing a certain percentage of the company's profits among employees based on predetermined criteria. Employees receive bonuses when the company meets or exceeds specific profit targets.
2. Performance Bonuses, Shared Risk, and Reward Structure-based Incentives	Employees are rewarded with one-time bonuses for meeting or exceeding specific productivity goals, such as increased output, defect reduction, or improved efficiency. These bonuses can be tied to individual, team, or company-wide performance metrics.
3. Team-Based Gainsharing Productivity Incentives and Performance Bonuses	This approach shares gains among teams based on the group's collective performance. Teams are encouraged to work together to identify areas of improvement and implement changes that enhance productivity.
4. Skill-Based Pay Skill Development Incentives	Employees receive additional compensation for acquiring new skills that enhance productivity. This approach encourages employees to develop their competencies and contribute to organizational improvement.
5. Cost Savings and Cost-Reduction Programs and Incentives	In this model, employees are incentivized to find ways to reduce costs without sacrificing quality. When employees successfully implement cost-saving measures, they receive a share of the savings as a reward.
6. Continuous Improvement Programs and Initiatives	Gainsharing programs can be incorporated into broader continuous improvement initiatives, such as Lean or Six Sigma, where employees are rewarded for identifying and implementing process improvements that lead to increased productivity.
7. Output-Based Bonuses and Rewards	Producers often implement bonuses tied to specific output metrics, such as increased crop yields or improved product quality. For example, farmers may receive additional payments if their harvest exceeds a specific benchmark.
8. Employee Stock Ownership Plans (ESOPs) Feedback and Participation Program	This practice involves giving employees an ownership stake in the company through stock options. As a company grows and becomes more productive, the value of its stocks increases, thereby benefiting its employees.
9. Sustainability Programs and Initiatives	As sustainability becomes a priority in the agrifood sector, gainsharing programs linked to sustainable practices can motivate employees. For example, initiatives to reduce greenhouse gas emissions or improve waste management can lead to shared rewards for achieving specific sustainability targets.
10. Production Targets and Metrics Yield Incentive Programs	Organizations may set specific production targets or key performance indicators (KPIs) and reward employees when these targets are met or exceeded. This approach focuses on productivity goals.
11. Shared Risk Models	Some agrifood producers establish partnerships in which profits and risks are shared between owners and labor, creating a vested interest among employees in the success of farming or production operations.
12. Feedback, Participation Mechanisms, and Suggestions Programs	Encouraging employee feedback on operational improvements can enhance employee engagement. Agrifood companies may implement formal mechanisms for employees to propose changes that increase productivity, providing rewards for successful implementations.

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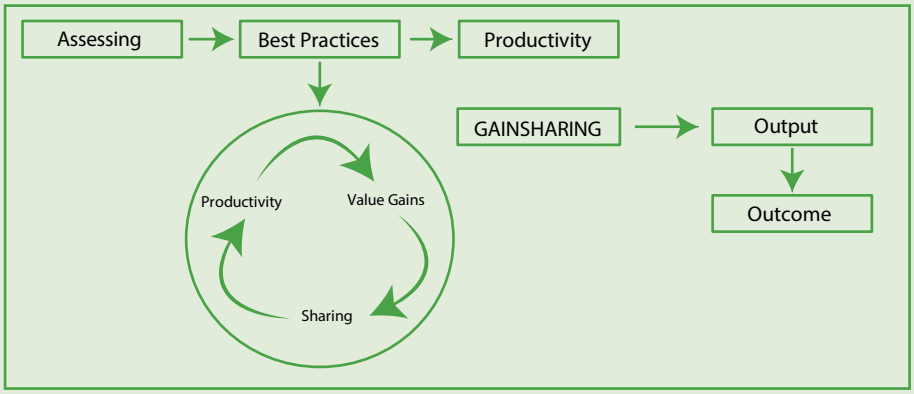
13. Collaboration with Cooperatives and Cost-Collaborative Cooperation	In many Asian countries, worker cooperatives play a significant role in the agricultural sector. Gainsharing can be incorporated into cooperative models in which members share the benefits of improved practices, collectively benefiting from enhanced productivity.
14. Flexible Work Arrangements, Operational Flexibility, and Innovation	Sometimes, productivity gainsharing can involve offering flexible work options, such as remote work or flexible hours, in conjunction with gainsharing incentives to improve work–life balance and productivity.
15. Workforce Participation Programs	Engaging employees in broader organizational decision-making can foster a sense of ownership and accountability. Programs that solicit employee input on productivity-related initiatives can lead to innovative ideas and improvements.
16. Resource Utilization Programs	These programs encourage employees to find ways to utilize resources (such as water, fertilizers, and energy) more efficiently. Successful suggestions leading to better resource use can lead to financial rewards.
17. Cultural Adaptation	Given the diverse cultural contexts across Asia, gainsharing practices are often adapted to align with local customs and expectations. Understanding cultural nuances is essential for the successful implementation of these programs.
18. Wellness and Well-Being Programs	Certain agribusinesses incorporate employee wellness into their gainsharing practices, providing incentives for participating in health and wellness initiatives that can improve overall productivity.
19. Lean Agriculture Practices	Several agribusiness enterprises implement lean management principles to enhance efficiency. Employees may receive gainsharing rewards for successfully identifying and eliminating waste in processes, including production, harvesting, and distribution.
20. Cross-Training Programs	Agribusiness firms may encourage employees to learn multiple roles within the operation. Gainsharing rewards can be offered when employees successfully adapt to various roles, enhancing flexibility and productivity.

This study adopts the community enterprise approach (CEA) to productivity gainsharing, which closely aligns with the collaboration with cooperatives and cost-collaborative cooperation approach described in number 13 in Table 4.

Conceptual Framework

FIGURE 6

CONCEPTUAL FRAMEWORK



Source: Assessing best practices in productivity gainsharing in the agrifood sectors of selected Asian countries (Islam, 2024)

Figure 6 demonstrates the conceptual framework of the study, illustrating a cycle of continuous improvement and inclusive growth through productivity gainsharing in the agrifood sector of Bangladesh. It begins with assessing current practices to identify gaps and opportunities, which then inform the adoption of best practices to enhance productivity. As productivity improves, value gains are generated and shared with contributors (such as workers and stakeholders) through a gainsharing mechanism. This process incentivizes further performance improvement and fosters a culture of shared responsibility and mutual benefit. The gainsharing loop (comprising productivity, value gains, and sharing) creates a sustainable system in which continuous improvement leads to tangible outputs and positive outcomes, such as increased efficiency, improved livelihoods, and sectoral growth.

Research Methodology

Qualitative and quantitative methods were employed to meet this study's objectives. Data were collected through expert interviews and various secondary sources. For secondary data, relevant existing studies from multiple sources were examined, whereas primary data were collected through online and face-to-face interviews.

Best Practices in Gainsharing within Bangladesh's Agrifood Sector

This study aims to identify Bangladesh's socially, environmentally, and economically important agrifood sectors. Among these subsectors, the fisheries sector has been regarded as environmentally and economically important. This study identifies the CEA in floodplain aquaculture (FPA) as a best practice within the fisheries sector.

Fisheries: An Important Agrifood Sector in Bangladesh

The fisheries sector is one of the most vibrant and promising industries within Bangladesh's agrarian economy, offering significant potential for future growth from economic, social, and environmental perspectives. It is crucial in ensuring food security and contributing to the national economy. This sector is generally divided into **inland and marine fisheries**.

TABLE 5

IMPORTANCE OF THE FISHERIES SECTOR

Category	Details
Economic Importance	One of the most productive and dynamic industries in Bangladesh
Fisheries Categories	Inland and marine fisheries
Inland Fisheries Area	47.60 lakh ha
Subsectors of Inland Fisheries	Inland Capture (39.27 lakh ha), Inland Culture (8.33 lakh ha)
Inland Capture Components	Beel, River, Estuary, Kaptai Lake, Flood Plain (39.27 lakh ha)
Inland Culture Components	Pond, Ditch, Baor, Pen Culture, Cage Culture, Shrimp/Prawn Farm, Seasonal Cultured Water Body (8.33 lakh ha)
Marine Capture Fisheries Area	1,18,813 km^2 with 200 nautical miles of exclusive economic zone (EEZ)
Fish Consumption	62.58 gm per capita (higher than the daily protein demand of 60 gm)
GDP Contribution	3.61% to national GDP and 24.41% to agricultural GDP
Sector Growth Rate (10 Years)	5.43%

Source: Economic contribution of fish and fish trade in Bangladesh (Shamsuzzaman, 2020)

Table 5 demonstrates the importance of Bangladesh's fisheries sector. Inland fisheries cover a vast area of 47.60 lakh hectares, including capture fisheries (39.27 lakh ha) such as rivers, estuaries, beels, Kaptai Lake, and floodplains. It also includes culture fisheries (8.33 lakh ha), ponds, ditches, baors,

shrimp/prawn farms, and modern methods such as pen and cage culture. The marine fisheries sector covers an area of 118,813 km² within a 200-nautical-mile of EEZ. Fish are considered a key part of the national diet, with per capita consumption of 62.58 grams per day, exceeding the daily protein requirement of 60 grams. The sector contributes 3.61% to the national GDP and a significant 24.41% to the agricultural GDP, with a 10-year average growth rate of 5.43%, highlighting its steady development and importance to the country's economy.

Bangladesh ranked third in the world in inland fish production, fifth in aquaculture production, and eleventh in marine fish production in 2018. Bangladesh is now self-sufficient in fish production and is increasingly gaining global recognition as one of the leading fish-producing countries (Department of Fisheries, nd).

The fisheries sector plays a significant role in achieving development goals by creating employment opportunities (directly for fishers and indirectly through related trades), which serve as a vital source of income. It directly and indirectly supports the livelihoods of over 18 million people in Bangladesh (Department of Fisheries, nd). Approximately 1.4 million women rely on this sector for income through activities such as fishing, aquaculture, and fish handling and processing. The sector also holds substantial potential for driving the country's economic development, reflecting the strong link between agricultural growth and broader economic progress (Shamsuzzaman, 2020). Fisheries and aquaculture represent the second largest export industry in Bangladesh and are among the top contributors to the country's export earnings. The country produces and exports various fish and fish products to approximately 60 countries worldwide, with major export destinations including the EU, the United States, and Japan.

Best Practices in the Agrifood Sector of Bangladesh

Community Enterprise Approach for Productivity Gainsharing in a Farm Community: As a delta, Bangladesh experiences widespread flooding of cultivable land during monsoons. Approximately 20% of the land is typically submerged annually; however, flooding can impact over 60% of the country in a few years. This situation makes floodplains one of Bangladesh's most significant common property resources (CPRs). Each year, roughly 2.8 million hectares of water bodies are formed due to floodplain inundation. During these periods, the land is often left fallow or used for cultivating low-yield deep-water rice.

Aquaculture is widely practiced in Bangladesh, with many households raising fish in ponds located next to their homes. Many aquaculture activities occur in water bodies that remain flooded year-round; however, seasonally flooded fields, also known as floodplains, present valuable opportunities for low-income individuals to engage in fish farming. Despite their potential, open access and unregulated use of these resources have resulted in overexploitation and declining productivity, making them unreliable sources of livelihood.

Since its founding in 1994, SHISUK, a private NGO, has focused on community development and sustainable agriculture. One of its most notable initiatives occurred in Daudkandi, where, in 1997, SHISUK launched a community-based collective enterprise for FPA (widely known as the Daudkandi model). In recognition of this pioneering effort, SHISUK was awarded the National Gold Medal from the Ministry of Fisheries and Livestock in 1999. The model was also recognized as one of SAARC's best practices for livelihood development in 2007. With funding support from the Krishi Gobeshona Foundation (KGF), Ministry of Agriculture, and Government of Bangladesh, SHISUK has begun implementing adaptive trials in other floodplains of the country, such as *tidal floodplains* on the coast and depressed areas in the North of Bangladesh (Shikkha Shastha Unnayan Karzakram (SHISUK), nd).

Why is this a Best Practice? Seasonally flooded floodplains in Bangladesh represent a resource with high economic potential but remain vastly underused. These areas typically consist of privately owned lands primarily used for agriculture during the dry season. When flooded, a floodplain transforms into a single water body spanning land owned by multiple individuals, often governed by different property

rights. As a result, without a collective agreement among landowners, these areas are difficult to manage or develop for investment-driven resource use or extraction.

As the number of seasonal floodplains is increasing owing to climate change and increased flooding, especially in low-lying countries such as Bangladesh, it is becoming increasingly important to utilize and manage these floodplains so that existing livelihoods are not disrupted. Adopting aquaculture on flood plains requires the agreement of all landowners. Informal agreements are often easier to enforce between socially similar groups. However, when multiple social groups interact, a formal contract involving multiple stakeholders becomes necessary to ensure inclusive participation. A few initiatives were attempted but failed due to a lack of consensus among landowners, conflicts over costs and benefits sharing, alternative seasonal uses of floodplain lands, and other issues. Furthermore, any initiative such as the floodplain aquaculture enterprise initiative would require considerable investment in infrastructure given the nature of the water body, in addition to fish culture-related investments.

TABLE 6

COMPARATIVE OVERVIEW OF THE COMMUNITY ENTERPRISE APPROACH (MORSHED, 2023)

Cooperatives under the Cooperative Act	Traditional companies under the Company Act	Community enterprises or trust-based organization
• Prevailing negative notions, poor individuals' initiative, savings-based • Project-driven, dependency on governmental support • Bureaucracy and political influence • Not much enthusiasm for forming a cooperative	• Compliance is not suitable for the rural farming community • It does not safeguard community ownership rights • Only profit-driven does not ensure environmental compliance	• Self-reliant/investment-based • Greater ownership and participation • Stronger social connections • Reduces transaction cost • Flexible • Wider scope • Less political interference

Source: Adapted from the community enterprise approach to productive gainsharing in a farm community (Morshed, 2023)

Table 6 shows a comparative overview of CEA. In rural development and farming communities, three major organizational models have been observed: **cooperatives under the Cooperative Act, traditional companies under the Company Act**, and **community enterprises or trust-based organizations**. Each has its strengths and limitations. **Cooperatives**, though historically important, often suffer from a negative perception as being initiatives primarily for poor individuals, heavily savings-based, and overly dependent on governmental support. They also face challenges such as bureaucratic red tape and political interference, discouraging rural communities from forming new cooperatives. In contrast, while profit-oriented and investment-driven, **traditional companies** often lack the flexibility and community protection needed in rural settings. Their strict compliance requirements do not suit the informal nature of rural farming, and their operations are usually not aligned with environmental or community welfare goals. Finally, **community enterprises or trust-based organizations** present a more balanced and inclusive model. They promote self-reliance and investment, encourage greater ownership and participation, and foster stronger social ties within the community. These models offer broader operational scope, reduce transaction costs, ensure flexibility, and are generally less susceptible to political interference, making them a more suitable option for sustainable rural development.

CEA can serve as an adaptive model that leverages changing conditions to enhance productivity, offering significant potential for advancing gainsharing aimed at collective growth. After the Gumti embankment was built in 1996, SHISUK began promoting a community-based management strategy for FPA, collaborating with local communities to establish effective FPA practices.

Community Enterprise Approach: CEA engages the community in forming enterprises or collective business groups that manage and use shared resources, such as underused floodplains. This approach

combines the efficiency-driven incentives of a corporate model with a democratic process that ensures the participation of all community members in economic development. Once the community and landowners are organized, the enterprise distributes "shares" to community members, making them shareholders and giving them the power to elect representatives who oversee management decisions. In this way, the enterprise operates similarly to a publicly traded company; however, its shares are not transferable (Shikkha Shastha Unnayan Karzakram (SHISUK), nd).

In 1996, SHISUK launched a pilot project to establish an effective community aquaculture management system in six villages of the Elliotgonj Union. Prior to the project, local residents (not professional fishermen) fished only during the rainy season when the floodplain was submerged. The project introduced an innovative solution to address the problem of limited capital by distributing shares to landowners and villagers and initiating FPA as a collective venture. This approach aimed to address the issue of underutilized local resources and encourage active community involvement. The project began with approximately 115 hectares (285 acres) of land that became a floodplain during the rainy season (June to October) and was shared by six villages. Following the project's success in its first two years, it was officially registered as a joint stock company in 1997 (Bayazid, 2016).

TABLE 7

SHAREHOLDING STRUCTURE AT A GLANCE

Area	115 hectares (285 acres)
Total land owners	395
Total number of shares	2000
Total number of shareholders	387
Share price	1,000
Share limit	20 shares (1% of total shares)
Community shares	1,600
SHISUK shares	400 (20%)

Source: Daudkandi model of community FPA in Bangladesh: A case for Ostrom's design principles (Bayazid, 2016)

The FPA project distributes shares valued at BDT1,000 to 400 households in six surrounding villages. Initially, shares were issued exclusively to landowners of the floodplain, with a cap of 20 shares per individual. Table 7 demonstrates that not all landowners within the selected aquaculture area invested in the project; however, it was subsequently discovered that issuing shares in this way was insufficient to raise sufficient capital. Later, other households without ownership in the floodplain lands were allowed to buy shares, given that *the shareholder must be an inhabitant of any of the surrounding six villages*. Eighty percent of shares were distributed to landowners and villagers, while the initiating NGO, SHISUK, acquired 20%. It reserves 5% of its 20% shares exclusively for the villages' less advantageous and impoverished people. These shares were used to form a private limited company, through which all FPA activities have since been managed. Shareholders select a board of directors comprising one chairperson, one managing director, and nine directors for two years, and this board oversees the day-to-day operations run by a group of employed personnel and occasionally forms a management committee for specific management operations (Bayazid, 2016).

A community enterprise is a people-led development model that extends beyond mere economic activities to include broader development objectives. This approach involves people collaborating to manage land, water, and common resources in rural areas. It focuses on how companies can enhance production and productivity, prepare for and manage risks, and minimize potential losses. Additionally, it encompasses setting clear goals, mobilizing resources, adopting modern technology, and acquiring the necessary knowledge and skills to transform their efforts into a functioning enterprise.

The local community owns and operates these enterprises, generating income and employment while empowering members to become entrepreneurs through active participation in decision-making, management, and project implementation. This approach is unique in that it involves the entire community rather than select groups. The enterprise structure promotes self-sustainability within a relatively short period, and a portion of the profits is reinvested into the community to support social development. The role of the NGO SHISUK is limited to providing a platform for dialogue, strengthening local-level governance, and facilitating more interaction and participation of all stakeholders.

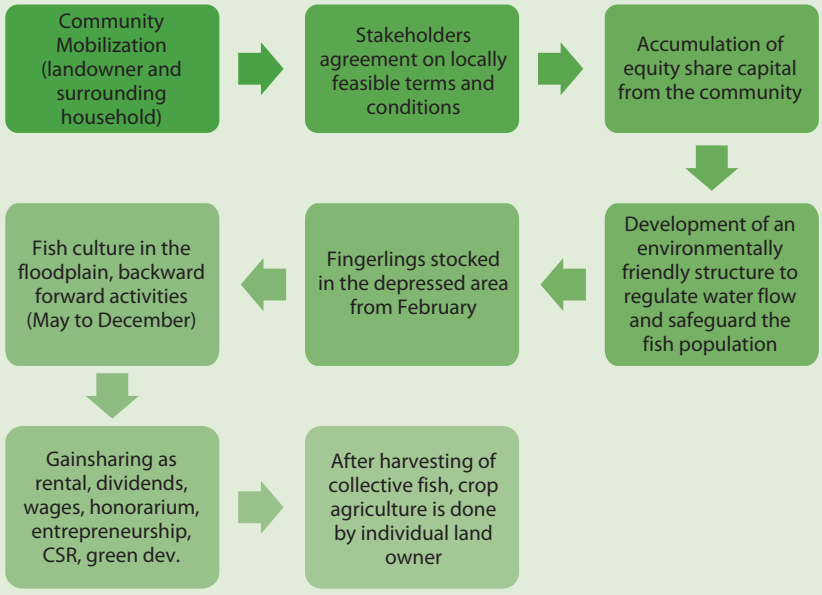
Process of Implementing the Community Enterprise Approach in Floodplain Aquaculture: To establish an effective management system for a floodplain, the primary challenge lies in addressing its seasonal nature and unique land tenure arrangements. SHISUK facilitated meetings with community members to mediate, discuss, and resolve stakeholders' concerns, primarily involving investment risks, potential property damage, and access rights.

The flood-affected land was leased from landowners who agreed to the arrangement in return for payment. An embankment was constructed to protect only the portion of floodplains owned by landowners who consented to the contract. The community enterprise managed this enclosed area during the monsoon, while landowners regained their land rights during the dry season. By implementing a leasing system and limiting individual shareholding, the landowners' bargaining power was reduced, thereby lowering transaction costs. Issuing shares also generated enough capital to invest in specialized infrastructure such as the embankment. Most community members were shareholders, thus minimizing the financial risk borne by each individual. Additionally, the CEA rewarded those who took greater risks with higher profits, effectively balancing the community's risk preferences, including those of the landowners.

Figure 7 outlines the formation and operational structure of the CEA within the FPA project. Initiating a community enterprise begins with mobilizing the entire community using the "asset-based community development" framework, which involves identifying community assets and

FIGURE 7

FORMATION AND OPERATIONAL FLOW CHART OF THE COMMUNITY ENTERPRISE APPROACH FOR FLOODPLAIN AQUACULTURE



Source: Adapted from the community enterprise approach for productive gainsharing in a farm community (Morshed, 2023)

networks, building relationships with local leaders, gathering success stories from community members, and engaging key stakeholders in the planning stage. Treating community networks as valuable assets fosters trust and strengthens social capital among members, significantly reducing transaction costs.

Furthermore, the CEA serves as a platform for transferring technology and supporting compliance with the Food Safety Code of Practice, thereby improving fish production, promoting sustainable agriculture, and ensuring safe food practices in floodplain management.

Other benefits of the CEA model include the following.

- Zero cleaning (weeds) cost: the floodplain remains clean because of aquaculture;
- Zero tillage: synchronization of water drainage and planting of seedlings eliminates the need for tillage;
- Less fertilizer cost: supplementary fish feed and fish droppings contribute to soil fertility;
- Less/no pest manifestation and pesticide use;
- Seedlings are planted using soil moisture, reducing the reliance on groundwater for irrigation;
- Increased replenishment of groundwater table (Shikkha Shastha Unnayan Karzakram (SHISUK), nd).

Bangladesh has over 2.83 million hectares of floodplains, a seasonal (during monsoon) CPR that remains untapped and unutilized due to the lack of collective initiatives. However, this resource holds significant potential of accelerating collective growth, as demonstrated by the CEA in floodplain aquaculture systems, where fish production increased from the typical yield to four MT per hectare.

As a result of climate change, more areas are experiencing flooding, disrupting traditional agricultural practices and livelihoods. The CEA can serve as an adaptive model to address these evolving conditions while simultaneously enhancing productivity.

Through active participation, hands-on experience, and targeted training, stakeholders have strengthened their capacity to withstand natural disasters such as storms, floods, and droughts. They have also become better equipped to adapt to the ongoing impacts of climate change. Additionally, the economic benefits generated by the project have boosted resilience at the household and community levels, enabling both groups to withstand such challenges.

Morshed, 2023 demonstrated the key principles of the SHISUK CEA model as follows:

- Providing income augmentation and purposeful employment;
- Adding value to agricultural production;
- Priority marketing for local consumers at wholesale prices;
- Allocating surplus to community projects;
- Spinning off more community enterprises;
- Fostering the development of decision-makers and entrepreneurs.

TABLE 8

KEY FEATURES OF THE SHISUK COMMUNITY ENTERPRISE APPROACH MODEL

Ownership	Investment	Governance	Community focus
• Community-led environmentally friendly collective initiative based on local potential • Owned by the broader local community • Single voting rights for every member • Incorporation: Producers/ community + related facilitating organization	• Comes from communities' equity share capital • Members' equity shares cannot be publicly traded but can be transferred within the community	• Ownership/ Shareholdings for every community HH • Democratic representation of the communities, elected management board (BoD) • Participatory decision-making and management • Accountability to shareholders, annual audit, and annual general meeting	• Equitable share ownership • Reserved shares for underprivileged individuals • Reserved funds for charity (5%–10% of the net profit) • Priority for local entrepreneurs in backward and forward linkages • Priority marketing for local consumers at wholesale prices • Inclusive growth – Growth and equitable distribution of benefits – Inclusive and well-functioning markets – Equal opportunities and foundations for future prosperity

Source: Adapted from the community enterprise approach for productive gainsharing in a farm community (Morshed, 2023)

Table 8 shows that the community-based enterprise model emphasizes collective ownership, democratic governance, and inclusive local development. This community-led, environmentally friendly initiative leverages local resources and potential. Ownership is broadly distributed among community members, where each household holds equity and has a single voting right, ensuring fairness and equal representation. Investment comes from community share capital, which cannot be publicly traded but may be transferred within the community, preserving local ownership. Governance is carried out by an elected board of directors, ensuring participatory decision-making, transparency, and accountability through annual audits and general meetings. This model also promotes social equity by reserving shares for underprivileged members and allocating 5%–10% of the net profit to charitable activities. Economically, it supports inclusive growth by prioritizing local entrepreneurs in supply chains and offering products to local consumers at wholesale prices. This approach fosters equal opportunities, sustainable prosperity, and the development of well-functioning, inclusive markets that benefit the entire community.

Outcomes of the Community Enterprise Approach for Productivity Gainsharing: Figure 8 illustrates the outcomes of CEA for productivity gainsharing by highlighting its multifaceted benefits across the agricultural value chain. It empowers smallholders, farmers, and small- and medium-sized enterprises through collective investment, access to affordable quality inputs, and enhanced bargaining power. Market aggregation allows for demand-driven production and better marketing opportunities by attracting wholesalers directly to the farm gate. Improved market governance helps prevent distress sales, reduce exploitative agent costs, and enhance security through shared market intelligence. This approach also supports last-mile delivery by fostering local entrepreneurship for "Plot to Plate" services and improving logistics and postharvest management. Financial inclusion is promoted through capacity-building in financial management and entrepreneurship, whereas public–private partnerships support mechanization, credit access, and contract farming. Overall, CEA strengthens productivity and ensures fair distribution of benefits among all stakeholders.

Productivity and Other Socioeconomic Gainsharing of the CEA Model: Aquaculture activities during the traditionally lean season have significantly increased production in the area, generating approximately USD10 million annually. Small farmers benefited from lease payments and dividends,

FIGURE 8

OUTCOMES OF THE COMMUNITY ENTERPRISE APPROACH FOR PRODUCTIVITY GAINSHARING

Source: Adapted from the community enterprise approach for productive gainsharing in a farm community (Morshed, 2023)

earning USD13.60 in 2004 for those holding 10 shares. The project also created substantial employment opportunities, with 144 nonrecurring person-days and 72 recurring person-days of labor per hectare. Furthermore, stakeholder participation rose from an average of 12 stakeholders in the preproject phase to 40 in the postproject phase, according to 2004 World Fish Center (WFC) data.

The distribution of net profit is as follows:

- 20%–25% to landowners as the lease value;
- 10% as remuneration for management;
- 5%–10% for community social services;
- 60% as dividends to shareholders (landowners + landless+ facilitating org.).

Benefits for the community marginal farmers/landless/fishermen include:

- Small lease value;
- Small dividend;
- Welfare support;
- Reserved shares for underprivileged individuals;
- Reserved funds for charity (5%–10% of the net profit);
- Empowerment;
- Opportunity for participation and ownership in significant investment;
- Equal voting rights;
- Increased intake of protein and nutrition (favorable environment for elastic demand);
- Full benefits of employment;
- Entrepreneurial opportunity (backward and forward linkages).

TABLE 9

BACKWARD AND FORWARD LINKAGES

Backward linkages (Input services)	Forward linkages (Output services)
1. Small household ponds for fingerling nursery	1. Ice plant operators
2. Fish hatchery operators	2. Ice suppliers/intermediaries
3. Fingerling traders	3. Local entrepreneur (wholesale buyers)
4. Fish feed sellers	4. Fish traders/wholesalers
5. Lime and fertilizer traders	5. Retail buyers in the local market
6. Transport workers (carrying inward): rickshaw/van/ truck/trolley	6. Transport worker (carrying outward): rickshaw/ van/ truck/ trolley
7. Transport owner (carrying inward): rickshaw/van/truck/ trolley	7. Transport owner (carrying outward): rickshaw/ van/truck/ trolley
8. Cow dung/poultry litter-based compost suppliers	8. Fish drying
9. Fingerling-rearing workers	9. Food vendors
10. Project staff (admin, security)	10. Fisherman harvesting
11. Local money lenders	11. Project staff marketing
	12. Local money lenders

Source: Community enterprise approach for productive gainsharing in farm communities (Morshed, 2023)

Table 9 outlines the backward and forward linkages associated with small-scale aquaculture, particularly focusing on the input and output services that support the sector. Backward linkages (input services) include stakeholders and activities that precede fish production, such as fish hatchery operators, fingerling traders, feed and fertilizer suppliers, compost providers, transporters (inward), and support staff. These entities provide the necessary resources and logistical support for successful fish farming.

Forward linkages (output services) relate to postproduction processes involving ice suppliers, wholesalers, retail buyers, transporters (outward), fish processors, and vendors who facilitate market access and value addition. Both linkages include common actors, such as local moneylenders and project staff, who support the system through financing, administration, or marketing efforts. Together, these linkages form an integrated supply and value chain that supports the aquaculture ecosystem.

Productivity Gainsharing–Climate Resilience: Small farmers and entrepreneurs can pool resources, knowledge, and skills to manage climate risks and improve their productivity, including:

- adopting climate-resilient farming practices;
- investing in climate-resilient infrastructure and;
- diversifying their income streams to reduce dependence on a single crop or product.

Effectiveness of the Best Practiced Productivity Gainsharing Approach

Several distinctive features of the CEA model contribute to its success in increasing net output. One key factor was the presence of prior public investments in flood protection infrastructure, such as embankments and culverts, which facilitated smaller-scale private investments to convert portions of the floodplain into controlled, seasonally closed water bodies. As these initial public works reduced the scale and risk of private investments, there was no immediate need for significant financial returns to justify them nor was there an urgent need to resolve complex production monitoring issues. Consequently, the economic and political challenges associated with transforming these areas for productive use were significantly minimized.

The first significant public investment occurred in the early 1990s when the Comilla flood protection barrier was constructed. The Pankauri Fisheries project, launched in 1997 with SHISUK's support, was the first such initiative under this model. Community shareholders raised sufficient funds to build a six-kilometer "country road" atop an embankment, effectively turning part of the floodplain into a seasonally enclosed waterbody. Landowners contributed their land to the project while retaining ownership and received rental payments in return. Moreover, the value of their remaining land increased due to its proximity to the new road. Following severe flooding in 2004, the local government engineering department (LGED) built additional roads and culverts, further encouraging private investment in similar seasonally enclosed waterbody projects, leading to more enterprise-driven initiatives (Khan, nd).

Another important aspect of the model was that the land was privately owned and leased to community-based organizations (CBOs) for fish farming during the flood season and subsequently reverted to individual use for rice cultivation in the dry season. Shareholding was limited to resident landowners; therefore, the associated project shares were typically transferred to the new owner when the land was sold. This structure effectively created long-term lease arrangements without the need for formal lease negotiations. For public lands to attract long-term investment, comparable lease durations and security would be essential to justify the required financial commitments.

In this case, the issue of fixed-technology appropriation was not a significant concern, primarily due to the seasonal nature of fish harvesting. Moreover, producers are not required to determine optimal catch rates to preserve fish stocks, as restocking with fingerlings is done each season. Sufficient capital was available for this restocking process. Nevertheless, the management committee had the capacity and motivation to enforce control measures, including setting limits on fishing if needed. Furthermore, fish sanctuaries and catch restrictions were effectively implemented.

However, efficient and timely labor management was essential to the success of this model. The risk of reduced productivity due to workers' free-riding was a real threat. This challenge was managed by employing wage labor or setting up shared catch agreements, administered by a team management structure with the authority and motivation to regulate fishing rights and conditions. As a result, team

oversight in this enterprise-based system proved to be more effective, helping to maintain the output levels required to satisfy investors.

Interestingly, although landlords comprised the majority of stakeholders, the role of the NGO SHISUK was crucial in establishing the CBO. Many internal disagreements and mistrust among participants had to be addressed, and SHISUK's neutral presence helped mediate and set up essential institutional frameworks, as well as ensure their continued functioning.

The model's relative success can be attributed to several factors: existing public investments in flood-control infrastructure, the availability of private landowners willing to pool their land and capital to create seasonally enclosed waterbodies, and the involvement of an effective NGO to facilitate organization and governance. However, this also implies that such a model may not readily apply to all waterbody contexts across Bangladesh.

The enterprise-based model embodies features that can address aspects of the investment-enabling appropriation problem and production monitoring problem to achieve significant investments and increase net output; however, the investments required to achieve closed waterbody conditions were fortuitously reduced due to public investments in flood prevention. Further investments will likely require more effective control over production to reduce monitoring costs and ensure adequate returns. Introducing labor-saving or production monitoring technologies will undoubtedly be criticized. Indeed, the enterprise model has already been criticized for excluding low-income individuals from free access to fishing and for its damaging impact on biodiversity. Shisuk, an advocate of the enterprise model, strongly contests these claims by highlighting rising wages and labor shortages in the area as evidence of poverty reduction resulting from wealth generated by its fishery projects. It denies that the temporarily closed waterbody aquaculture it practices has significantly reduced the varieties of fish in the region. While both sides of the argument may have some factual merit, and even if there are some immediate trade-offs along these lines, the enterprise-based CBO model should still be seriously considered as a way of addressing the constraints on raising net output in Bangladesh fisheries (Khan, nd).

Recommendations

This study recommends a practical productivity gainsharing approach in the agrifood sector.

1. Ensure that gainsharing models are tailored to specific agrifood subsectors such as fisheries, aquaculture, and floodplain agriculture to maximize their impact.

2. Conduct regular training and capacity-building programs for farmers, agribusiness owners, and other stakeholders to enhance their understanding of productivity gainsharing models.

3. Establish multistakeholder platforms to facilitate collaboration between farmers, agribusinesses, government, and NGOs, thereby enabling the design and implementation of gainsharing mechanisms.

4. Scale up the CEA model in other floodplain regions by leveraging the lessons learned from the Daudkandi model.

5. Introduce gainsharing mechanisms that reward innovative farming practices and adopt advanced technologies in the agrifood value chain.

6. Align gainsharing models with sustainable agricultural practices to minimize environmental impacts and improve resource efficiency.

7. Launch awareness campaigns to highlight the benefits of gainsharing models for improving productivity, livelihoods, and sustainability.

8. Promote community ownership and collective action to encourage wider acceptance of gainsharing approaches.

By implementing these recommendations, Bangladesh can harness the potential of productivity gainsharing to transform its agrifood sector, fostering inclusive growth, sustainable development, and economic resilience.

Conclusion

This study concludes that gainsharing practices in the agrifood sector of Bangladesh hold significant potential for driving sustainable development by enhancing productivity, ensuring equitable profit distribution, and fostering resilience against market and climate shocks. The fisheries sector, particularly Daudkandi FPA under the CEA, emerged as a flagship example of inclusive and community-driven models that deliver social, economic, and environmental benefits. However, systemic challenges such as fragmented ownership, resource overexploitation, and inadequate policy support must be addressed for these practices to reach their full potential. The agrifood sector can catalyze equitable growth, rural development, and environmental sustainability in Bangladesh by scaling successful models, strengthening institutional frameworks, and promoting capacity-building initiatives.

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GAINSHARING APPROACHES AND PRACTICES WITHIN INDIA'S TOMATO SUPPLY CHAIN

Executive Summary

India's horticulture sector significantly contributes to the economy, accounting for approximately 30% of the agricultural GDP while using only 13.1% of the gross cropped area. Despite its importance, the sector faces challenges, such as postharvest losses, inadequate infrastructure, and market access issues, leading to inefficiencies in the supply chain. Efforts are underway to transition from traditional supply chains to value-based systems focusing on quality management, safety, storage, profitability, increased export potential, and consumer demands.

The traditional horticulture supply chains are fragmented and characterized by a lack of coordination among various stakeholders, including farmers, wholesalers, and retailers, inadequate cold storage facilities, and poor transportation infrastructure. Traditional markets in India are typically dominated by intermediaries, particularly in the sale of fruits and vegetables. This structure significantly reduces farmers' profit margins. Organized supply chains are still in nascent stage in India, as farmers individually sell their produce in open wholesale markets. This situation poses a significant challenge for farmers in obtaining a reasonable price for their products. Soft products such as tomatoes require handling, storage, and transportation care, resulting in severe losses, low price realization, and gains in absence of organized supply chains.

In India, efforts are underway to bring farmers together in organized formats such as the creation of farmer producer organizations (FPO), farmer cooperatives, and the establishment of direct marketing channels to enhance the market access for smallholder farmers and reduce the number of intermediaries for improving supply chain efficiency and better gain distribution. This current study examines the challenges farmers and related stakeholders face in the tomato agribusiness supply chain, with the aim of ensuring equitable profit distribution among all stakeholders.

Various gainsharing models in horticulture include contract farming arrangements, collaborative supply chain frameworks, revenue sharing agreements, information sharing systems, and sustainability-focused initiatives. These models strengthen cooperation, align incentives, and enhance supply chain performance, benefiting all stakeholders. Two key criteria for assessing supply chain efficiency are the management of marketing costs and price realization by farmers.

Tomatoes are an important crop in India, and the tomato supply chain involves key stakeholders. These include input suppliers who provide necessary resources for cultivation, producers who are categorized by landholding size and cultivate tomatoes, commission agents who facilitate transactions between farmers and buyers, wholesalers who purchase in bulk and supply to retailers who then sell to consumers, processors who manufacture tomato-based products, and distributors who supply processed products and exporters who sell in international markets. Traditional marketing channels involve producers, commission agents, and retailers. Farmers face several challenges, including high input costs, marketing constraints, and a low producer share in consumer prices. Improving producer's share requires addressing factors such as high marketing costs, inefficient supply chains, and limited market access. Inefficient supply chains with multiple intermediaries often result in farmers receiving a marginal share of the final consumer price.

Gainsharing in the Indian tomato supply chain aims to increase farmers' share of consumer prices. Strategies to improve gainsharing include reducing intermediaries, enhancing market infrastructure, and improving farmers' access to information and technology. New supply chain channels include wholesalers with cold storage facilities and organized retailers such as supermarkets. The upcoming advanced format of an organized retail chain that integrates small and marginal farmers is the formation of FPOs, a refined version of a cooperative that offers the additional advantages typically associated with a company structure. FPOs integrate small and marginal farmers as stakeholders and empower them to collectivize production systems, resource pooling, bulk production and handling, price negotiations with buyers, and eliminate intermediaries.

The emergence of FPOs such as Sahyadri Farms as an integrated agribusiness platform showcases successful gainsharing practices. These initiatives offer better price realization, access to quality inputs, shared logistics, and direct market linkages through open networks for digital commerce. Moreover, they also facilitate the creation of a credit guarantee fund for risk-sharing. Furthermore, adopting modern supply chain strategies, such as cluster-based tomato farming, digital market access, and structured gain distribution models, can help optimize stakeholder revenue distribution. FPOs can ensure farmers' participation by defining clear performance metrics and mechanisms for calculating gains based on contributions and ensuring transparency through data sharing and periodic audits. As a policy support, the government of India can strengthen such FPOs by upgrading the status of FPOs as Common Services Centres-Special Purpose Vehicle (CSC-SPV), enabling them to provide government-related services to the country's citizens.

Future growth in this sector depends on strengthening farmer training programs, improving postharvest handling, and implementing efficient gainsharing mechanisms. By leveraging digital platforms, reducing intermediaries, and enhancing infrastructure, India's tomato supply chain can achieve a more equitable and sustainable model, benefiting farmers and consumers.

Introduction

Background of the Horticulture Sector in India

Horticulture production plays a crucial role in the Indian economy, contributing significantly to farmers' incomes, employment generation, and the generation of substantial foreign exchange through exports (Sebastian et al., 2023). Horticulture production accounted for approximately 223.089 million tons during the 11th five-year plan, primarily driven by fruits and vegetables (Vikram et al., 2023). Despite occupying a relatively small portion of the total cropped area, horticulture contributes around 30% to India's agricultural GDP, highlighting its economic significance (Vikram et al., 2023). According to FAO (2022), India is the largest producer of onions, ginger, and okra among vegetables and ranks second in the production of potatoes, cauliflowers, brinjal, and cabbages. Among fruits, India ranks first in the production of bananas, mangoes, and papayas (FAO, 2022). Horticulture contributes approximately 30.4% to the GDP while using only 13.1% of the gross cropped area, making it a significant player in India's agricultural growth (Economic Times, 2023). In 2023–24, India recorded the production of fruits as 112.73 million tons and vegetables as 205.80 million tons (PIB, 2024). During 2023–24, India exported fresh fruits and vegetables valued at USD1,814.58 million (i.e., fruits worth USD986.32 million and vegetables worth USD828.26 million). Grapes, pomegranates, mangoes, bananas, and oranges account for the larger portion of fruits exported from the country, whereas onions, mixed vegetables, potatoes, tomatoes, and green chilies primarily contribute to vegetable exports. The Harmonized System code for exporting tomatoes from India is 07020000, which refers to "tomatoes, fresh or chilled" (APEDA, 2024).

The horticulture sector faces several challenges, including postharvest losses, inadequate infrastructure, and market access issues. Inefficiencies in the supply chain can lead to significant postharvest losses, particularly for perishable commodities such as tomatoes, which are extensively cultivated in India (Mohan et al., 2023). The adoption of protected cultivation techniques, such as greenhouse farming, has emerged as a viable solution to mitigate the adverse effects of extreme weather conditions and improve crop quality (Indurthi et al., 2023; Jain et al., 2023; Ranjan et al., 2023).

Horticulture Supply Chains in India and the Concept of Gainsharing

The existing horticulture supply chains are fragmented and often characterized by a lack of coordination among various stakeholders (including farmers, wholesalers, and retailers), inadequate cold storage facilities, and poor transportation infrastructure (Negi et al., 2014; Bidyasagar et al., 2018). Most fruits and vegetables are sold through traditional markets where multiple intermediaries are involved, leading to increased costs and reduced profit margins for farmers. Reports indicate that less than 5% of the total fruits produced in India are sold through organized supply chains, with the majority passing through a long chain of intermediaries before reaching consumers (Veera et al., 2014; Oberoi et al., 2019). This situation affects the income of farmers and the quality and safety of the produce available to consumers (Nedumaran et al., 2020). The COVID-19 pandemic witnessed lockdowns and restrictions and disrupted transportation and market access, leading to significant losses for farmers and increased consumer prices (Negi et al., 2015; Ravi Kumar et al., 2021).

This unorganized and fragmented value chain in horticultural commodities poses significant challenges for farmers in obtaining reasonable product prices. Soft products such as tomatoes require handling, storage, and transportation care, resulting in severe losses, low price realization, and gains without organized supply chains. In India, efforts are underway to bring farmers together in organized formats. These include creating farmer producer organizations (FPO), cooperatives, digital integration, and establishing direct marketing channels to enhance market access for smallholder farmers and reduce the number of intermediaries. This approach can improve supply chain efficiency and ensure more equitable distribution of gains across stakeholders (Negi et al., 2015; Gardas et al., 2017; Raut et al., 2019; Nedumaran et al., 2020).

This study examines the challenges faced by farmers and related stakeholders in the agribusiness supply chain of tomatoes, with the aim of ensuring equitable profit distribution among all stakeholders.

Study Objectives

This study aims to:

- Identify economically important stakeholders in India's agrifood supply chain of fresh tomatoes;
- Identify best practices regarding farm productivity gainsharing across stakeholders in the tomato supply chain in India;
- Provide recommendations to improve gainsharing in tomato supply chains in India.

Figure 1 presents the research framework.

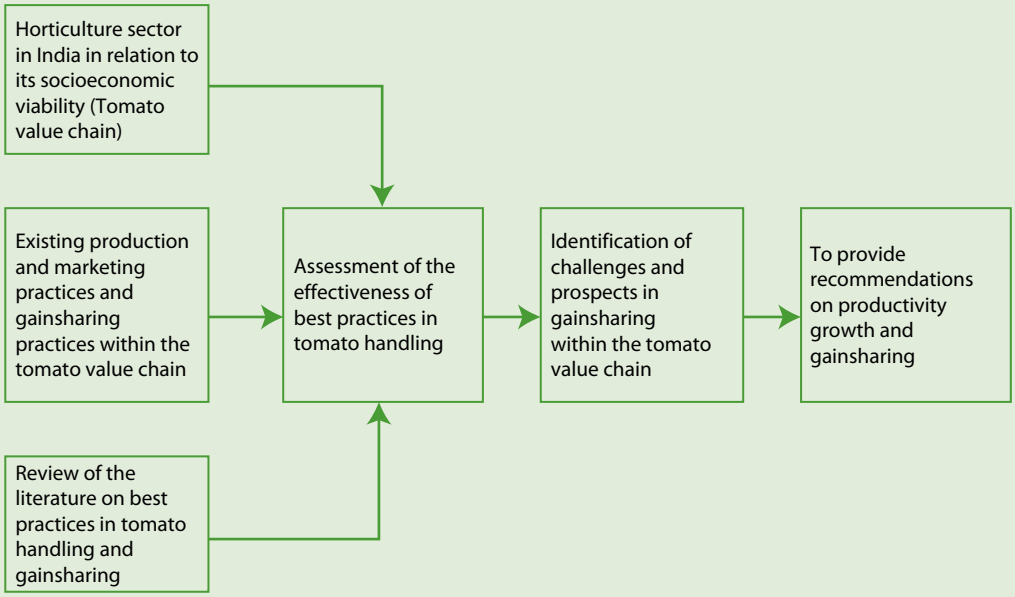
Literature Review

Overview of Gainsharing in Horticultural Supply Chains

Productivity gainsharing practices within the horticulture supply chain is a multifaceted topic encompassing various strategies to enhance stakeholder collaboration, improve sustainability, and address economic challenges. Gainsharing is a collaborative approach in which benefits derived from the value of productivity gains are distributed among supply chain partners, resulting in enhanced supply chain performance in horticulture. One of the primary challenges in horticultural supply chains is the coordination among multiple stakeholders, which is crucial for maintaining supply volumes, ensuring product quality, and facilitating information sharing. Contract-based supply chains offer a potential solution by improving collaboration among stakeholders (Schrobback et al., 2023). Implementing gainsharing practices can address these challenges by fostering a collaborative environment where all parties are incentivized to work together toward achieving common goals. Direct purchasing strategies can also promote collaborations and agreements with horticultural producers, contributing to increased value and sustainability within supply chains (Molla et al., 2011; Mesa et al., 2019; Jiang et al., 2021; Drechsler et al., 2022; Susanto et al., 2023).

FIGURE 1

RESEARCH FRAMEWORK



Models in Gainsharing

Gainsharing Models

Gainsharing models in horticulture include (a) contract farming arrangements, (b) collaborative supply chain frameworks, (c) revenue sharing agreements, (d) information sharing systems, and (e) sustainability-focused initiatives (Kariuki et al., 2016; Narulidea et al., 2018; Wichitpong et al., 2018; Guo et al., 2022; Tarifa-Fernández et al., 2023). These models are designed to strengthen cooperation, align incentives, and enhance supply chain performance, benefiting all stakeholders.

- **Contractual Farming Arrangements (CFAs):** Kariuki and Loy (2016) highlighted that CFAs can establish clear stakeholder expectations and responsibilities to correct market failures and enhance income generation among smallholder farmers. This model facilitates better quality control, aligns incentives across the supply chain, and creates a stable and predictable environment for stakeholders (Kariuki et al., 2016).

- **Collaborative supply chain framework:** Collaborative efforts enable shared investments in resources and technology as well as the adoption of best practices, resulting in improved product quality, greater market responsiveness, increased consumer satisfaction, better returns, and more informed decision-making (Wichitpong et al., 2018).

- **Revenue Sharing Contracts:** These contracts can link compensation and performance metrics to ensure that all stakeholders in the horticulture supply chain are incentivized by optimizing their contributions (Narulidea et al., 2018).

- **Information Sharing Mechanisms:** These mechanisms facilitate information sharing among supply chain stakeholders regarding market demands, price fluctuations, arrival and sale of commodities in the marketplace, production, and storage capacity. These data also help make informed decisions (Guo et al., 2022).

- **Sustainability-Focused Models:** This model encourages adopting environmentally friendly, cost-effective, durable, and less complex practices. The inclusion of nonrenewable energy management sources through solar-powered cold storage systems, developing short supply chains, using eco-friendly refrigerants and green vehicles, and replacing bamboo-based products in handling with more durable

plastic crates contribute to cost management and the reduction of carbon footprint within commodity supply chains (Tarifa-Fernández et al., 2023).

Gainsharing Practices in the Fruits and Vegetable Supply Chain in India

The Indian horticulture sector (one of the largest producers of fruits and vegetables globally) faces significant challenges, including inadequate infrastructure, high postharvest losses, and inefficient supply chain management (Negi et al., 2015; Rais et al., 2015). Implementing effective gainsharing practices can address these issues by fostering stakeholder cooperation, ensuring better resource allocation, and enhancing product quality. Important factors in the gainsharing of horticulture supply chains include collaborative agreements, effective information sharing, technological integration, robust postharvest management practices, improved market access, sustainability considerations, and supportive government policies (Prabhu et al., 2018; Elik et al., 2019; Onwude et al., 2020; Guo et al., 2022). Some of these arrangements are reviewed below.

- **Farmer Producer Companies (FPO):** It refers to organizations incorporated or registered under Part IXA of the Companies Act or the Cooperative Societies Act of the concerned states in India. These are formed to leverage collective production through economies of scale in agricultural and allied sector production and marketing for small and marginal farmers (PIB et al., 2025).

- **Contract Farming Agreements:** Prabhu et al. (2018) found that contract farming improves farmers' economic stability, assures buy-back agreements and price stability, and reduces the risk of market fluctuations. Such agreements also motivate farmers to adopt good agricultural practices (GAP) (Prabhu et al. 2018).

- **Government policies and support systems:** The Indian government can play a pivotal role by creating an enabling environment that encourages collaboration and investment at different supply chain stages. Approaches include providing subsidies for cold storage facilities, improving transportation infrastructure, developing product-based clusters enabling primary, secondary, and tertiary processing, and facilitating market access to smallholder farmers (Negi et al., 2015; Rais & Sheoran, 2015). These organized supply chains and processing clusters can thereby promote gainsharing practices.

Current Trends and Drivers

In India, the supply chain network is evolving into a value chain-based system that goes beyond the mere handling of produce to include the management of quality, safety, hygiene, storage, and shelf life, aligning with the requirements of consumers and processors. Additionally, this network integrates various logistics and transportation functions. Gainsharing practices in horticulture supply chains are influenced by several critical drivers that enhance collaboration, efficiency, and sustainability among stakeholders (Mashapa et al., 2014; Negi et al., 2015; Kariuki et al., 2016; Benson et al., 2017; Mahajan et al., 2017; Elik et al., 2019; Azka et al., 2019; Schrobback et al., 2023; Tarifa-Fernández et al., 2023). A few of these drivers are listed below.

- Collaborative agreements and contract farming arrangements
- Technological integration for postharvest management
- Market access and value chain development
- Sustainability and environmental considerations
- Data transparency and sharing
- Clear performance metrics
- Fair gain distribution mechanism

- Legal and contractual agreements
- Shorter supply chains
- Risk management and cost control
- Commitment and leadership support

Contractual farming and collaborative approaches lead to better decision-making in horticultural supply chains. These approaches reduce price and market risks and decrease operating costs, increasing overall supply chain efficiency and consumer satisfaction (Kariuki et al., 2016; Drechsler et al., 2022).

Methodology

Research Design

This study employs a secondary research methodology approach to analyze existing literature, case studies, and industry specific reports on tomato production, the tomato supply chain, the value chain, and gainsharing practices in India. The study focuses on developing insights into gainsharing practices by gathering information from peer-reviewed journal articles, books, industry white papers, and credible online sources to prepare a comprehensive overview of gainsharing models and implementation strategies.

Data Collection

The study involves secondary research and data collection from different primary sources of print and published media from academic and research journals, data generated by research organizations, industry reports, government publications, and databases such as CABI, PubMed, Elsevier, Scopus, and JSTOR. Secondary desk research was conducted to collect the available information (Negi et al., 2015; Kariuki et al., 2016; Gardas et al., 2017; Sasidharan et al., 2020; Boiteau et al., 2022; Sadashiva et al., 2022; Sulthana et al., 2024; Kumar et al., 2024b). The collected data were screened for its relevance to India's tomato supply and value chain.

Data Analysis: The collected information underwent subjective assessment to identify patterns and insights related to production, profit sharing, and gainsharing in the tomato value chain in India. The results and findings of different research work and reports were analyzed and the data were interpreted to avoid any biases. An attempt has been made to ensure proper citation of the information sources referred to in this study.

Current State of Productivity Gainsharing in the Agrifood Sector (Tomato)

Overview of Existing Gainsharing Practices in the Tomato Supply Chain

Gainsharing in the Tomato Supply Chain in India

Tomato cultivation offers significant economic benefits over traditional field crops. However, the lack of inadequate marketing infrastructure, high transportation costs, and substantial profit margins captured by retailers and wholesalers contribute to higher marketing costs, resulting in lower profitability for tomato farmers. In addition to these factors, tomato growers often face challenges such as excessive commissions, high sorting, grading, and packaging costs, delayed payments, seasonal production fluctuations, the volume of tomatoes arriving in markets, and their prices. Less distinction between table-purpose (fresh) tomatoes and a processable variety of tomatoes limits the demand for tomatoes in the processing sector. Most tomato farmers rely on commission agents for sales, lacking direct access to retail markets. Consequently, market intermediaries claim larger margins (Siva et al., 2015; Handa et al., 2024). Moreover, intermediaries in private trade channels often secure substantial margins, resulting in producers receiving less than 40% of the final consumer price.

Producers Share in Consumer's Rupee in the Tomato Supply Chain

The producer's share in consumer's rupee is dynamic and subject to change. Tomato producers could realize up to 42.18% of the producer's share in consumer's rupee in a traditional supply chain and 59.50% in a supermarket-organized supply chain (Ramappa et al., 2016). In a shorter supply chain with no intermediaries, farmers in the Karnataka State of India could realize up to 68% of the producer's share in consumer's rupee (Narasalagi et al., 2020).

In traditional supply chains, farmers bear the additional expenses of 13.60% of the consumer's rupee at the wholesaler's level and 8% commission charges, along with high transportation costs, loading and unloading charges, and personal expenses. In the organized retail chain, higher value addition costs were observed due to increased rejection rates while sorting and grading at collection centers and at various stages within the distribution chain, particularly at warehouses, resulting in lower retailer margins (i.e., 7.03%) compared with about 11% in the traditional supply chain (Ramappa et al., 2016).

A Special Case of Sahyadri Farms in Nashik, Maharashtra (India)

Sahyadri farms started as an FPO and has since evolved into India's largest integrated platform for handling fruits and vegetables. The company fostered partnerships with small and marginal farmers, ensuring fair compensation for their produce and labor. Over the years, the company also developed a strong capability in the primary processing of fruits and vegetables, semi-processed products such as frozen and aseptic pulp, and processed products such as fruit jams, tomato ketchup, and fruit beverages. The company also targets fruit and vegetable waste processing as part of its integrated zero-discharge processing facility. Sahyadri Farms Post Harvest Care Limited recently raised INR310 crore (about USD36.22 million) in growth capital from investors such as Incofin, Korys, FMO, and Proparco (Sahyadri, 2024).

Stakeholder Engagement

Major Actors in the Tomato Supply Chain in India

Input Suppliers provide essential inputs such as seeds, fertilizers, pesticides, and other supplies needed for tomato cultivation. They distribute their products through company-owned outlets and authorized dealers, offer technical guidance related to usage, and provide timely delivery to farmers. Additionally, they maintain strong relationships with farmers and provide credit facilities.

Producers (farmers) cultivate fresh tomatoes. As per the agriculture census (2019), farmers in India are categorized into five classes (Table 1) based on operational landholdings: marginal, small, semi-medium, medium, and large (PIB, 2019 a; PIB, 2019 b; PIB, 2024; Sulthana et al., 2024).

TABLE 1

CATEGORIZATION OF FARMERS BY OPERATIONAL LANDHOLDING SIZE IN INDIA

Sl. No.	Category	Size-Class
1	Marginal	Below 1.00 hectare (i.e., less than 2.5 acres)
2	Small	1.00–2.00 hectares
3	Semi-Medium	2.00–4.00 hectares
4	Medium	4.00–10.00 hectares
5	Large	10.00 hectares and above

Commission Agents operate within Agricultural Produce Market Committees (APMCs). They are authorized traders who facilitate transactions between producers/farmers and buyers such as wholesalers, retailers, and processors. They help farmers participate in open auctions and determine the selling price for crops. They charge a commission, usually between 5% and 8%, from buyers and maintain strong connections with farmers and buyers across various markets.

Wholesalers are the primary bulk purchasers in the market, supplying to organized and unorganized retailers and processors. As wholesalers deal in bulk quantities, they operate on thin profit margins.

Retailers sell tomatoes directly to consumers through various channels, including grocery stores, specialized fruit and vegetable shops, and supermarkets. They procure produce from wholesalers and offer fresh products to household consumers in smaller quantities, often achieving higher profit margins.

Processors are secondary processors involved in manufacturing tomato-based products such as pulp, powders, paste, sauce, and ketchup. Fresh tomatoes are sourced from wholesalers in APMCs or cooperatives in primary production areas, especially during peak seasons. Larger processors, such as Field Fresh, P-agro, SAFAL, and HOPCOMS, also engage in direct procurement from farmers through contract farming arrangements.

Distributors purchase processed tomato products from processors and supply them to grocery stores and supermarkets.

Exporters primarily sell large quantities of processed tomato products in international markets. Some wholesalers may also supply fresh tomatoes directly to exporters who then distribute them to neighboring countries such as Nepal, Bangladesh, and Myanmar.

Input Cost of Tomato Production in India

The cost of tomato production in India varies significantly based on location, farming practices, and market conditions. A comprehensive analysis of the costs associated with tomato cultivation reveals several key components, including land preparation, seeds, nursery and transplantation, fertilizers, labor (gender, worker days, and time of operation), irrigation, pest management, automation, and open field cultivation versus protected cultivation (Jain et al., 2003; Djidonou et al., 2013; Lewis et al., 2014; Kumar et al., 2016; Yelmen et al., 2019; Sharma et al., 2021; Reeves et al., 2023; Shaikh et al., 2023; Kumar et al., 2024a). Table 2 summarizes the key input costs.

TABLE 2

KEY INPUT CATEGORIES FOR TOMATO PRODUCTION IN INDIA AND THEIR INDICATIVE COSTS (OPEN VS PROTECTED CULTIVATION)

Sl no.	Input Category	Cost Range (INR Per hectare)	Cost Variation Factors
1	Seeds	2,000–5,000	Quality (traditional vs hybrid), seed/seedling rate
2	Labor	10,000–25,000	Gender, duration of cultivation, and deployment
3	Farmyard manures and fertilizers	15,000–30,000	Quality and quantity
4	Pesticides and Herbicides	5,000–15,000	Quality, quantity, number of applications, and mode of application
5	Irrigation	10,000–20,000	Number of irrigation cycles and mode of irrigation
6	Miscellaneous	10,000–20,000	Incidentals, transportation, marketing, rentals, etc.
	Total estimated cost	52,000–115,000/-	

INR = Indian Rupee: INR1 = USD0.012
1 hectare = 2.47105 acres; 1 acre = 0.404686 hectares

Supply Chain Channels of Tomatoes in India

Traditional Channels: The marketing aspects include the analysis of marketing channels, prices received, costs, and losses incurred by the farmer (Dileep et al., 2002; Gulati et al., 2022). Figure 2 shows four categories of traditional marketing channels for the tomato industry supply chain.

FIGURE 2

TRADITIONAL MARKETING CHANNELS FOR THE TOMATO INDUSTRY SUPPLY CHAIN

Channel I	Producer (Farmer)	→		Contractors	→	Processing Firms	
Channel II	Producer	→	Commission Agent	→	Retailer	→	Consumer/Wholesaler
Channel III	Producer	→	Retailer	→	Consumer		
Channel IV	Producer		→	Consumer			

New Upcoming Channels: In Figure 3, the new marketing channels (Channel V–VII) include wholesalers equipped with cold storage facilities and supermarkets that maintain organized backward linkages with farmers, collection centers, and wholesalers as well as forward linkages with consumers (Bhardwaj et al., 2016; Karthick et al., 2023; Mohan et al., 2023).

FIGURE 3

NEW MARKETING CHANNELS FOR THE TOMATO INDUSTRY SUPPLY CHAIN

Channel V	Producer (Farmer)	→	Wholesaler (Cold Storage)	→	Supermarket/ Retailer	→	Consumer
Channel VI	Producer	→	Supermarket	→	Consumer		
Channel VII	Producer	→	Organized Retailer (Government/ Private)	→	Consumer		

Limitations of Gainsharing Practices in India

In India's tomato supply chain, limited information is available to assess gain sharing, as trade largely occurs in the mandi market (bulk selling in the wholesale market), which results in direct price realization for the farmer. The literature also suggests some constraints at the farmer (producer level) that hinder better price realization, including high costs of plant growth fertilizers and plant protection measures, poor seedling stock resulting in higher prevalence of insect pests and diseases, and low soil fertility. Additionally, farmers also face several marketing challenges with respect to contact farming, which often results in higher rejection rates during grading. They also face high marketing costs, low price realization during periods of oversupply, limited access to market information systems, insufficient knowledge about export regulations, long distances to markets, challenges in establishing sales networks, inadequate market infrastructure and cold storage facilities (Dileep et al., 2002; Ramappa et al., 2016; Gulati et al., 2022; Karthick et al., 2023).

Assessment of Best Practices

Criteria for Best Practices

Key metrics for assessing productivity gainsharing in the tomato supply chain include an increase in net revenue, cost savings percentage, profit share per farmer, and market price realization.

Marketing Costs: Marketing costs incurred by farmers typically include expenses related to grading and packing (using bamboo/plastic *tokri* or plastic crates), loading onto vehicles, weighing charges, transportation charges, unloading, and commission agent charges. Apart from these costs, each stage includes loading and unloading, transportation, weight loss, storage, and handling losses, varying between 12% and 14%. Another study also revealed that in the tomato supply chain, the losses may range up to 12.5%, out of which about 9.5% occurs at the level of farm operations and 3% in the storage, wholesale, retail, and processing levels (Wire, 2021).

Price Realization by Farmers: Farmers engaged in shorter supply chains typically achieve higher price realization as compared with those engaged in longer ones. Value addition practices undertaken by farmers, such as sorting, grading, and packing in the field, also help them realize better prices and deal with shorter supply chains. A study conducted on tomato supply chains in Uttrakhand found that commission agents may charge up to 8% per transaction for handling tomato produce (Bhardwaj et al., 2011).

Organized retail is also picking up in states such Karnataka and Delhi, where cooperatives like HOPCOMS (Horticultural Producers' Cooperative Marketing and Processing Society Ltd), SAFAL Market, Namdhari Fresh, Reliance Retail, Adani Wilmar, Aditya Birla "More," Sahyadri Farms, and Nashik (Maharashtra) are setting up collection centers and facilitating timely payments. However, most farmers still sell their produce through traditional channels, i.e., wholesale markets (Bhandari et al., Gulati et al., 2022; PIB, 2025).

Producers also use alternate channels to sell damaged or low-quality tomatoes, directing them to Hotel, Restaurant, and Catering chains, underdeveloped areas with lower affordability, and processing units for conversion into other products. When producers independently manage excess production, supply, and transportation, it results in faster movement of produce from farms to markets and a lower selling price for consumers. Producers earn higher profits by avoiding wholesalers and retailers. However, farmers who lack strong networks often tend to sell their produce quickly at reasonable prices to avoid potential losses, neglecting effective postharvest management techniques.

Some other metrics that may be developed for strengthening gainsharing may include metrics related to product quality (viz., freshness, appearance, minimal damage, and consistent quality grading at collection points); efficiency metrics (viz., delivery time, reduced handling delays, and route optimization, selection of vehicle, trained vs untrained labor, etc.) and waste reduction metrics (viz., amount of produce spoilage or waste during storage and transportation)

Comparative Analysis of Effective Gainsharing Models

In India, establishing an FPO is considered an effective gainsharing model to strengthen the position of farmers. FPO is promoted under a central government-funded scheme launched in 2020 with a budget outlay of INR6,865 crore (about USD803.23 million) until 2027–28. The scheme offers handholding for a period of five years to each newly formed FPO and financial support of INR18 lakhs (about USD21,000) to each FPO over a three-year period to cover management costs. The formation of FPOs helps farmers to achieve higher net annual returns, ranging from INR7,254–8,133 (approximately USD84.88–95.16), along with a 4.6%–4.8% increase in return on investment and 8%–8.4% higher profit margins.

In addition to improved net returns and higher profits, membership in an FPO provides access to better quality input materials and competitive prices, shared machines and logistics facilities, and better bargaining and price negotiation power due to produce aggregation. The details are summarized in Table 3 below.

TABLE 3

BENEFITS OF BECOMING A MEMBER OF THE FARMER PRODUCER ORGANIZATION

Sl no.	Parameter	Benefit
1	Quality input supply	Manage the wholesale and bulk supply of quality production inputs such as seeds, fertilizers, and pesticides at lower prices.

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Sl no.	Parameter	Benefit
2	Production and postproduction machinery and equipment	Arrange for machines and equipment for quality production on a custom hiring basis to reduce the cost of production (cultivator, tiller, sprinkler set, combine harvester, etc.).
3	Farm level value addition and primary processing facilities	Make facilities available for cleaning, assaying, sorting, grading, and packing at the farm level on a nominal user-charge basis.
4	Aggregation facilities	Aggregate smaller quantities of farmer-members' produce and create a bulk quantity for trading and value addition.
5	Logistics and storage facilities	Provide logistics services such as storage, transportation, loading/unloading, etc., on a shared cost basis.
6	Marketing and Price negotiation	Market the aggregated produce with enhanced bargaining power to secure remunerative prices from buyers.

Stakeholder Perspectives

The stakeholders in FPOs benefit from access to a credit guarantee fund, participation in the open network for digital commerce (ONDC) platform, and the opportunity to serve as a SPV.

- The Credit Guarantee Fund helps to develop input collection resources, working capital, marketing strategies, and improved services for member farmers. It provides credit guarantee coverage to financial institutions for extending loans to FPOs.

- The ONDC platform is the portal for selling produce online to consumers nationwide. The onboarding of FPOs on ONDC helps them reach out to buyers in any part of the country, which aligns with the central government's objective of providing growers with better market access. The portal empowers FPOs with direct access to digital marketing, online payment, business-to-business, and consumer transactions.

Recommendations

Strategies for Enhancing Productivity Gainsharing

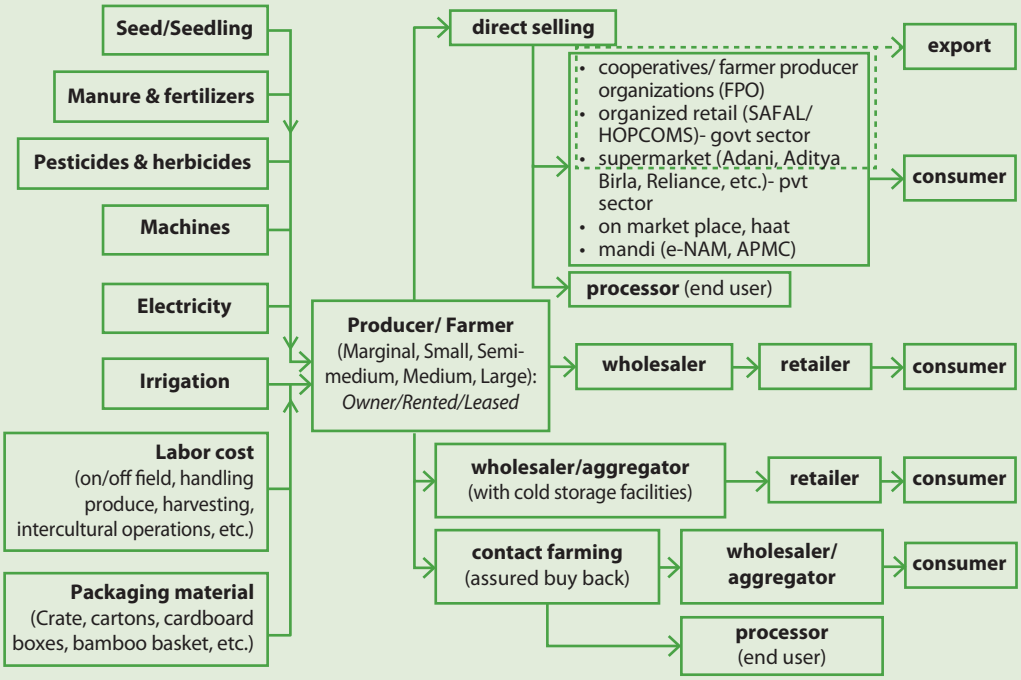
Develop Tomato Clusters for Improved Handling of Produce: Vegetable clusters include geographically concentrated groups of interdependent farmers who share technology, knowledge, and agricultural inputs. These clusters address challenges such as produce perishability, volatile market prices, and rising cultivation costs by facilitating knowledge transfer, innovation, and cooperative practices. These clusters enable farmers to share infrastructure costs, develop a skilled labor force, and enhance transaction efficiency, increasing productivity and profitability. Integrating ICT into these clusters empowers farmers with market intelligence, allowing them to plan cultivation based on consumer demand, optimize cropping patterns, and reduce transportation costs, thereby improving market efficiency. Emphasizing agro-processing within clusters reduces postharvest losses and extends product shelf life, further enhancing market opportunities. Clusters equipped with ICT tools improve production and marketing aspects, including product quality consistency, responsiveness to market changes, price competitiveness, risk management, and adherence to GAP (Dileep et al., 2002; Siva et al., 2014; Ramappa et al., 2016).

Develop Organized Supply Chains: Past studies indicate that marketing margins can be as high as 58.93%, indicating the importance of optimizing supply chains to ensure that producers receive a fair share of profits (Bhandari et al., 2021; Saugat et al., 2022). Organized supply chains can significantly enhance profitability for farmers and other stakeholders involved in the tomato supply chain by focusing on efficient resource allocation and quality supply. There are five prominent marketing channels for tomato marketing: (i) producer–retailer–consumer, (ii) producer–wholesaler–retailer–consumer, (iii) produce–cooperative–retailer–consumer, (iv) producer–collector–wholesaler–retailer–consumer,

and (v) producer–wholesaler–processor–wholesaler–retailer–consumer. Among these, channel (iv) was the most dominant channel for fresh tomatoes. However, channel (ii) offered the highest producer's share of about 66%, followed by channel (i) with about 63% (Bhandari et al., 2021). Organized supply chains offer several benefits, including production planning, timely harvesting, assured buy-backs, and improved profit margins for producers. Based on the information collected, a supply chain cum-value chain model is proposed below (Figure 4).

FIGURE 4

MARKETING CHANNELS IN THE INDIAN TOMATO VALUE CHAIN, INDICATING DIRECT SELLING OPPORTUNITIES TO ENGAGE WITH ORGANIZED SUPPLY CHAINS



Capacity Building

Capacity-building activities will help strengthen stakeholders' contribution and trust in gainsharing models. A few important considerations involve raising awareness and developing gain calculation and distribution patterns, stakeholder training programs, and risk assessment and loss-sharing mechanisms.

Gain Calculation and Distribution Mechanism

Gain Calculation: Gain calculation may include calculating total supply chain savings derived from waste reduction, improved operational efficiency, and quality consistency. It also includes determining the specific contributions of each partner by assessing their impact on key performance metrics (e.g., farmers for product quality, logistics providers for delivery times, etc).

Developing Gain Distribution Ratios: Depending on the stakeholders and mode of operations, equitable gain sharing can be structured by linking specific contributions to certain parameters. For example farmers may receive approximately 30% of the total gainshare based on factors such as production quality consistency and volume, thereby incentivizing sustainable practices. Similarly, collection centers may be allocated around 15% of the gainshare, depending on quality grading accuracy and waste reduction in storage. Logistics providers may be allocated approximately 20% for maintaining delivery efficiency, route optimization, and freshness. Distributors and wholesalers may also be allocated around 20% of the total gainshare for maintaining proper storage, handling efficiency, and inventory management to minimize wastage, and retailers may receive around 20% for optimizing sales performance and reducing wastage in stores.

Development of Relevant Training Modules for Stakeholders

Farmer Training: Farmers will be provided with regular training on best practices in crop handling, postharvest processing, and sustainable farming practices. This training may include the development of standard operating procedures, training manuals, and protocol charts.

Logistics Partners: Such training may include logistics optimization training to educate logistics partners on route optimization, cooling techniques, spoilage prevention, adoption of cost-effective green technologies, and life cycle assessment analysis.

Quality Standards Training: Training on FSMS, HACCP, and good hygiene practices is important for wholesalers and stakeholders involved in handling tomatoes at collection centers to ensure quality grading in accordance with marketing standards, improve market demands, and increase customer satisfaction.

Risk Assessment and Loss-Sharing Model Development

Risk Pooling: This may include establishing a fund, jointly contributed by each partner, to mitigate unforeseen losses (e.g., due to extreme weather or transport disruptions), thereby ensuring that financial risks are shared equitably rather than borne solely by a single stakeholder.

Insurance Coverage: Insurance coverage helps the holder recover from unforeseen losses.

Contingency Distribution: It helps regulate the market supply of produce in case of unexpected losses. This condition temporarily reduces distribution rates across the supply chain rather than solely impacting a single group of farmers.

Policy Implications

Upgrading farmer producer organizations to common services centres-special purpose vehicle (CSC-SPV): One significant policy initiative for supporting FPOs could be to convert FPOs into "common service centers," which will help them deliver citizen-centric services. This transition will also enable FPOs to provide services on the government's digital portal, which in turn will help increase rural employment.

Incorporating total quality management concepts into gainsharing: Incorporating total quality management (TQM) principles into gainsharing practices within the horticulture supply chain (particularly for fruits and vegetables) can significantly enhance collaboration, efficiency, and product quality across the supply chain. TQM emphasizes continuous improvement, customer satisfaction, and the involvement of all employees in the quality management process. Some specific continuous improvement activities can be applied in gainsharing under organized tomato supply chains, such as process improvements (Kaizen), customer-focused goals, regular audits and inspections, and short feedback loops. This approach must follow a top-to-bottom strategy, in alignment with the organizational philosophy for easier implementation.

Conclusions

Horticulture in India is a prominent agrifood sector that involves multiple stakeholders such as farmers (producers), intermediaries, commission agents, wholesalers, retailers, and processors. The sector is operated primarily under traditional supply chain systems, which involve preselling or direct selling arrangements to intermediaries or wholesalers through a commission agent, resulting in inefficiencies in marketing, high transportation costs, excessive intermediary margins, and delayed payments that significantly impact farmers' earnings. Such arrangements restrict direct profit realization for producers and the fair distribution of gains among farmers and other stakeholders in the supply chain, such as workers and logistic handlers.

The newer supply chain models such as organized retail supply chains and cooperatives are gaining momentum as they offer inclusive backward and forward linkages through resource pooling, bulk production, price negotiation power, and pooling of infrastructure for storage and transportation,

resulting in better net returns and profits. FPOs are becoming popular among small and marginal farmers in India as an advanced form of cooperative that enables farmers to come together and form a company.

The formation and promotion of FPOs represents a strategic initiative by the Indian government to make farmers self-reliant. By fostering the aggregation of produce and production resources, FPO's improve market access and enable better financial and institutional support. This initiative of forming FPOs has empowered millions of small and marginal farmers, including women and those from economically weaker sections. This achievement boosts agricultural productivity and income and contributes to rural job creation and economic resilience.

In India's tomato supply chain, gainsharing emphasizes technological adoption, contract farming, stakeholder collaboration, and cooperative networks. These associations seek to increase profitability, enhance quality, and lower postharvest losses. Government assistance is essential in the form of infrastructure development and subsidies. The emergence of FPOs and integrated agribusiness platforms such as Sahyadri Farms showcases successful gainsharing practices. These initiatives offer better price realization, access to quality inputs, shared logistics, and direct market linkages. By adopting modern supply chain strategies, including cluster-based tomato farming, digital market access, and structured gain distribution models, we can help optimize gain distribution among related stakeholders.

Future growth in this sector depends on strengthening farmer training programs, improving postharvest handling, and implementing efficient gainsharing mechanisms. By leveraging digital platforms, reducing intermediaries, and enhancing infrastructure, the tomato supply chain in India can achieve a more equitable and sustainable model, benefiting farmers and consumers. Gainsharing models with transparent performance indicators and data sharing should also be implemented to increase efficiency and transparency. The primary aim is to increase farmers' share of the price paid by final consumers.

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PUBLIC–PRIVATE PARTNERSHIP (PPP) POLICY ENHANCES RICE PRODUCTIVITY GAINSHARING IN LAO PDR

Executive Summary

Rice forms a crucial part of the economy and the daily lives of the people in Lao PDR, with over 70% of the population relying on agriculture for their livelihood. Although it is the most important crop, the sector faces several challenges, such as limited access to modern farming methods and inadequate infrastructure. The government has increasingly turned to public–private partnerships (PPPs) to tackle these issues in order to improve productivity, promote sustainable farming practices, and boost economic development.

This study aims (1) to identify socially and economically prevalent agricultural sectors in Lao PDR, (2) to evaluate the competitiveness and potential for rice exports, and (3) to assess the effectiveness and best practices for enhancing rice productivity gainsharing through cooperation among different stakeholders. We incorporate quantitative and qualitative methods, employing the normalized revealed comparative advantage (NRCA) and export potential index (EPI) to analyze the competitiveness of Lao's rice exports. Value chain analysis is applied to analyze the value-added distribution of rice production across stakeholders.

The findings show that in 2022, agricultural production in Lao PDR contributed USD1,080 million, accounting for 20% of the GDP and 55% of the total labor force. Furthermore, agricultural cropping remains the largest contributor to agricultural output, sharing 62%–66% from 2013 to 2023. Although rice harvested areas have slightly decreased from 855,114 hectares in 2010 to 818,200 hectares in 2022, rice yields have increased significantly from 3,591 kg/ha in 2010 to 4,394 kg/ha in 2022, driven by improved farming techniques, mechanization, improved irrigation facilities, high-yield varieties, and private sector participation under PPPs. However, rice export values remained low at USD28.4 million, comprising 3.2% of agricultural exports in 2023.

The result of the 2022 NRCA indicates that among the top 10 agricultural export products, cassava exhibits the highest comparative advantage (11.86), followed by coffee (3.39) and fresh or dried bananas (1.60). Despite recent declines in export volumes, these products remain competitive. While the comparative advantage for semi- or wholly milled rice fluctuated, the NRCA value was 0.069 in 2010, which increased to 2.362 in 2020 before dropping to 0.735 in 2022. Major rice exporting countries, such as Thailand, Vietnam, and India, may have sharply increased their production, making it more challenging for Lao PDR to maintain its market share. Furthermore, export tariffs or unfavorable trade policies could have contributed to the diminishing comparative advantage.

In 2022, the Philippines, the United States, and Malaysia were identified as having untapped potential exports of semi-milled rice, ranging between USD0.33 million and USD1.3 million. Value chain analysis reveals that exporters dominate the rice value chain, earning the highest profit (LAK1,970 per kg[1]) and value-added (LAK3,700 per kg) due to their access to global markets and product improvement. Farmers contribute significant value-added through primary production (LAK2,612 per kg) but earn a lower profit share of 8.40% of total profit; their earnings are highly dependent on wages rather than profit. Wholesalers and retailers play key roles in distribution, generating moderate profits and value-added.

The Lao PDR government should implement the following policies to foster sustainable and inclusive improvements in rice productivity and gainsharing.

1 The official exchange rate in December 2024 was USD1 = LAK21,886.

1. **Support smallholder farmers:** Improve access to resources and integrate farmers into PPP by providing access to improved seeds, fertilizers, and farming technologies. Furthermore, farmer cooperatives should be strengthened to improve their bargaining power and integrate them into PPP projects as key stakeholders.

2. **Encourage private investment:** Promote investments in infrastructure, such as irrigation systems and storage facilities, which are critical for enhancing rice productivity. Tax incentives and low-interest financing options can be offered to incentivize private sector participation.

3. **Facilitate knowledge sharing:** Collaborate on training programs to promote sustainable farming practices and research on developing resilient crop varieties.

4. **Implement fair profit-sharing models:** Design gainsharing agreements in which farmers receive a share of profits linked to productivity improvements or cost reductions achieved through PPP projects.

Introduction

Rice production in Lao PDR is essential to the country's economy, food security, and population's livelihood, with over 70% of the population depending on agriculture. Although rice is the most important crop, this sector has historically faced several challenges, including limited access to modern farming techniques, poor infrastructure, and financial constraints. The government has increasingly prioritized public–private partnerships (PPPs) to address these challenges to enhance rice productivity, promote sustainable agricultural practices, and boost economic growth.

PPPs in agriculture involve collaboration between government entities, private companies, and occasionally NGOs to address specific issues in the agricultural sector. In Lao PDR's rice sector, PPPs serve as a strategic approach to leverage private sector expertise, financial resources, and technology, whereas the government contributes through policy support, infrastructure development, and the creation of an encouraging regulatory environment.

No publicly accessible database exists on the number of PPP projects implemented by Lao PDR. According to the data visualization website on Private Participation in Infrastructure from the World Bank, Lao PDR has witnessed 34 PPP projects with an aggregate investment value of USD23.658 billion. The energy industry accounts for the majority of these investments, with 29 projects valued at over USD17.8 billion. This is followed by the transportation sector, with a railway project valued at USD5.7 billion (Farrands et al., 2023). Under the Investment Promotion Law, prior PPP projects would have been directly negotiated, awarded, and implemented on a concession basis before the PPP Decree's enactment in January 2021.

In Lao PDR, competitive bidding for PPP projects remains a narrative. When the government participated in a PPP project, it did so either directly through the Ministry of Finance, which served as the government's proxy for a shareholder, or indirectly through state-owned businesses. The PPP Decree stipulates that a PPP proposal, whether solicited or unsolicited, must pertain to a significant project, involve new technology and high innovation, and produce "broad socio-economic benefits"; however, it does not mention any specific industries targeted for investment (Article 23, PPP Decree).

Research Objectives

- Identify socially and economically important agrifood sectors in Lao PDR.

- Analyze the export competitiveness and potential of rice production in Lao PDR.

- Assess the effectiveness and best practices of rice productivity gainsharing across stakeholders and provide policy recommendations.

Review of Existing Studies and Literature

Review of Existing Public–Private Partnership (PPP) Policies to Promote Rice Commercialization

The government introduced Decree No 624/Gov on PPP, dated 21 December 2020, which aimed to (1) promote, regulate, and monitor PPP to ensure efficiency, productivity, fairness, transparency, accountability, and compliance with the periodic national socio-economic development plan. It also aimed to (2) build confidence and attract private investments into public projects, contributing to the nation's development following the green growth and sustainability strategy (MPI, 2021; Article 1, PPP Decree). The PPP decree consolidates investment requirements, structures, and procedures for the proposal, bidding, and awarding of PPP projects. It represents a key step toward enhancing the commercial viability of PPP projects in Lao PDR.

The partnerships can be divided into two types: (1) joint investments between public and private entities and (2) partnerships in which the investment capital is born entirely by a private party. As a newly established initiative, the project encompasses efforts to improve existing infrastructure or provide public services, including in sectors such as tourism, agriculture, energy, mining, and other sectors, through a partnership contract with a clearly defined time duration, in accordance with the laws (MPI, 2021; Article 2, PPP Decree).

According to PPP Decree No. 624/Gov, PPPs can be classified into eight different investment models, with the possibility for other investment structures to be adopted, as determined by the Government of Lao PDR (GOL). These investment models include (1) design–build–finance–operate (DBFO), (2) design–build–operate (DBO), (3) build–operate–transfer (BOT), (4) build–own–operate–transfer (BOOT), (5) build–own–operate (BOO), (6) build–transfer–operate (BTO), (7) build–lease–transfer (BLT), and (8) operation and maintenance.

Levels of Partnership Project Considerations and Endorsements

Partnership project consideration and approval levels depend on the projects' total investment value and nature (MPI, 2021; Article 26, PPP Decree).

Under Article 26 of the PPP Decree, the levels of consideration and approval for partnership projects are determined based on the total investment value and nature of the project. The issuing authorities and their respective conditions are as follows.

1. **The National Assembly** is responsible for approving partnership projects when the total investment capital exceeds USD300 million or the government's contribution to the investment capital equals or exceeds LAK20 billion. It also approves projects involving the construction of nuclear power plants, the use of nationally conserved and protected forests, or those that significantly impact the environment, nature, or society. Moreover, projects seeking special incentives also require approval from the National Assembly.

2. **The Provincial People's Assembly** considers and approves partnership projects when the government's investment capital contribution is less than LAK20 billion. It also handles projects involving deteriorating forests that cannot be self-rehabilitated, covering an area of 100 hectares or less, as proposed by the provincial authority. Projects utilizing bare land ranging from 30 to 200 hectares per project or involving the lease or concession of deteriorating forests that cannot self-rehabilitate, covering up to 150 hectares for a period not exceeding 30 years, also fall under its jurisdiction. Furthermore, projects that significantly impact the environment, nature, or society at the provincial or capital city level require approval from the Provincial People's Assembly.

3. **The Government** approves partnership projects that do not involve any direct government investment. It also oversees projects that do not involve the utilization of nationally conserved and protected forests, have no severe impacts on the environment, nature, or society, and require the resettlement of no more than 500 households. Furthermore, it handles projects in which the total investment capital does not exceed USD300 million.

Review-related Literature

The value chain refers to the comprehensive sequence of activities involved in the conception, processing, distribution, and delivery of a product to end users (Kaplinsky & Readman, 2001). This process includes

increasing a product's value by varying its outputs through deliberate product upgrading, processing, and marketing to provide customers with added value (Demont, 2013). Value chain models are categorized into two types: traditional and modern. In traditional models, the agricultural value chain typically begins with smallholders, progresses through connections between small farmers and traditional wholesale markets, and concludes with connections involving wholesalers, retailers, and processors. Conversely, modern value chain models are distinguished by vertical coordination, supply-based consolidation, industrial processing practices, and product and process standardization (McCullough et al., 2008).

A case study of the Hani Terrace integrated rice-fish farming system in China analyzed the type, structure, partner roles, and nature of the partnership (Yuan et al., 2024). It also explored the significant challenges encountered, development outcomes achieved by these projects, and development and application of the PPP model in the aquaculture sector. The results indicate that the aquaculture PPP generated favorable outcomes for various partners and facilitated the expansion of economic, social, and environmental benefits through targeted interventions.

The Central River Region of The Gambia was the site of a study that examined the impact of a rice value chain program on rice farmers' production (Gomez et al., 2022). The research revealed that program enabled farmers to benefit from interventions such as access to improved seed varieties and fertilizers, which in turn significantly increased rice production. Nevertheless, obstacles persist, including inadequate supplies of fertilizers and seeds as well as underdeveloped market structures. Based on these discoveries, NGOs and investors should augment government initiatives by offering rice farmers credit facilities and a sufficient supply of high-quality inputs (seed, fertilizer, and machinery) at a discounted rate and promptly. Additionally, they should strengthen the connections between farmer groups/cooperatives and buyers (producer–buyer linkage) to facilitate market access.

Farmers, investors, and agricultural officers in Lao PDR continued to encounter successes and failures in their pursuit of viable, profitable enterprise agreements, as reviewed by Fullbrook (2011). To guarantee successful production agreements, it is recommended that enduring and trusted relationships between farmers and public/private partnerships be established. Moreover, farmers must receive precise market information. Rice is the most significant agricultural commodity in Lao PDR in terms of the number of farmers involved in production, amount of cropland allocated, and amount of food consumed. Rice also generates significant economic spillover effects, which support employment in the Lao PDR's food catering, trading, and milling sectors. Benefiting from the increasing demand for nutritious and diverse diets among more affluent and urbanized Laotians, vegetable cultivation is emerging as an important agricultural commodity.

In a study published by the World Bank (2018), the critical stages of the rice production value chain in Lao PDR were identified as input supply, production, assembly, processing, wholesaling, and retailing. The expansion of regional value chains has been consistent with the development of Lao PDR's agricultural value chains; however, market access is impeded by the strict product quality regulations of the importing countries. This circumstance further emphasizes our thorough country study. The arrival of foreign businesses in Lao PDR marked a critical turning point in the development of agricultural value chains, significantly enhancing farmers' participation. Numerous crops are cultivated for domestic processing factories, while an even greater number are cultivated for foreign collectors or Lao PDR businesses acting as nominees for foreign buyers.

The procedure analysis of the rice value chain relates to backward and forward linkages. The backward linkages refer to the connections between rice producers and input suppliers, such as seed providers, fertilizer companies, agrochemical dealers, and machinery suppliers. These linkages ensure farmers have timely access to quality inputs, directly affecting productivity and overall value chain efficiency. Strengthening these backward linkages can improve yields, reduce production costs, and increase resilience for smallholder farmers (Food and Agriculture Organization, 2013). Forward linkages refer to the connections between rice producers and downstream actors, such as millers, traders, retailers, exporters, and food processors. These linkages play a vital role in determining the flow of rice from farms to markets and ultimately to consumers. Strong forward linkages promote better market access, improved quality through processing, and higher income for producers (International Rice Research Institute, 2021). Concerning the value chain model used

in the study conducted by Menon and Roth (2022), the Chinese-owned Xuanye Company processes rice in Lao PDR for export to China. Two mills supply this rice: the Vanida rice mill (Khammuan province) and the Indochina Development Partners-Laos (Champasak province). The research demonstrated that two organizations (Xuanye and IDP) occupy critical positions throughout the rice value chain, including presowing, harvesting, paddy collection and delivery, and export milling. It is advantageous for farmers to engage in rice exports to China rather than selling their locally grown rice. Local rice collectors also benefit from representing rice mills and collecting rice from farmers dispersed across various villages. Nevertheless, rice exporters, who serve as online retailers for high-end markets, have reaped the greatest advantages.

Research Methodology

This research applies quantitative and qualitative analysis to analyze the impact of PPP on rice productivity in Lao PDR. We apply the NRCA index to capture rice export competitiveness and the EPI to capture the potential of rice exports to major Lao PDR trading partners. Furthermore, we apply the value chain analysis of rice production under PPP across stakeholders to estimate the value added in each rice production procedure.

Normalized Revealed Comparative Advantage

NRCA is widely used to assess the comparative advantage of a country's exports and serves as a valuable metric for comparing exports across commodities, countries, and time (Richardson & Zhang, 2021; Hassan & Ahmad, 2018; Wongpit & Inthakesone, 2017). It measures the degree to which a country's actual exports deviate from its comparative advantage-neutral levels, in terms of its relative scale concerning the world export market. Thus, this measure accurately indicates the underlying comparative advantage of a country's exports (Yu et al., 2009). It can be expressed using the following equation:

$$NRCA_i = \frac{EX_i^d}{\sum_{i=1}^{n} EX_i^w} - \frac{\sum_{i=1}^{n} EX_i^d * EX_i^w}{\sum_{i=1}^{n} EX_i^w * \sum_{i=1}^{n} EX_i^w}.$$

Here, EX_i^d is the export value of commodity i from country d, $\sum_{i=1}^{n} EX_i^w$ is the total export value of the world, $\sum_{i=1}^{n} EX_i^d$ is the total export value of all commodities from country d, and EX_i^w is the export value of commodity i from the world (w). A positive NRCA (>0) indicates that the country has a comparative advantage in exporting commodity i; the greater the NRCA score, the stronger the comparative advantage. In contrast, a negative NRCA (<0) indicates the country has a comparative disadvantage in exporting commodity i.

Export Potential Index

The International Trade Center (2021) developed the EPI, which can be used to capture a country's export potential for specific export products. The index can be written as follows:

$$EPI_{ijk} = \frac{X_{ik}}{X_k} m_{jk} \frac{X_{ij}}{\sum_k \left(\frac{X_{ik}}{X_k} m_{jk} \right)}$$

Here, X represents exports, m represents imports, i represents exporter, j represents importer, and k represents product. X_k represents the exports of product k (all exporters and markets). X_{ik} refers to exports of exporter i of product k (to all markets). X_{ij} refer to exports of exporter i to market j, m_{jk} refers to imports of market j of product k. ∑k (…) Sum of (…) over all products k. The EPI can be interpreted in the following way. If a country's actual exports fall below its estimated export potential, it indicates underperformance or untapped opportunities in the target market. In contrast, if actual exports exceed the export potential, it suggests that the country is already exporting more than is expected.

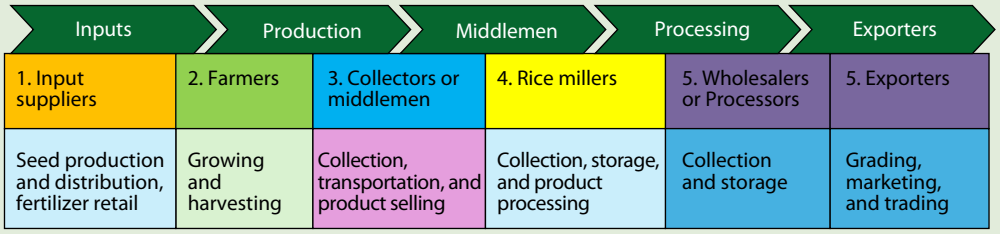
Value Chain of Rice Production in Lao PDR

To analyze the role of each stakeholder along the value chain of rice production, in-depth interviews were conducted with the representatives of three input suppliers, five farmers, three collectors, three wholesalers or processors, and three exporters to estimate the value, costs, and profits generated at

each stage of the value chain. We also asked for their perspectives on the role of government agencies, including the head of the Agricultural and Forestry Division, head of the Industry and Commerce Division, representative of two private sectors, and director of the Agricultural Promotion Bank, in supporting each stakeholder in creating value-added at various stages of the value chain (Figure 1).

FIGURE 1

PROCEDURE OF AGRICULTURAL VALUE CHAIN



Source: World Bank, 2018.

The profit and value-added of rice production along the value chain were calculated as follows:

Profit = gross value of total output divided by total costs;

Value added = profit + wages + interest + rentals.

The total costs were derived from seed, land development, pruning, pest control, fertilizer, irrigation, harvest, management, storage, and transportation.

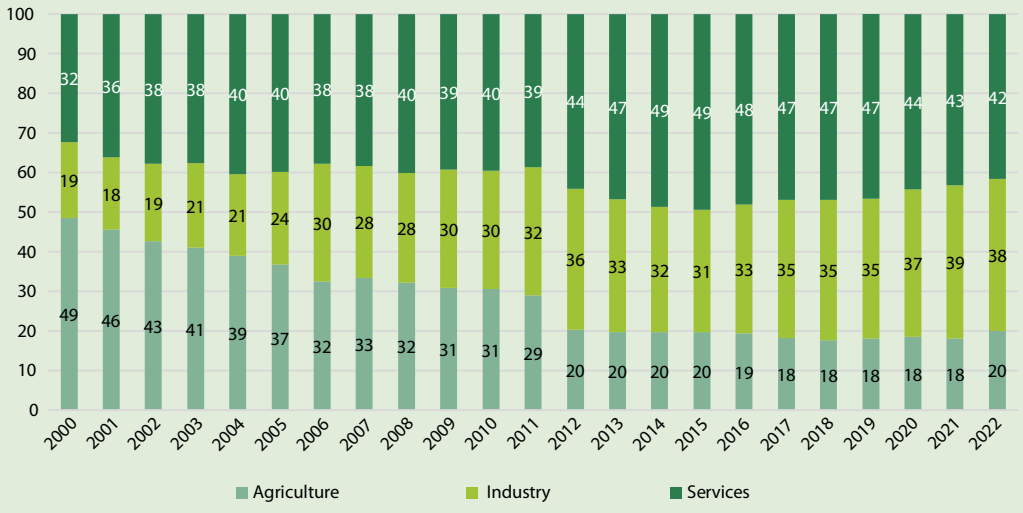
Empirical Results

Social and Economically Important Agrifood Sectors in Lao PDR

Figure 2 presents the structural changes in Lao PDR's economy. While initial reliance on agriculture is characteristic of developing economies, as the economy grows, industry and services begin to take over.

FIGURE 2

THE SHARE OF AGRICULTURE PRODUCTION TO GDP



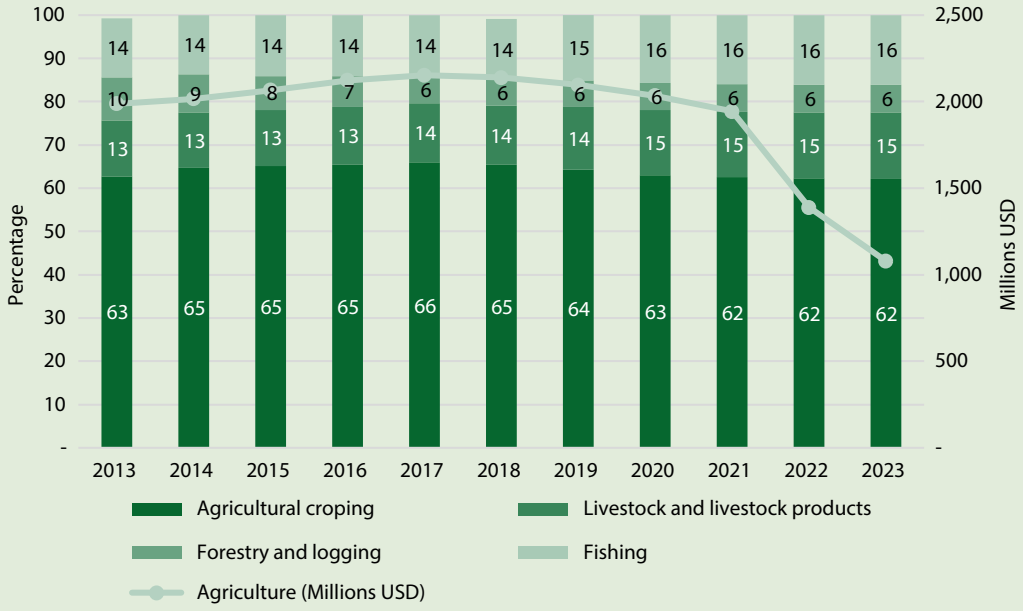
Source: ADB, 2024.

Figure 2 shows a steady decline in the share of agriculture, starting from 49% in 2000 and dropping to 18% by 2021, with a slight recovery to 20% in 2022, reflecting a typical development pattern in which agricultural reliance decreases as economies grow. Urbanization, technological advancements, and improved agricultural efficiency have likely contributed to this decline. The industry sector's share fluctuated over the years but demonstrated moderate growth, increasing from 19% in 2000 to 33% by 2022, indicating industrialization, which was possibly driven by foreign investments, export-led manufacturing, and infrastructure development. The services sector expanded significantly, growing from 32% in 2000 to 49% by 2014 and maintaining dominance at around 47% until 2022. This situation reflects an increased demand for knowledge-based and consumer services driven by economic growth, globalization, and urbanization.

Figure 3 provides the structure of Lao PDR's agricultural production from 2013 to 2023, covering total agricultural output and the percentage shares of four key sub-sectors: agricultural cropping, livestock and livestock products, forestry and logging, and fishing. The total value of agricultural output decreased significantly from USD1,987 million in 2013 to USD1,080 million in 2023. This decline aligns with a broader economic shift from agriculture to industry and services. Additionally, adverse climatic factors such as natural disasters, irregular rainfall, or droughts may have likely impacted crop yields. Similar patterns are observed in many countries experiencing climate change due to less predictable weather patterns. Unsustainable agricultural practices may have contributed to soil erosion and land degradation, thereby reducing the availability of arable land for high-yield cropping.

FIGURE 3

STRUCTURE OF AGRICULTURAL PRODUCTION IN LAO PDR



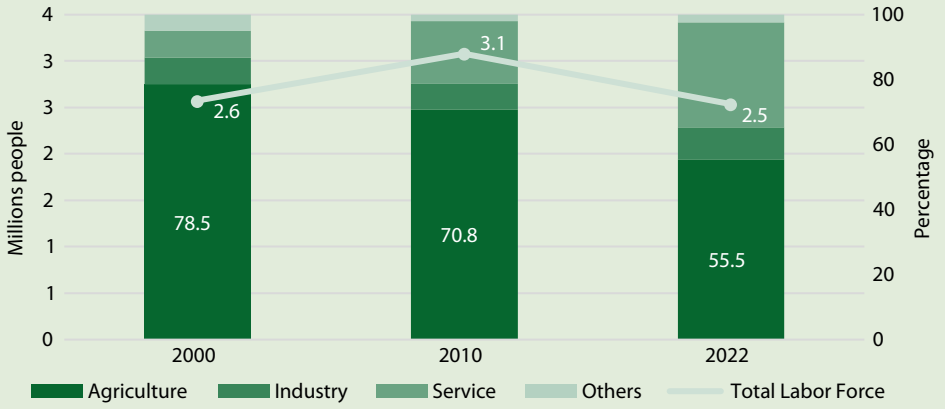
Source: ADB, 2024.

Agricultural cropping remains the most significant contributor to agricultural output, with a share between 62% and 66%; however, it experienced a slight decline from 66% in 2017 to 62% by 2023. Reliance on monocultures could have reduced soil fertility and lowered productivity over time, contributing to the sector's slight decline. While farmers have gradually diversified away from purely cropping activities into livestock or fishing, the share of livestock in agricultural output increased from 13% in 2015 to 15% by 2023. This trend is likely attributable to rising incomes and urbanization, which often lead to increased demand for meat and dairy products. Similarly, the fishing sector saw a steady rise in its share, increasing from 14% in 2013 to 16% in 2023, which can be attributed to improved fishing techniques, modern fish farming practices, and enhanced supply chains.

Figure 4 shows a significant shift in labor distribution across key economic sectors (agriculture, industry, and services) from 2000 to 2022. During this period, the total labor force decreased from 3.1 million people in 2010 to 2.5 million in 2022 due to reduced birth rates and migration patterns. Moreover, the proportion of labor force engaged in agriculture drastically declined from 78.5% in 2000 to 55.5% in 2022. This significant reduction reflects broader structural transformation, where rural-to-urban migration intensifies as economies develop. Individuals increasingly seek better job opportunities, particularly in the industrial and service sectors, leading to a significant reduction in the agricultural workforce.

FIGURE 4

EMPLOYMENT IN THE AGRICULTURAL SECTOR



Source: ADB, 2024.

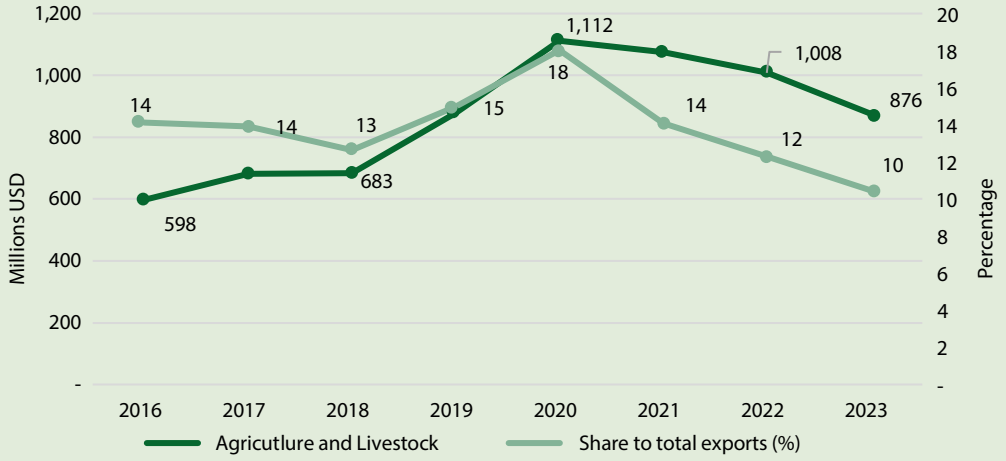
The industry's share remained relatively stable between 2000 and 2010 but showed a noticeable increase in 2022, suggesting that industrialization is gradually gaining momentum, though the sector continues to lag behind agriculture and services. The slight increase observed in the industry's share highlights the country's ongoing efforts to diversify its economy by boosting manufacturing and construction sectors, supported by policies promoting industrialization and foreign direct investment (FDI). The service sector exhibited a dramatic increase from 8.2% in 2000 to 32.2% in 2022, signaling a transformative shift in the labor market toward a service-based economy. Additionally, an increase in urban populations is typically accompanied by greater demand for services such as retail, education, healthcare, banking, tourism, and transportation. The rapid expansion of these services reflects shifting consumption patterns. Furthermore, advancements in digital technologies, telecommunications, and e-commerce have created numerous service-oriented job opportunities.

Figure 5 presents Lao PDR's agriculture and livestock exports from 2016 to 2023, along with the percentage share these exports contributed to the country's total exports. The export value of agriculture and livestock increased modestly from USD597 million in 2016 to USD1.074 billion in 2021, peaking at USD1.11 billion in 2020. The global demand for food and livestock surged, especially during the COVID-19 pandemic, as countries increased stockpiling of essential goods. Subsequently, the depreciation of exchange rates may have enhanced export competitiveness, thereby increasing revenue in domestic currency terms. However, agriculture and livestock exports have declined since 2021, decreasing slightly to USD876 million in 2023. This decline coincides with the rapid growth in nonagricultural sectors, possibly driven by industrialization, urbanization, and a shift toward the services sector. As countries diversify their economic base, the relative share of agriculture typically declines, even if the sector remains important. At the same time, adverse weather conditions, such as droughts and floods, may have negatively affected the production of exportable agricultural goods.

Figure 6 indicates the rice harvested areas and yield data from 2010 to 2022. The initial increase in rice harvested area grew consistently, from 855,114 hectares in 2010 to 973,327 hectares in 2016, before

FIGURE 5

SHARE OF AGRICULTURAL EXPORTS TO TOTAL EXPORTS

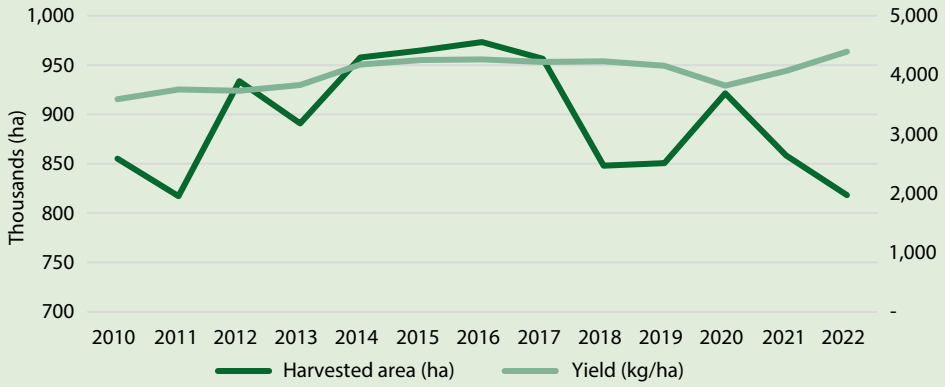


Source: Ministry of Industry and Commerce (MOIC), 2024.

declining to 818,200 hectares in 2022. This reduction can be attributed to the expansion of the service and industrial sectors, resulting in the conversion of agricultural land for nonagricultural purposes such as urban expansion, infrastructure projects, or industrial activities. The rice yield significantly increased from 3,591 kg/ha to 4,394 kg/ha, demonstrating improvements in agricultural productivity. Higher yields reflect the adoption of improved farming techniques, mechanization, better irrigation systems, and high-yield crop varieties. Interestingly, an inverse relationship emerged between harvested area and yield. Since 2016, the yield per hectare increased even as harvested areas decreased. This trend indicates that farmers focus on increasing productivity per unit of land, which may involve the use better inputs, such as high-yield seeds and fertilizers. Furthermore, agricultural policies aimed at boosting productivity through private sector participation under the PPP may have positively influenced rice productivity.

FIGURE 6

RICE HARVESTED AREAS AND YIELD



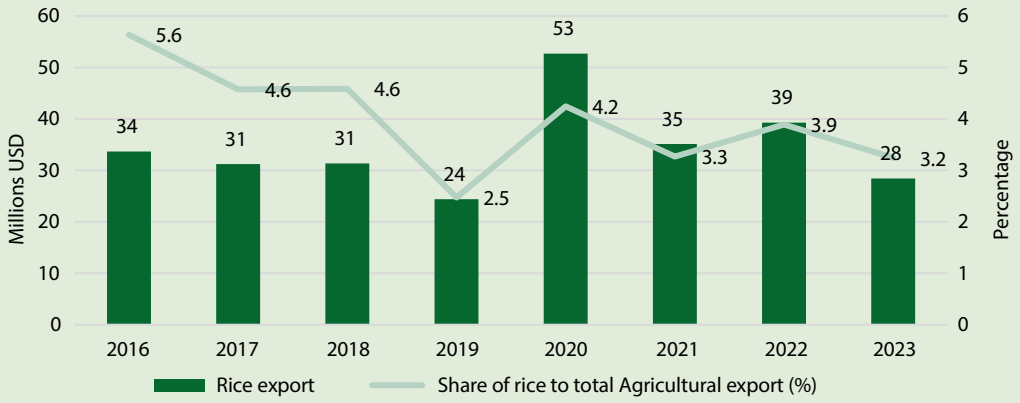
Source: FAO, 2024.

Figure 7 displays data on rice export values and the share of rice agricultural exports from 2016 to 2023. The rice export values were relatively stable during 2016–18, following which, the export value spiked to USD52.7 million in 2020, accounting for 4.2% of total agricultural exports. The COVID-19 pandemic likely stimulated increased global demand for staple foods, including rice, as countries stockpiled food

supplies in response to growing uncertainty. Subsequently, global rice prices surged in 2020 due to supply chain disruptions, which may have boosted the value of rice exports. However, rice exports dropped to USD35.1 million in 2021 and further fluctuated to approximately USD28.4 million in 2023, accounting for 3.2% of total agricultural exports. The postpandemic decline in rice export values suggests a return to normal trading conditions, with reduced demand for emergency stockpiling. Additionally, supply chain recovery may have enabled other rice exporting countries to regain market share.

FIGURE 7

MAJOR EXPORTS OF AGRICULTURAL PRODUCTS IN LAO PDR



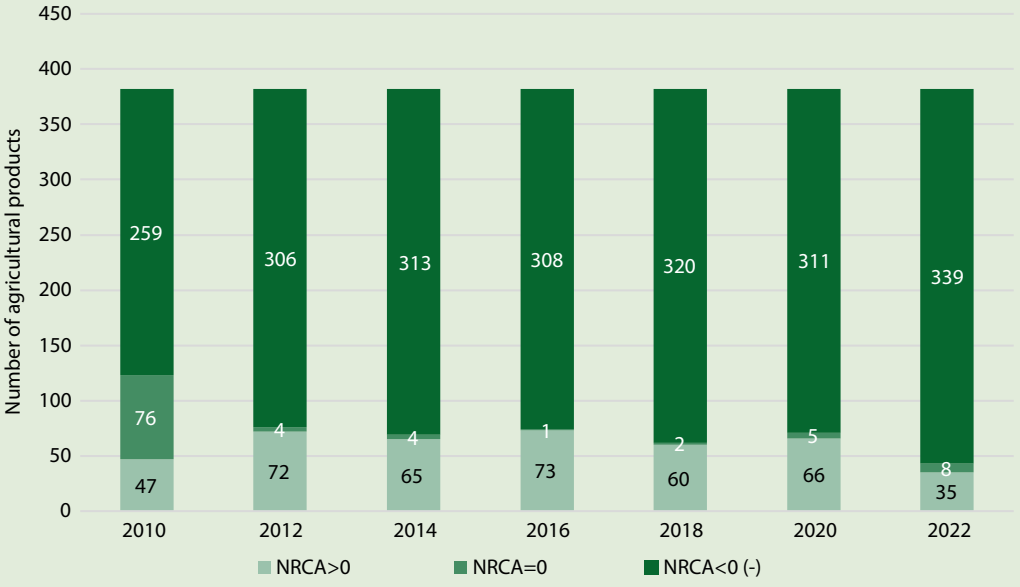
Source: Ministry of Industry and Commerce (MOIC), 2024.

Analysis of the Comparative Advantage of Agricultural Exports and the Export Potential of Lao PDR Rice Production

Figure 8 presents the computed NRCA of Lao PDR's agricultural export products from 2010 to 2022; 382 product categories are classified based on whether they have a comparative advantage (NRCA > 0), are neutral (NRCA = 0), or have a comparative disadvantage (NRCA < 0) in exports.

FIGURE 8

COMPARATIVE ADVANTAGE OF LAO PDR'S AGRICULTURAL EXPORT PRODUCTS (HS 010110-200990)



Source: Author's calculation using the 2024 International Trade Center (ITC) database, 2024.

The number of sectors with a comparative advantage rose sharply from 47 in 2010 to 72 in 2012, suggesting a substantial improvement in export competitiveness. Economic reforms and trade liberalization attracted FDI inflows in agricultural sectors, which could have contributed to enhanced productivity, enabling specific sectors to become globally competitive. Between 2014 and 2020, the number of sectors with comparative advantage stabilized, indicating a relatively mature export structure with no significant gains or losses. Conversely, the number of sectors with comparative advantage dropped to 35 in 2022, potentially due to increased competition from emerging economies and disruptions in export markets caused by the COVID-19 pandemic, reducing competitiveness in relation to several agricultural products.

Moreover, sectors with comparative disadvantage grew steadily, from 259 in 2010 to 339 in 2022, reflecting underlying structural weaknesses in the economy. The sharp decline in the number of sectors with comparative advantage in 2022 coupled with the rise in those with a comparative disadvantage underscores increased economic vulnerability, especially due to global competition and postpandemic trade disruptions.

TABLE 1

TOP 10 NRCA AGRICULTURAL EXPORT PRODUCTS OF LAO PDR

No	Harmonized System (HS) code	All products	2010	2012	2014	2016	2018	2020	2022
1	'071410	Fresh, chilled, frozen, or dried roots and tubers of manioc "cassava," whether or not sliced	0.091	0.296	0.784	3.887	3.909	11.093	11.863
2	'090111	Coffee (excl. roasted and decaffeinated)	1.503	3.673	3.198	3.738	4.075	4.428	3.399
3	'080390	Fresh or dried bananas (excl. plantains)	-	0.201	0.118	0.778	0.214	2.524	1.602
4	'100630	Semi-milled or wholly milled rice, whether or not polished or glazed	0.069	0.387	0.249	1.502	0.810	2.362	0.735
5	'081340	Dried peaches, pears, papaws "papayas," tamarinds and other edible fruits	0.011	0.014	(0.005)	0.008	0.003	0.078	0.434
6	'070490	Fresh or chilled cabbage, kohlrabi, kale, and similar edible brassicas (excl. cauliflowers	0.064	0.191	0.056	0.813	0.706	0.685	0.363
7	'071420	Sweet potatoes, fresh, chilled, frozen, or dried, whether or not sliced or in pellet form	(0.001)	0.160	0.152	1.188	0.484	0.849	0.258
8	'080540	Fresh or dried grapefruit and pomelos	(0.007)	(0.004)	(0.006)	(0.010)	0.154	0.117	0.245
9	'100640	Broken rice	(0.010)	(0.003)	(0.003)	(0.020)	0.179	(0.032)	0.232
10	'081090	Fresh tamarinds, cashew apples, jackfruit, lychees, sapodilla plums, passion fruit	0.003	0.250	0.141	0.420	0.905	2.223	0.137
11	'100610	Paddy rice (rice in the husk or rough rice)	(0.006)	0.031	0.025	0.334	0.237	0.202	(0.015)
12	'100620	Husked or brown rice	(0.004)	(0.005)	(0.006)	0.046	(0.008)	(0.032)	(0.024)

Source: Author's calculation using the ITC database, 2024

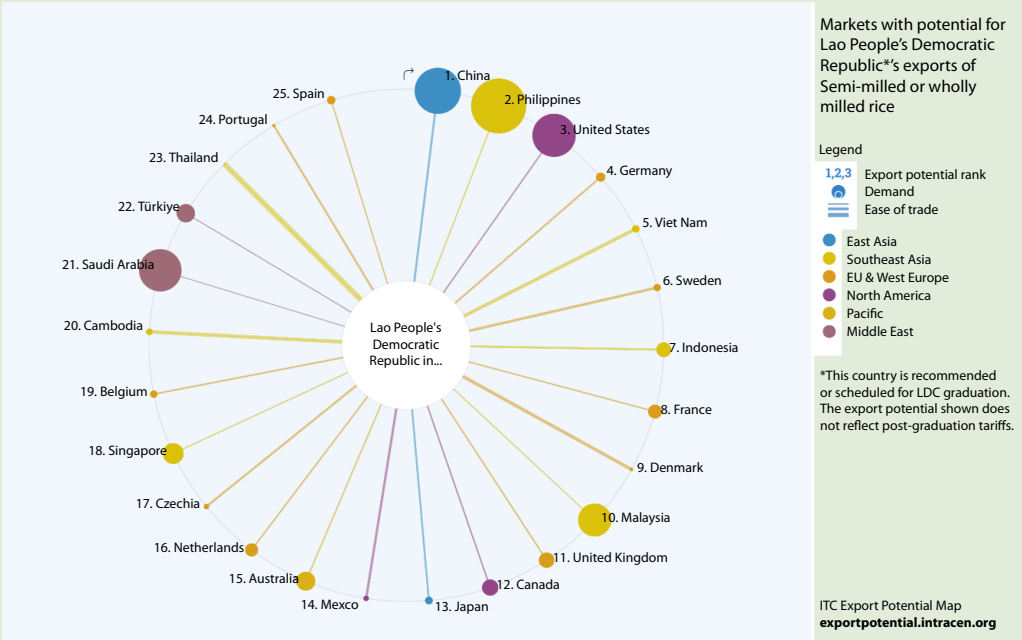
Among the top 10 agricultural export products, cassava demonstrated the most significant increase in comparative advantage, rising from 0.091 in 2010 to 11.863 in 2022. This trend indicates their significant competitive edge in the global market, possibly due to growing demand and effective export strategies. Coffee and fresh or dried bananas followed, with comparative advantages of 3.399 and 1.602, respectively (Table 1). These products remain a competitive export, though the recent decline suggests the need for sustaining competitiveness.

For the comparative advantage of semi-milled or wholly milled rice, the NRCA value was 0.069 in 2010, which increased to 2.362 in 2020 before dropping to 0.735 in 2022. Major rice exporting countries, such as Thailand, Vietnam, and India, may have sharply increased their production, making it challenging for Lao PDR to maintain its market share. Subsequently, export tariffs or unfavorable trade policies could have contributed to the diminishing comparative advantage. Broken rice consistently exhibited a comparative disadvantage over the period, with the NRCA declining from –0.010 in 2010 to –0.032 in 2020, before showing a modest recovery to 0.232 in 2022. It is typically sold at lower prices, making it less competitive in premium markets. Its demand may also fluctuate based on the end-uses, such as in animal feed or industrial applications, which tend to be less stable. Paddy rice has struggled to gain a comparative advantage, with an NRCA value of –0.006 in 2010, marginally increasing to 0.334 in 2016, and then declining to –0.015 in 2022. The global demand for paddy rice is generally lower than that for milled rice. Additionally, exporting paddy rice is often costlier due to higher transportation costs. Moreover, phytosanitary regulations imposed by importing countries could also serve as potential barriers.

Focusing on the export potential of rice (HS:100630) to major trading partners, we find that the markets with the greatest potential for Lao PDR's exports of semi- or wholly milled rice are China, the Philippines, the United States, Saudi Arabia, and Malaysia (Figure 9). Lao PDR has already maximized its potential in the Chinese market; the export of semi-milled rice to China (USD25 million) far exceeds the predicted export potential (USD5.1 million) due to zero import tariffs and the strong demand for rice in China. Meanwhile, the Philippines (35%) and Malaysia (20%) impose high tariffs on Lao PDR rice, creating significant barriers to market access. This may potentially explain why the export potential in these countries remains largely untapped. The United States and Saudi Arabia had untapped potential exports of USD0.717 million and

FIGURE 9

LAO PDR'S EXPORT POTENTIAL MAP OF SEMI-MILLED OR WHOLLY MILLED RICE (HS:100630) IN 2022



Source: Authors adopted from the ITC database, 2024.

USD0.100 million in 2022, respectively (Table 2). A relatively low import tariff and high import demand provide an excellent opportunity for Lao PDR to increase its exports to these markets.

TABLE 2

EXPORT POTENTIAL OF LAO PDR'S SEMI-MILLED RICE (HS 100630) TO MAJOR TRADING PARTNERS

Main Partners	Export potential	Actual exports	Untapped potential	Wholly milled rice imports	Total trade in goods with Lao PDR	Applied tariff for milled rice from Lao PDR
	(Thousand USD)			(Billion USD)	(Million USD)	%
China	5,100	25,000	0	1.2	2,500	0%
Philippines	1,300	0	1,300	1.2	7.8	35%
USA	739	22	717	1	165	6.15%
Saudi Arabia	100	0	100	1.2	3.6	0%
Malaysia	331	0	331	0.6	22	20%

Source: ICT export potential map (2024)

Analysis of Rice Production Value Chain

This section focuses on the value chain of sticky rice production in Savannakhet province, where sticky rice serves as the primary staple food crop, accounting for over 80% of the country's total rice production and occupying over 75% of arable land dedicated to rice cultivation (Sengsourivong & Ichihashi, 2019). Rice plays a crucial role in ensuring national food security, as the average per capita consumption in Lao PDR is approximately 206 kg per year, one of the highest rates in the world (Mullis, 2020).

TABLE 3

THE VALUE CHAIN OF RICE PRODUCTION (LAK PER KILOGRAM)

No	Value chain of rice	Farmer	Collector	Rice miller	Wholesaler	Retailer	Exporter
1	Total costs	7,092	7,950	9,140	10,032	14,210	16,030
2	Gross value of total outputs	7,500	8,060	9,500	11,250	15,000	18,000
3	Profit	408	110	360	1,218	790	1,970
4	Share of total profit (%)	8.40	2.27	7.41	25.08	16.27	40.57
5	Wage	2,204	90	180	100	100	1,730
6	Value added	2,612	200	540	1,318	890	3,700
7	Profit sharing (wage/profit)	5.40	0.82	0.50	0.08	0.13	0.88

Source: The author's interview, 2024.

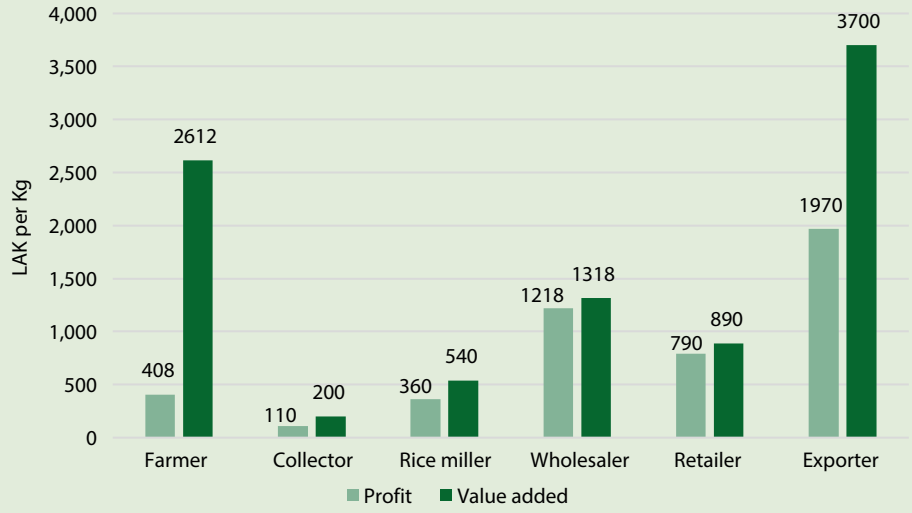
Table 3 shows that exporters dominate the value chain and earn the highest profit of LAK1,970 per kg, capturing 40.57% of total profit, due to their access to higher-priced global markets. Wholesalers and retailers follow, earning moderate profits of LAK1,218 per kg and LAK790 per kg, capturing 25.08% and 16.27% of total profit, respectively. Their roles in bulk distribution allow for some value addition. In contrast, collectors profit the least (LAK110 per kg), receiving only 2.27% of the profit share. Collectors operate in low-value-added segments, primarily buying and transporting raw products, resulting in minimal profits. Farmers also receive a modest share of the profit (8.40%) due to limited bargaining power and reliance on primary production.

For the value-added of rice production, exporters contribute the highest value-added (LAK3,700 per kg), driven by their activities at the end of the chain. They refine the product for export by ensuring quality assurance, developing branding strategies, and facilitating access to international markets, thereby enhancing its value. Farmers contribute the second highest value addition in the chain, with a value-added amount of LAK2,612 per kg. This positioning reflects the inherent importance of primary production; however, their earnings are predominantly wage-based rather than profit-driven.

Wholesalers and retailers generate moderate value-added of LAK1,318 per kg and LAK890 per kg, respectively, playing a vital role in linking upstream production to downstream markets. Value-added is minimal for collectors (LAK200 per kg), as their role is restricted to aggregation and transportation, which do not significantly enhance the product's quality or marketability.

FIGURE 10

PROFITS AND VALUE-ADDED FROM RICE PRODUCTION



Source: The author's interview, 2024.

Figure 10 shows that exporters capture the highest profit of LAK1,970 per kg and contribute the most value-added of LAK3,700 per kg within the rice value chain. Their ability to access global markets enables them to sell rice at premium prices, which is reflected in their massive profit shares compared with other stakeholders. Furthermore, exporters often possess more market information and resources, providing them with a competitive advantage over other stakeholders. Farmers can generate a value-added of LAK2,612 per kg, contributing significantly to rice production; however, their profit margin is relatively low at LAK408 per kg, indicating a lack of pricing power. Farmers face challenges such as limited access to markets, dependence on intermediaries (collectors), and price volatility, limiting their ability to earn higher profits despite their fundamental role in rice production.

Wholesalers maintain a healthy balance between profit margin (LAK1,318) and value-added (LAK1,218), playing a crucial role in the distribution of rice to retailers and exporters. Their profitability is supported by their intermediary position in the value chain, where they can take advantage of economies of scale by buying in bulk from millers and selling in smaller quantities to retailers or exporters. Finally, retailers add less value than wholesalers but capture a decent profit (LAK790) and value-added (LAK890). Retailers mark up rice for final consumers who are typically willing to pay higher prices for convenience. Rice millers add considerable value (LAK540) to rice by processing and refining it; however, their profit margin (LAK360) remains relatively low. This disparity indicates that although the milling process is crucial, the margins for millers are constrained by high operating costs, including machinery and labor.

Comparative Analysis of the PPP Policy with and without the Value Chain: Sticky Rice Production in Lao PDR

The value chain of sticky rice production in Lao PDR operates under varying conditions depending on the presence or absence of PPP policies. Under a PPP framework, collaboration between government agencies and private actors enhances coordination, investment, and technology transfer across the value chain. Farmers benefit from improved access to quality inputs, technical support, and assured markets through contract farming schemes or collective agreements. This situation leads to higher productivity, value addition, and more

stable incomes. In contrast, sticky rice producers experience fragmented value chain linkages without a PPP framework. Moreover, limited access to finance, modern inputs, and market information weakens production efficiency and competitiveness. Private actors may hesitate to invest due to higher perceived risks, and farmers may lack bargaining power in the market. The comparative analysis details are as follows:

a. Production and Input Access

PPP programs make it convenient for farmers to obtain high-quality inputs and technical assistance. For instance, the Phutawen Farm Project has enhanced sustainable agriculture in Lao PDR by implementing good agricultural practices and organic standards in partnership with the German Corporation for International Cooperation as part of the Southeast Asian Food Trade (SAFT) initiative (Phuthawen, 2017). Farmers often struggle with high input costs and restricted access to high-quality inputs without PPPs, lowering productivity. According to Greater Mekong Subregion (GMS, 2013), Khammouane Province's rice value chain is characterized by low productivity among smallholder farmers due to high input costs and restricted access to inputs.

b. Market Access and Value Chain Integration

PPP frameworks promote better integration of farmers into value chains through mechanisms such as contract farming. The Lao Farmer Network has been instrumental in connecting smallholder rice producer groups with rice companies through contract farming, following which farmers were able to obtain rice seeds and organic fertilizers at a reasonable price. The company guarantees the price of rice, fostering trust and ensuring a regular supply. The results indicated that farmers engaged in contract farming experienced an 82% increase in income compared with those who were not (AFASRD, 2019). Without PPPs, farmers often operate in fragmented markets with limited bargaining power. The World Bank (2018) reported that the rice value chain in Lao PDR suffers from inefficiencies, with farmers receiving low profits due to high production costs and fragmented market systems.

c. Infrastructure and Postharvest Processing

PPP initiatives frequently make infrastructural investments to enhance postharvest storage and processing. Combining commerce, tourism, and agriculture, the Phutawen Farm Project sets an example for agrotourism and sustainable food production throughout Lao PDR (Phuthawen, 2017). Lack of PPP involvement and infrastructure deficits hinder the efficiency of the rice value chain. The Mekong Institute's analysis in Khammouane Province identified poor farm-to-market roads and low rice milling efficiencies due to outdated equipment as significant barriers (GMS, 2013).

d. Policy and Regulatory Environment

PPP arrangements can influence policy reforms and regulatory improvements. In the Regional Workshop on Agribusiness PPPs in Luangprabang, Phounvisouk et al. (2024) emphasized the role of PPPs in promoting evidence-based policy formulation practices in the Mekong region. Without the collaborative framework of PPPs, policy implementation may lack coordination and farmers may remain unaware of beneficial programs. The absence of specific regulations for contract farming in Lao PDR has led to uncertainty among farmers and investors, highlighting the need for clearer policies (Mekong Region Land Governance [MRLG], 2021).

Conclusions and Policy Recommendations

Rice production is a cornerstone of Lao PDR's economy and society, serving as a vital food source and significant economic driver. It provides food security for most Laotian populations, with rice being the primary diet in most Lao households. As a critical source of livelihood, rice farming supports nearly 70% of the labor force, primarily in rural areas, reducing poverty and contributing to income generation for farming communities. Despite its contributions, the sector faces challenges, including low productivity, limited access to modern farming technologies, poor infrastructure, and a lack of active private sector support for rice production.

Therefore, this study aims to assess the best practices in enhancing the role of PPP to improve rice productivity across stakeholders, promote sustainable agricultural practices, and boost economic growth.

The rice harvested areas slightly decreased from 855,114 hectares in 2010 to 818,200 hectares in 2022; however, the rice yields increased significantly from 3,591 kg/ha in 2010 to 4,394 kg/ha in 2022, driven by improved farming techniques, mechanization, better irrigation systems, high-yield varieties, and private sector participation under PPPs. Rice export values of USD28.4 million remained relatively low, accounting for 3.2% of agricultural exports in 2023. The result of the NRCA analysis for 2022 indicated that among the top 10 agricultural export products, cassava demonstrated the most comparative advantage (11.86), followed by coffee (3.39) and fresh or dried banana (1.60). These products remain a competitive export through the recent decline. The comparative advantage for semi-milled or wholly milled rice fluctuated between 0.06 and 2.36 from 2010 to 2022. The export potential of semi-milled rice shows that the Philippines, the United States, and Malaysia had untapped potential exports between USD0.33 million and USD1.3 million in 2022. The results of the value chain analysis indicate that exporters dominate the rice value chain, earning the highest profit and value-added due to their access to global markets and product improvement. Conversely, farmers contribute significant value-added through primary production but receive a relatively smaller share of the overall profit. Moreover, wholesalers and retailers play key roles in distribution, generating moderate profits and value-added.

The Lao PDR government should consider implementing the following suggested policies to foster sustainable and inclusive improvements in rice productivity and equitable gainsharing.

1. Promote Inclusive Participation of Smallholder Farmers

   - ✓ Design PPP projects to prioritize smallholder farmers by providing access to improved seeds, fertilizers, and farming technologies.

   - ✓ Strengthen farmer cooperatives to improve their bargaining power and integrate them into PPP projects as key stakeholders.

2. Leverage Private Sector Investment for Infrastructure Development

   - ✓ Encourage private sector investment in rural infrastructure, such as irrigation systems and storage facilities, which are critical for enhancing rice productivity.

   - ✓ Offer tax incentives and low-interest financing options to incentivize private sector participation.

3. Facilitate Knowledge Transfer and Capacity Building

   - ✓ Collaborate with private sector actors to deliver training programs on modern agricultural practices, sustainable farming techniques, and efficient water management.

   - ✓ Encourage research and development collaborations to introduce high-yield and climate-resilient rice varieties.

4. Implement Performance-Based Gainsharing Models

   - ✓ Design gainsharing agreements whereby farmers receive a share of profits linked to productivity improvements or cost reductions achieved through PPP projects.

   - ✓ Regularly monitor and evaluate project outcomes to ensure transparency and equitable sharing of benefits.

By implementing these policy recommendations, Lao PDR can enhance rice productivity, promote sustainable agricultural practices, and ensure equitable economic benefits for all stakeholder

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ASSESSING BEST PRACTICES IN PRODUCTIVITY GAINSHARING IN MONGOLIA'S GOAT CASHMERE SECTOR

Executive Summary

This study examines the transformation of Mongolia's goat cashmere supply chain, comparing the Soviet-era (1950–70) model with the current modern system and assessing the benefits of implementing a gainsharing model. The Soviet-era supply chain was characterized by centralized control, price stability, and standardized processing, whereas the modern system operates within a competitive free-market environment, experiencing challenges such as price volatility, quality inconsistency, and economic instability among herders.

To address these issues, this study explores gainsharing, a performance-based incentive system that rewards all supply chain participants, including herders, processors, manufacturers, and exporters, based on shared productivity and efficiency improvements. Given Mongolia's significant role in global cashmere production, optimizing the supply chain through fair profit distribution and value-added processing can enhance the industry's sustainability and long-term growth.

Methodology: Sampling and Sample-Based Research Method

The principal method of scientific research is sampling. Due to limited resources, such as time and financial constraints, studying an entire population is often not feasible. Consequently, the need arises to determine an appropriate sample size that can represent the population being studied. In this study, the sample size was determined based on internationally recognized methodologies and procedures.

A **nonprobability** form may be used when selecting samples (i.e., supplemental information about the herder households that constitute the original population). A **random sampling** method was applied among those considered to have sufficient representativeness.

In determining the necessary sample size, the maximum sampling error (e) was set at 0.05, with a **confidence level of 95%**. After determining the total sample size, the sample distribution across provinces (**aimags**) and districts (**soums**) was calculated using **targeted sampling** methods.

A **statistical *t*-test** was employed to measure the reliability or representativeness of the sample. For this purpose, the average indicator of the entire population was compared with the average indicator of the herder households from the selected aimags and soums.

Key Findings

- **Soviet-Era vs. Modern Supply Chain:** During the Soviet period, state-managed operations ensured predictable pricing, consistent quality, and government-backed processing infrastructure. The shift to a market-driven economy has introduced inefficiencies, including fluctuating prices and private-sector competition.

- **Challenges in the Modern Supply Chain:** The free-market approach has led to inconsistent fiber quality, limited domestic value-added processing, and income instability among herders.

- **Opportunities Through Gainsharing:** Implementing a gainsharing model can align stakeholder incentives and encourage better fiber quality, ethical sourcing, and long-term economic stability.

- **Stakeholder Benefits:** A well-structured gainsharing framework can provide herders with higher compensation for superior cashmere quality, enhance efficiency in processing facilities, and strengthen exporters' market positioning through ethical and sustainable branding.

- **Implementation Strategies:** Key success factors include transparent pricing structures, cooperative agreements among stakeholders, government support, and the adoption of digital tracking technologies for improved traceability and quality assurance.

Recommendations

- **Develop a Cooperative Gainsharing Model:** Establish industry-wide agreements to ensure fair profit-sharing based on measurable quality improvements.

- **Strengthen Government and Policy Support:** Advocate for regulatory frameworks that promote sustainable practices and equitable revenue-sharing.

- **Invest in Capacity Building:** Provide training programs for herders and processors to improve fiber quality, sustainability, and ethical sourcing practices.

By integrating a gainsharing model, Mongolia's cashmere industry can foster economic sustainability, improve global competitiveness, and ensure fair compensation for all stakeholders.

Introduction

Mongolia is a landlocked country in East Asia bordered by Russia to the north and China to the south. It covers 1,564,116 km² (603,909 sq mi) and has a population of 3.5 million, making it the world's most sparsely populated sovereign state.

As the world's largest landlocked country, much of Mongolia is covered by grassy steppe, with mountains to the north and west and the Gobi Desert to the south. Ulaanbaatar, the capital and largest city, is home to roughly half of the country's population (Figure 1).

FIGURE 1

MAP OF MONGOLIA

Mongolia's geography significantly influences its climate. Owing to its distance from the sea, the country experiences a continental climate characterized by four distinct seasons. Moreover, the temperature tends to vary between seasons as well as within a single day (Figure 2).

FIGURE 2

SEASONS IN MONGOLIA

Winter | Spring | Summer | Autumn

The climate in the northern part of the country is extremely cold, with winter temperatures dropping as low as –50°C. Conversely, southern regions may experience winter temperatures around +4°C. During the summer, particularly in July, daytime temperatures range between 10°C and 15°C in Altai, Hangai, Hovsgol, and Hentii. In the eastern part of the Dornod plain, temperatures may exceed 20°C. Maximum summer temperatures may reach up to 35°C in Hangai and 41°C in the Gobi region.

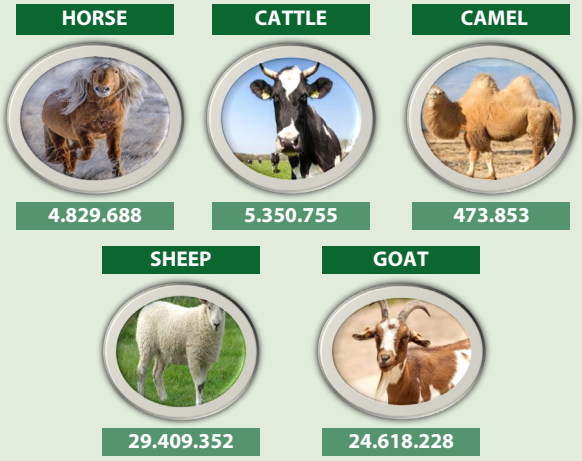
The coldest period of winter typically occurs in mid-January, with temperatures dropping to –25°C to –30°C in the northern mountains and –15°C to –20°C in the Gobi region. Extremely low temperatures ranging from –45°C to –53°C have been recorded in the northern part of the country. The land is covered in snow for 40–60 days in the south and 150 in the north. The ground freezes down to 3 meters, with the number of cold days per year ranging from 160 to 220.

The harsh climate of Mongolia has the following effects on goat cashmere production.

- The quality of cashmere is enhanced by the region's severe climatic conditions and traditional pastoralist practices, resulting in fiber that is soft and exhibits good heat retention properties.
- Cashmere raw materials are seasonal in nature and primarily prepared between March and May, leading to differences in their prices by region.
- Processing plants compete to procure raw materials only during these months, necessitating substantial working capital.

FIGURE 3

LIVESTOCK IN MONGOLIA



Source: National Statistics Office, 1212.mn, 2024.

- Inclement weather in 2024 led to 11.5% of the total livestock in Mongolia, or 7.44 million head, being killed, reducing the amount of cashmere production and affecting the global market.

In 2024, Mongolia's total livestock population reached 64.6 million, comprising approximately 24.6 million goats, 29.4 million sheep, 5.3 million cattle, 4.8 million horses, and 473,853 camels (Figure 3).

Mongolia has a population of 3.5 million, with 70% of the population under the age of 29. The population density of Mongolia is 2.7 people per square kilometer. Of the population, 56.4% live in cities, and the remainder reside in the countryside. (Mongolian Highway Network, 2023).

TABLE 1

NUMBER OF HOUSEHOLDS WITH LIVESTOCK

Group amount of livestock	Number of households with livestock/thousand/				Amount of livestock per household with livestock/million head/			
	2015	2019	2022	2023	2015	2019	2022	2023
Up to 10	14,2	12,8	13,2	14,0	0,1	0,1	0,1	0,1
11–30	19,9	18,9	22,2	24,0	0,4	0,4	0,5	0,5
31–50	15,5	14,9	17,4	18,7	0,6	0,6	0,7	0,8
51–100	29,3	27,9	32,7	34,1	2,2	2,1	2,4	2,5
101–200	46,3	46,0	51,1	51,9	6,8	6,8	7,5	7,6
201–500	60,1	67,5	67,3	66,4	19,1	21,8	21,7	21,3
501–1000	23,1	33,0	32,3	30,0	15,5	22,6	22,2	20,4
1001–1,500	7,0	10,0	10,0	7,5	8,0	11,6	11,6	8,6
1501–2000	1,0	1,6	1,5	1,0	1,7	2,7	2,5	1,6
2000 up	0,5	0,7	0,6	1,2	1,2	1,9	1,6	1,0
Total	**216,7**	**233,3**	**248,3**	**247,9**	**55,6**	**70,6**	**70,8**	**64,3**

Source: Ministry of Food, Agriculture, Light Industry, 2023

Agriculture accounts for 35% of Mongolia's workforce, and 247.9 thousand households are engaged in livestock production. Of these, 76.4%, or 189.3 thousand households, are herding households, which raise livestock throughout the year across all four seasons and rely on livestock for their livelihood.

Mongolia has 14,000 households with up to 10 livestock (accounting for 5.7% of all livestock households), 24,000 households with 11–30 livestock (accounting for 9.7%), 18,700 households with 31–50 livestock, (accounting for 7.5%), 34.1 thousand households with 51–100 livestock (accounting for 13.8%), 51,900 households with 101–200 livestock (accounting for 20.9%), 66,400 households with 201–500 livestock (accounting for 26.8%), and 38,800 households with over 501 livestock (accounting for 15.7%).

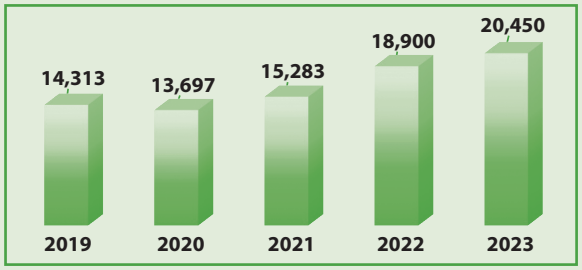
The income of a herder household depends on the number of livestock. According to the 2019 Household Livelihood Survey conducted by the Mongolian Marketing Consulting Group, households with over 200 livestock are generally able to sustain themselves with their income. Conversely, households with a higher proportion of goats within their livestock tend to generate greater income.

The Current Situation of Mongolia's Livestock Sector

Mongolia is primarily an agricultural country, with the agricultural sector serving as the pillar of Mongolia's economic development. This sector supplies the population with healthy food and raw materials for the light and food processing industries.

FIGURE 4

GROSS DOMESTIC PRODUCTION/CURRENT PRICES (MLN. USD)



Source: National Statistics Office, 1212.mn, 2024.

As of 2024, Mongolia's GDP was USD20.45 billion and USD20.3 billion as per 2015 constant prices. Over the past five years, the GDP increased by 42% or USD6.35 billion (Figure 4).

In 2024, the GDP per capita reached USD5,875, whereas the country's national foreign exchange reserves stood at USD5.0 billion.

According to the sector's structure, the primary or agricultural sectors, including the livestock sector, produced about 30%–40% of the total domestic product until 1999. Following 2000, owing to the expansion of the mining and service sectors, the share of the agricultural sector in the total domestic product decreased. Conversely, the share of the mining, manufacturing, and service sectors continued to increase (Ch. Avdai, 2022).

TABLE 2

SHARE OF THE AGRICULTURAL SECTOR IN THE GDP (MLN. USD)

	2019	2020	2021	2022	2023
Percentage of the agricultural sector	11.50	12.84	13.02	12.83	9.79

Source: National Statistics Office, 1212.mn, 2024

As of 2024, Mongolia's agricultural sector accounted for 9.79% of the total domestic product (8.68% of the animal husbandry sector, 1.1% of the farming sector, and 0.01% of other agricultural sectors). Agricultural products comprised 6.0% of the country's export earnings, and 24.16% of the total workforce was employed in this sector.

TABLE 3

SHARE OF ANIMAL HUSBANDRY IN AGRICULTURE (% AGE)

	2019	2020	2021	2022	2023
GDP	**100**	**100**	**100**	**100**	**100**
Agriculture	12.65	12.84	13.02	12.83	9.79
Farming	1.07	0.94	1.29	1.14	1.1
Animal husbandry	11.35	11.85	11.64	11.6	8.68
Others	0.03	0.04	0.09	0.1	0.01

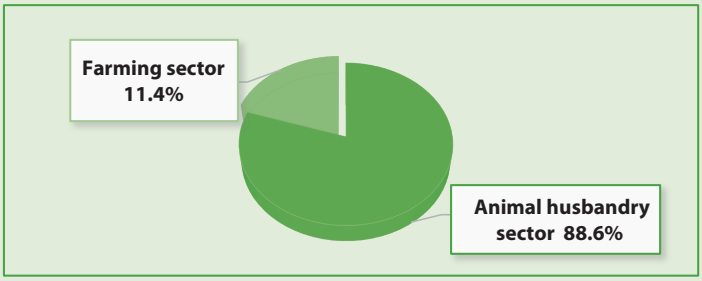
Source: National Statistics Office, 1212.mn, 2024.

Mongolia's agriculture sector consists of two main sectors: the animal husbandry sector, which accounts for 88.6% of the total agricultural output, and the farming sector, which constitutes the remaining 11.4% (Figure 5).

Over the past 12 years, Mongolia's livestock population has doubled, reaching 64.6 million head (Figure 6).

FIGURE 5

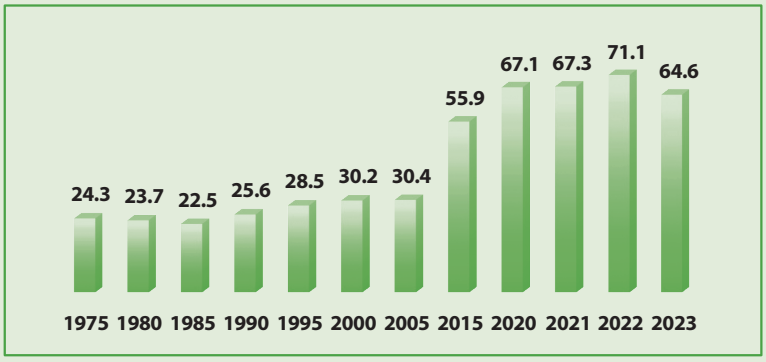
SHARE OF THE ANIMAL HUSBANDRY SECTOR (% AGE)



Source: National Statistics Office, 1212.mn, 2024.

FIGURE 6

TOTAL NUMBER OF LIVESTOCK (MLN. HEAD)

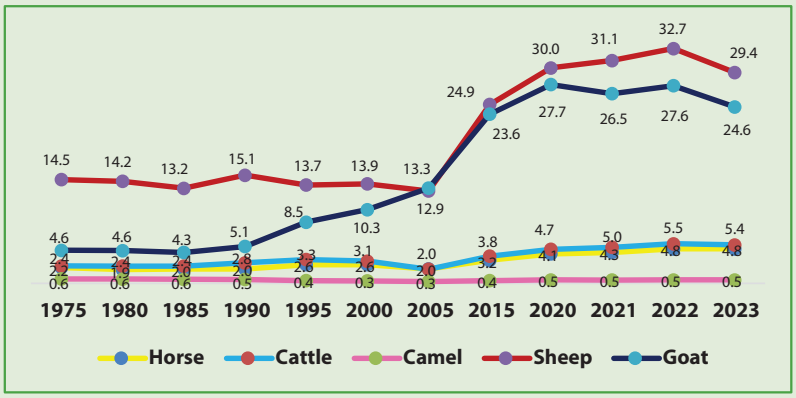


Source: Ministry of Food, Agriculture and Light Industry, 2024.

Since 2005, the number of horses and cattle increased by 2.5 times, reaching 5.4 million and 4.8 million, respectively. The camel population grew by 1.7 times to 0.5 million, sheep by 2.0 times to 29.4 million, and goats by 1.7 times to 24.6 million head (Figure 7).

FIGURE 7

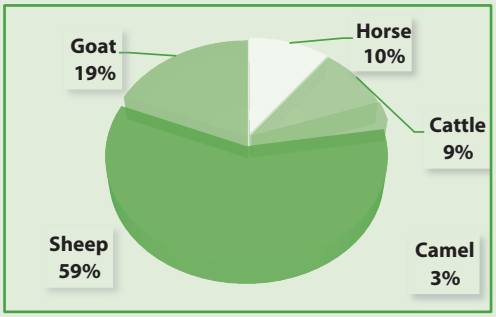
NUMBER OF LIVESTOCK (TYPE, MLN. HEAD)



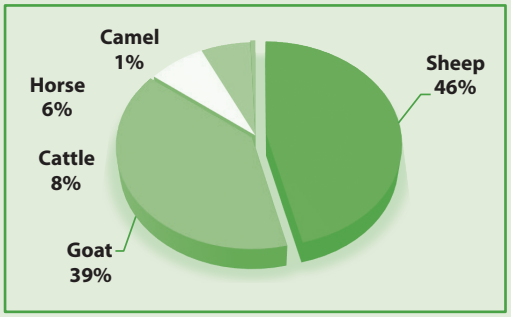
Source: Ministry of Food, Agriculture and Light Industry, 2024.

FIGURE 8

TOTAL NUMBER OF LIVESTOCK (1970)



TOTAL NUMBER OF LIVESTOCK (2022)



Source: Ministry of Food, Agriculture and Light Industry, 2024.

As of 1970, sheep and goats accounted for 78% of livestock and camels, horses, and cattle accounted for 22%. By 2022, sheep and goats accounted for 85%, and camels, horses, and cattle accounted for 15% (Figure 8).

Therefore, the share of small livestock is almost at the same level as in 1970 (Socialist Agriculture,1974); however, the share of goats has increased by 20%.

Cashmere Characteristics, Breeds, Strains, and Geographical Locations of Mongolian Goats

Cashmere is a type of animal fiber obtained by combing the undercoat of cashmere goats, typically raised in cold and temperate regions. Renowned for its soft material exhibiting good heat retention properties, it is considered a luxurious raw material.

Very few countries and regions produce cashmere, making it a rare commodity. Mongolia, along with China, is one of the few producers of raw cashmere in the world, serving as the most important source of cash income for herders.

It constitutes one of the most important livestock-based exports, which, from the perspective of the country's foreign trade balance, is considered the most economically effective export.

Therefore, we selected goat cashmere for the purpose of this study due to its substantial impact on the income of Mongolian herders.

Globally, approximately 24,000 tons of cashmere are produced annually, generating an estimated turnover of USD20 billion; 48% of the cashmere reserve is produced by China, 40% by Mongolia, and 12% by Iran and Afghanistan (Figure 9).

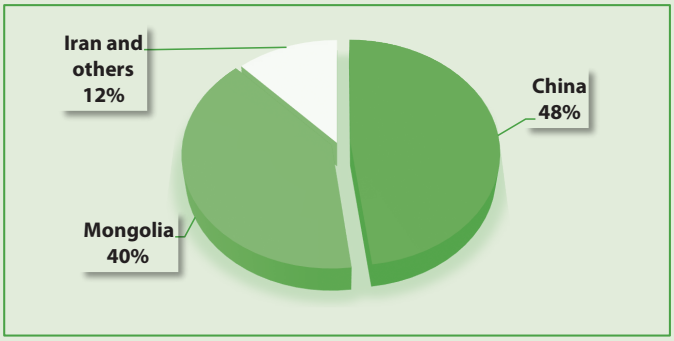
Due to the natural nanostructure of the cashmere fiber, it is extremely soft, light, warm, flexible, durable, breathable, air-filtering, fire-resistant, and biodegradable. As a result, cashmere products are suitable for middle- to high-end consumer markets, particularly within the luxury segment.

Mongolian goats are grazed for four seasons of the year and are hardy animals that can withstand 40-degree temperature changes and other harsh natural hazards (Nadmid, N., 2020).

The average fiber length of cashmere obtained from Mongolian goats is approximately 40 mm; however, depending on factors such as age, gender, and breed, it can range from 33 to 56 mm (Ministry of Food, Agriculture and Light Industry, 2020). About 81.0% of Mongolia's total goat herd (21.5 million head) comprises local Mongolian goats, while the remaining 19% (or 5 million head) comprises goats from nine different breeds, three strains, and one breeding area (Figure 10).

FIGURE 9

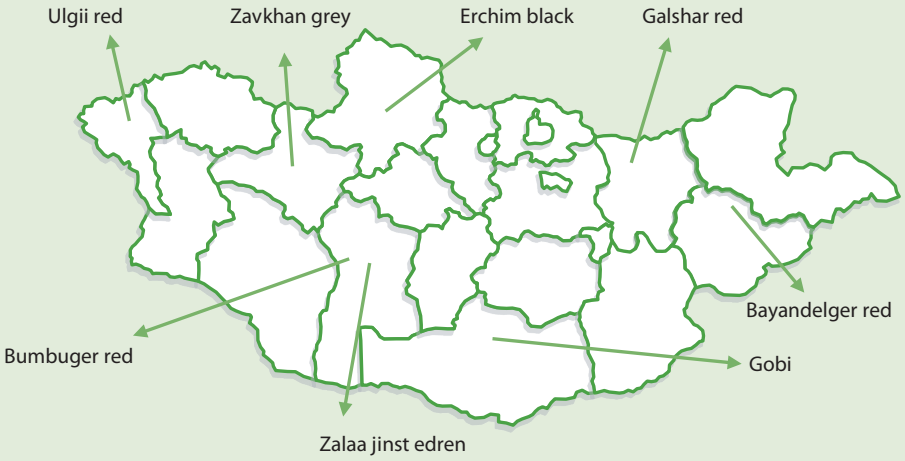
WORLD CASHMERE PRODUCTION (% AGE)



Source: CNBC, Mongolia, 2024.05.10.

FIGURE 10

GEOGRAPHICAL LOCATION OF MONGOLIAN MAIN GOAT BREEDS



Source: B. Narantuya, 2020, Mongolian breed section.

Mongolian Cashmere Production and Resources

The National Congress of Mongolia approved the concept of regional development of Mongolia as of Decree No.65 of 5 June 2024.

The regional development mission aims to develop a competitive region that respects our national culture, preserves the natural landscape and ecological balance, and promotes green production through economic diversification, specialization, and cooperation.

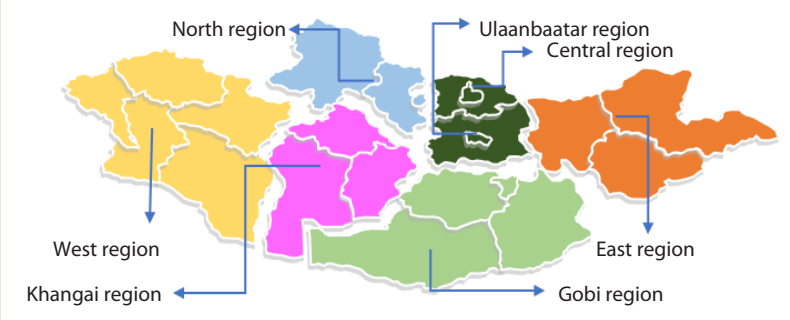
Mongolia will be developed according to the zoning system of the Khangai, Western, North, Central, Eastern, Govi, and Ulaanbaatar regions (Figure 11).

In recent years, the number of goats in Mongolia has been increasing, although as of 2023, the national goat population was recorded at 24.6 million, representing a decrease of 2.9 million or 11% compared with the previous year (Figure 12).

Since 2010, the number of goats has doubled rapidly. As goat cashmere can be easily cashed, it remains the primary source of income for most Mongolian herders.

FIGURE 11

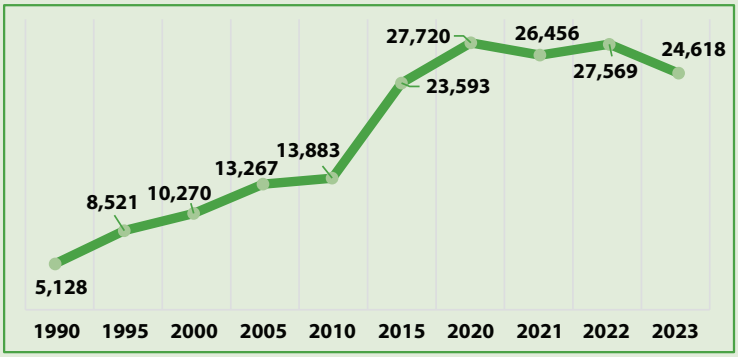
ECONOMIC REGIONS



Source: Regional development concept of Mongolia, 2024.

FIGURE 12

NUMBER OF GOATS (THOUSAND HEAD)

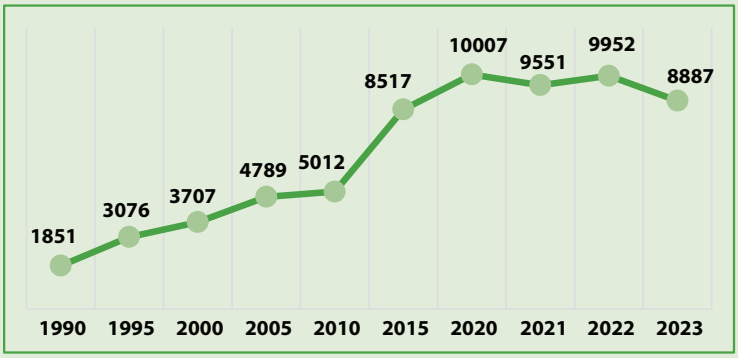


Source: National Statistics Office, 2024.

Mongolia's raw cashmere production doubled from 5.0 thousand tons in 2010 to 10.0 thousand tons in 2020 (Figure 13).

FIGURE 13

RAW CASHMERE PRODUCTION IN MONGOLIA (THOUSAND TONS)



Source: Chamber of Commerce and Industry, 2023.

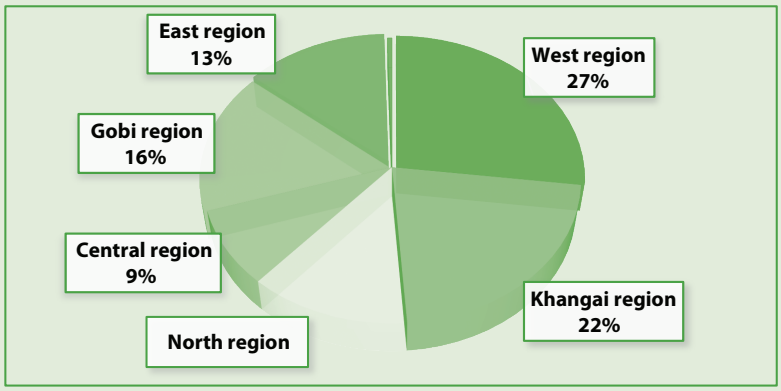
The country's cashmere production over the past 5 years grew by an average of 7.3% annually in 2015–18, remained stable in 2018–2019, and increased by 7.8% in 2020, before declining in 2023.

Mongolia produced approximately 8.9 thousand tons of cashmere in 2023 due to the decrease in goats, which decreased by 1,000 tons or 11% from 2022.

Regarding goat cashmere production, 27% is produced in the West region, 22% in the Khangai region, 16% in the Gobi region, and 13% in the East and Northern regions (Figure 14).

FIGURE 14

RAW CASHMERE PRODUCTION IN MONGOLIA BY REGION (TONS)



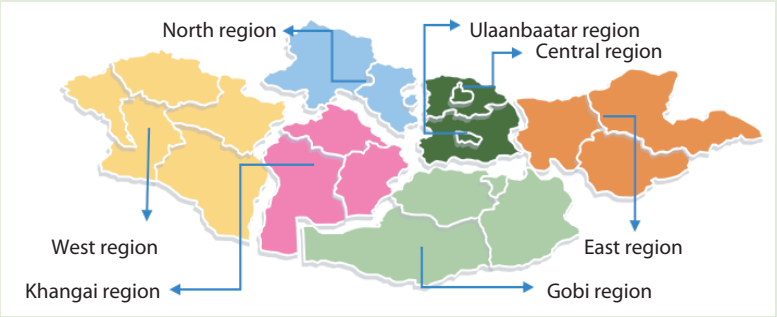
Source: B.Baasansukh, Supply chain for Agricultural Products, 2024.

Raw Cashmere Price

Procurement periods for raw cashmere vary by geographic location, generally starting in March, when raw cashmere prices tend to be higher (Figure 15).

FIGURE 15

COAT COMBING DURATION BY REGION



Central Region Starting from the first week of April Ending in the first week of May	**East Region** Starting from the first week of March Ending in the fourth week of March
West Region Starting from the second week of April Ending in the second week of May	**Gobi Region** Starting from the fourth week of March Ending in the second week of April

Source: Sustainable Wool Cashmere Coalition, 2020.

Mongolian goats exhibit a wide range of coat colors and produce cashmere in various natural shades. Based on raw material characteristics and processing standards, Mongolian cashmere is classified into four color categories (Table 4). Cashmere is considered a national treasure, which is regenerated annually and used to produce woven and knitted clothes, fabrics, and blankets.

Cashmere quality is determined based on fineness, length, grain, color, hair content, and contamination.

Cashmere Fineness: One micrometer is a unit equal to one part of 1,000, or a measurement of the diameter of cashmere in microns.

Length of Cashmere: The longer the cashmere, the tighter the yarn. After the combing process, it typically measures between 42 and 46 mm in length. Additionally, the presence of a twist in the fiber contributes to the durability of the final product.

Color of Cashmere: Mongolian cashmere predominantly appears in four light and dark shades.

Cashmere Yield: It refers to the proportion of usable fiber obtained from raw cashmere after removing impurities such as coarse hairs, dirt, oil, and other contaminants. For example, if 50 kg of clean cashmere is extracted from 100 kg of raw material, the yield is considered to be 50%. The yield largely depends on the level of impurities present in the raw fiber. On average, Mongolian goat cashmere yields range between 45% and 50% (Enkhtuyaa & Ganbat, 2016).

TABLE 4

CASHMERE COLORS

Color Class	Color	Definition
1	White	Cashmere fiber and guard hair are white
2	Beige	Cashmere fiber is light-colored, whereas the guard hair may be red, beige, or brown
3	Warm grey	Cashmere fiber is light, with guard hair showing a mix of black and white
4	Black	Cashmere fiber contains dark or black guard hair

Source: Sustainable Wool Cashmere Coalition, 2020

Of the total processed Mongolian cashmere, approximately 60% is dark, 15% is red, 10% is gray, 10% is light gray, and 5% is white.

The grade of cashmere is determined by its color and hair content.

TABLE 5

CASHMERE GRADES

Grade	Diameter of cashmere	Size of the pores, %	Definition
Top grade	Up to 15.5	Up to 20	Cashmere from brown and toothed goats of the local Mongolian and chosen tribes
Grade 1	15.51–16.8	Up to 20	Cashmere from mature goats of the local Mongolian and Shimel tribes
Grade 2	16.51–17.5	20.1–30	Cashmere from mature goats of the local Mongolian and Shimel tribes
Grade 3	17.51–19.0	30.1–60	Cashmere from the local Mongolian, Shimel, Serkh, and hybrid goats

Source: Sustainable Wool Cashmere Coalition, 2020

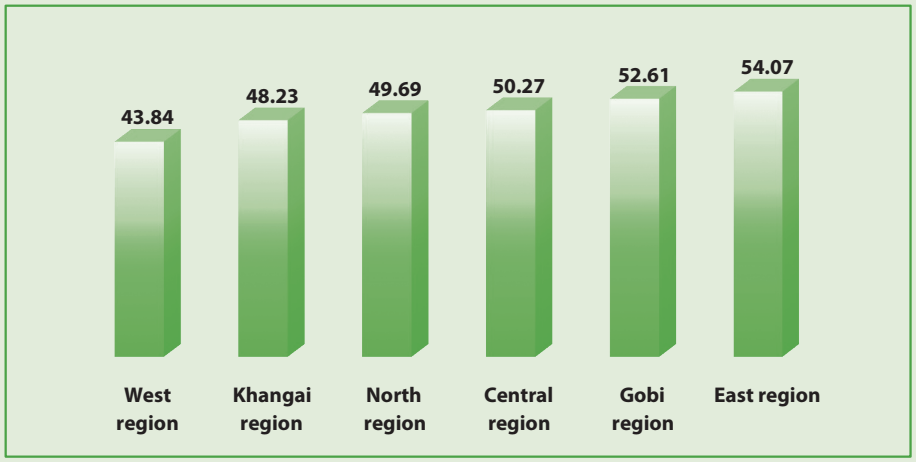
The price of raw cashmere is classified according to its color and length, with the price varying for each category.

The price of cashmere in the domestic market differs depending on the climatic zone. In the eastern region, cashmere is typically harvested earlier due to climatic conditions (Ministry of Food, Agriculture and Light Industry, 2012).

Domestic cashmere prices vary within the region depending on cashmere procurement and delivery time, length, and diameter (Figure 16).

FIGURE 16

PRICES OF RAW CASHMERE BY REGION (USD)



Source: Agricultural Exchange News, 2024.

Literature Review

Until 1990, agricultural cooperatives in Mongolia were state-organized associations composed of individual herder households, functioning as a farming enterprise focused on livestock production.

Until 1990, the government established fixed nationwide rules for:

- The number of goats allocated per cooperative herder household;
- The amounts of cashmere, meat, and milk obtained from each goat;
- The price at which these products are sold to the state.

These products were supplied to domestic textile and food factories at fixed state-controlled prices throughout Mongolia. This system, known as the country's centralized state procurement system, formed the primary (initial) market for products of animal origin produced by agricultural cooperatives.

The state preparation system covered the entire sale of livestock products in Mongolia, with agricultural cooperatives primarily responsible for facilitating the sale of these products in the centralized market (Figure 17).

Each agricultural unit was part of a supply chain that provided livestock products to the food and light industry through its trade preparation unit, operating under strictly defined contractual agreements.

The price of livestock products supplied to the state was determined by the government, based on predefined quality categories (Sharavsambuu, B., 2021).

FIGURE 17

AGRICULTURAL PRODUCT SUPPLY CHAIN BEFORE 1990

Source: B.Baasansukh, Supply Chain for Agricultural Products, 2024.

The state preparation system did not function as a direct purchaser of animal products from agricultural cooperatives; rather, it operated as an intermediary between producers and consumers.

This system ended with the transition period from centrally planned economic growth to a market economy or the "8th Five-Year Plan for the Development of the Country."

Since 1991, following the privatization of state-owned factories and agricultural cooperatives, the former supply chain system has disintegrated, with intermediaries assuming its role. In soums located near centralized markets with developed infrastructure, some herder families have established self-sufficient networks for supplying animal products (Mongolian Development Research Support Center, 2007).

Animal husbandry is season-dependent, resulting in income instability, as herders' earnings rely directly on the sale of livestock products.

The motivation of herders to increase their number depends on income. For households with fewer herds, a higher proportion of goats typically results in greater income. Conversely, for households with larger herds, cashmere contributes a smaller share to total income (Mongolian State University of Agriculture, 2018).

Herders can sell other animal products (such as meat, milk, and wool). According to the National Statistics Office, cashmere accounts for approximately 56% of the income of herders with smaller herds, whereas it accounts for 43% of the income of herders with larger herds.

From 2010 to 2022, Mongolia's goat population rose from 13.8 million to 27.5 million head, effectively doubling. In line with the increasing goat population, Mongolia produces approximately 10,000 tons of cashmere annually. Despite the rise in goat numbers and cashmere output, roughly 80% of the cashmere is exported to foreign markets after only minimal (primary) processing. As a result, domestic cashmere processing operations are not running at full capacity and fail to generate significant value-added within the country (Dashdolgor B., 2021).

As of 2023, Mongolia produced 8,887 tons of washed cashmere (Mongolian Agricultural Exchange, 2024). Of this amount, 6,651 tons were washed, and 4,905 tons were exported, indicating that over 75% of the total raw cashmere produced was exported after primary processing. Approximately 80% of all washed cashmere is exported to China.

Under the Government's "Vision–2050" and "New Recovery Policy," as well as Mongolia's long- and medium-term development policies, work is being conducted to:

- Develop processing industries, especially those handling animal-derived raw materials, in an environmentally friendly manner;
- Increase production and export of value-added products;
- Establish favorable conditions for production.

The government aims to increase the full processing of cashmere from 20% to 40%, raise manufacturing output from MNT1.5 trillion to MNT2.3 trillion, boost exports from USD398 million to USD690 million, and generate over 3,000 new job opportunities.

Methodology

TABLE 6

DATA COLLECTION STAGE

No.	Research Stage	Research Methods
1	Data Collection Stage	**Sampling Survey** • Sample and organizing the sample **Sociological Research** • Questionnaire • Discussion
2	Data Processing Stage	**Statistical Method** • Relative and average measures, time-series (dynamic series) analysis, grouping, indices, correlation, regression **Graphical Representation** • Growth, structural relationships, sequential analysis
3	Conclusion Stage	**Cognitive (Epistemological) Methods** • Abstraction, analysis, synthesis, induction, deduction, logic

The first stage of the sampling process, in which the objects of study are selected, relies on four criteria:

- Mongolia's **regional development** concept;
- Number of **herder households;**
- Total **number of livestock;**
- **Goats** in particular

Three aimags (**Bayankhongor**, **Khuvsgul**, and **Sukhbaatar)** were selected based on these four criteria.

The second stage selected soums within each aimag using the following four criteria:

- Number of **herder households;**
- Total **number of livestock;**
- **Breed of goats;**
- Distance from **markets** (degree of remoteness).

Four hundred goat herders were selected from Baatsagaan, Buutsagaan soums from Bayankhongor aimag, Bayandelger, Tuvshinshiree soums from Sukhbaatar aimag, Tumurbulag, and Ikh-Uul soums from Khuvsgul aimag.

Sociological Research Method

The **questionnaire** method is a sociological research technique that enables the collection of data from a large number of respondents, allowing researchers to gain insights into herders' perceptions of economic and social phenomena.

Surveys (including interviews) were designed with 10 questions on goat breeding (breed, lineage, cashmere yield), cashmere supply, product quality, and marketing channels.

Data were collected through **face-to-face interviews** with preprepared questionnaires involving herders, cooperatives, local traders (collectors), and local authorities. Responses were recorded and later processed using the dedicated software **SPSS**.

Discussion Method

Two rounds of discussions were organized on the current state of the goat cashmere supply chain and ways to improve it.

- **Public discussions were organized twice,** with participation from companies producing goat cashmere products, professional associations, and other interested parties.
- **Target group discussions** occurred twice with herders, cooperatives, local traders, and local authorities.

Graphical Representation Method

A wide variety of graphs are used in economic analyses. This study used **representational** and **analytical** graphs.

- **Representational graphs** display the economic phenomena's magnitude, structure, development, and movement.
- **Analytical graphs** explore the participants' relationships, development, and movements.

Common basic graph types were used, such as diagrams, bar charts, line graphs, and pie charts.

Strengths, Weaknesses, Opportunities, and Threats Analysis

Strengths, weaknesses, opportunities, and threats **(SWOT) analysis** is a tool used for studying external and internal possibilities and conditions related to the operations of a sector, enterprise, organization, or economy.

Table 7 presents the **key principles** for conducting a SWOT analysis.

TABLE 7

KEY PRINCIPLES FOR SWOT ANALYSIS

Internal Environment	External Environment
Strengths: Identify positive internal aspects or factors that positively influence outcomes.	**Opportunities:** Identify positive external factors that affect internal performance or outcomes as well as any external resources or advantages.
Weaknesses: Identify negative internal aspects or factors that adversely influence outcomes.	**Threats:** Identify negative external factors (along with potential barriers) affecting internal performance or outcomes.

Strengths, Weaknesses, Opportunities, and Threats Analysis of the Supply Chain

Table 8 presents the SWOT analysis of the supply chain based on the research results.

TABLE 8

SWOT ANALYSIS RESULTS

Strengths	Threats
Cashmere is a rare and valuable raw material, which contributes to its strong demand in the market. There are few producers of raw cashmere in the world. Mongolian goats adapt to natural and climatic conditions, and the cashmere quality is soft with excellent heat retention properties. There are knitting factories for the production of semi-finished and finished cashmere products. International demand for washed cashmere is relatively stable in line with China's domestic consumption growth.	With an increase in the number of goat herds, pasture carrying capacity may be exceeded, leading to degradation of grazing lands. Combined with climate-related challenges such as drought, this can result in a decline in goat populations and a subsequent reduction in the supply of raw cashmere. As the diameter of cashmere increases, the final product's production cost will also increase. Refineries cannot compete with Chinese traders in the competition for raw materials. The textile industry cannot compete with Chinese products in terms of price and quality.
Opportunities	**Weakness**
Improving the breed of goats, regulating herd size through tax policies, and increasing the profitability per goat. Enforcing quality standards in cashmere production by supporting herders' groups and cooperatives and introducing a system of differentiated prices and incentives based on quality. The government will support primary processing in the Sum region Provision of low-interest, long-term loans to manufacturing industries. Provision of tax, sales, customs, and other related concessions to processing industries. Ban the export of raw and washed cashmere and promote the production of finished products. Support activities aimed at increasing the Mongolian cashmere brand. It is relatively easy to create a sales channel through e-commerce.	In recent years, the diameter of cashmere fibers, the most important indicator of quality, has been increasing. The quality of cashmere deteriorates as the number of goat herds increases. Goat cashmere is distinguished only by color and not quality. Due to the lack of working capital, processing plants cannot fully collect the necessary raw materials. The supply chain and infrastructure for cashmere processing are poorly developed. Exports of raw and washed cashmere are not declining. Insufficient human resources and low production capacity utilization in the processing industry.

The evaluation is considered appropriate if the evaluation consistency ratio (CR) is CR < 0.1:

$$CR = CI: RI.$$

CI = appropriateness index

RI = randomness index of repeated experiments

The effects of internal and external factors on each livestock sector were calculated using the SWOT-analytic hierarchy process analysis method, and the evaluation CR was also determined, The results obtained are presented in Table 9.

TABLE 9

EFFECTS OF EXTERNAL AND INTERNAL FACTORS

Internal factors	
Strengths	**Weaknesses**
Cashmere exhibits strong market competitiveness	Declining Cashmere quality
Goats are able to adapt to climatic conditions	Low drought resistance
External factors	
High demand for cashmere in China	Negative impacts on ecology
Strong international reputation of Mongolian cashmere	Low demand for meat

Internal Factors Assessment Matrix								
№	1	2	3	4	PV	%		
1	1	1	0.3	0.3	0.13	12.92	Λ max	4.16
2	1	1	1	0.3	0.18	17.92	CI	0.05
3	3	1	1	1	0.30	30.42	CR	0.06
4	3	3	1	1	0.390	38.75		

External Factors Assessment Matrix								
№	1	2	3	4	PV	%		
1	1	1	0.3	3	0.23	22.81	Λ max	4.15
2	1	1	1	3	0.29	29.06	CI	0.05
3	3	1	1	3	0.38	38.44	CR	0.06
4	0.3	0.3	0.3	1	0.10	9.69		

The Current State of Productivity Gainsharing in the Goat Cashmere Sector

Stakeholders in Mongolia's Cashmere Supply Chain

The primary participants in Mongolia's cashmere supply chain include raw cashmere suppliers (herders), cooperatives and traders (intermediaries), and primary and deep-processing factories. Additional supporting participants include financial institutions, training and research organizations, industry/professional associations, and government agencies (Bakei A., 2014).

Stakeholders at Stage one of the Supply Chain: Herders

As of 2023, Mongolia had a workforce of around 1.2 million, of which 24.16% (293,757) worked in the agricultural sector (Table 10).

TABLE 10

NUMBER OF WORKFORCE

	2019	2020	2021	2022	2023
Total	1,146,161	1,162,912	1,125,593	1,180,474	1,215,835
Number of Agricultural employees	290,160	276,455	291,678	293,974	293,757
Percentage	**25.32**	**23.77**	**25.91**	**24.90**	**24.16**

Source: Ministry of Labor and Social Defense, 2023

The average monthly income of herders is USD439.1 (Policy Research Center, 2012). Of this, agricultural production constitutes 61.7%, pensions and allowances account for 21.5%, wages represent 8.3%, nonagricultural production and services account for 7.9%, and other sources make up 0.6 % of the total income (Figure 18).

FIGURE 18

AVERAGE MONTHLY INCOME FOR HERDERS (%)

Source: B.Baasansukh, Supply chain for Agricultural Products, 2024.

When examining the structure of the average monthly income of herders based on the number of animals owned, the proportion of income from wages, pensions, and allowances decreases as the number of animals increases (Table 11).

TABLE 11

AGRICULTURAL INCOME (IN TERMS OF THE NUMBER OF LIVESTOCK)

	Total	up to 200	201–500	501–1000	1001–1500	1501–2000	2001 and above
Average	438.93	246.76	329.72	394.48	554.69	696.55	1090.83
Agricultural income	275.65	100.38	176.55	241.51	386.65	515.67	785.20

Source: Ministry of Labor and Social Defense, 2023.

However, as the number of animals increases, the share of income from agricultural and nonagricultural production services also increases.

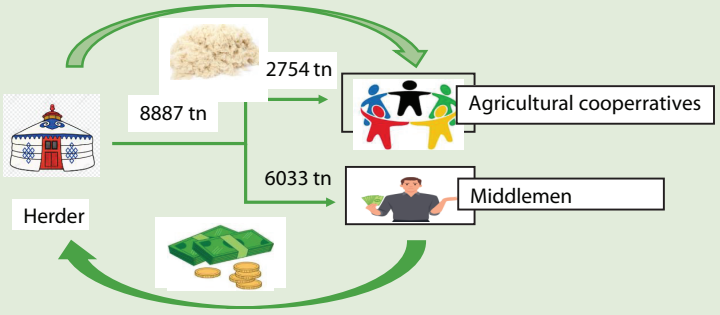
Agricultural Products Supply Chain Herders: Intermediaries

Herders supply approximately 8.9 thousand tons of goat cashmere to the Mongolian market. Agricultural cooperatives supply 2,754.6 tons of processed cashmere and 6,033 tons of raw cashmere through intermediaries (Figure 19).

Although gainsharing initiatives can improve productivity and create fairer economic outcomes, several challenges hinder widespread adoption. These barriers are often rooted in cultural attitudes, economic limitations, and systemic inefficiencies that make implementation difficult. Understanding these challenges is essential for designing effective solutions that encourage gainsharing uptake.

FIGURE 19

AGRICULTURAL PRODUCTS SUPPLY CHAIN (HERDERS–MIDDLEMEN)



Source: B.Baasansukh, Supply chain for Agricultural Products, 2024.

Cultural Challenges

- **Limited Awareness and Understanding:** Gainsharing is a relatively new concept, with many stakeholders lacking knowledge about its benefits and mechanisms.
- **Individualistic vs. Collective Work Cultures:** In some cases, employees and employers may favor individual performance incentives over collective gainsharing models, making adoption difficult.

Economic Challenges

- **Market Volatility:** Fluctuations in commodity prices, input costs, and global demand can make gainsharing unpredictable and challenging to sustain.
- **Short-Term Profit Focus:** Some businesses prioritize immediate financial returns over long-term productivity-sharing strategies, discouraging investment in gainsharing models.

Systemic Challenges

- **Weak Legal and Policy Frameworks:** Inconsistent or underdeveloped regulations can create uncertainty regarding how gainsharing should be structured and enforced.
- **Fragmented Supply Chains:** Poor infrastructure and weak market linkages make it difficult for agribusiness and cooperatives to sustain productivity improvements and ensure the equitable distribution of gains.

Addressing these challenges requires coordinated efforts from policymakers, businesses, cooperatives, and educational institutions. Raising awareness, providing financial incentives, strengthening legal frameworks, and fostering a culture of collaboration can help overcome these obstacles and promote the successful adoption of gainsharing initiatives.

Assessment of Best Practices

Best practices in cashmere production involve a combination of adherence to quality standards, sustainable sourcing, and ethical treatment of animals. Key aspects include fiber length and fineness, softness, tactile properties (hand feel), minimal pilling and shedding, and the fabric's overall durability. Sustainable practices such as responsible herding, effective land management, and decent labor conditions are crucial for long-term viability.

The demand for cashmere products is growing in the global market. Italy, the United Kingdom, and China are leading suppliers of cashmere products. The global cashmere clothing market is growing by 3%–5% annually and is predicted to reach USD2.7 billion by the end of 2025. Prognoses show that this growth will steadily increase each year. However, market leaders face several challenges. In 2024, Mongolia, the world's second-largest supplier of cashmere raw materials, experienced a decline in the number of goats by 2.5 million due to a natural and climatic disaster, disrupting the stable supply of cashmere and introducing unforeseen challenges in the global cashmere supply chain.

Since 2024, the Government of Mongolia has been developing and implementing the "New Cooperative-Professional Herder" and "White Gold" programs. As a result, herders established cooperatives to supply goat cashmere directly to processing plants without selling through intermediaries.

In the same year, 60-month loans were extended to herders to voluntarily collaborate on the basis of trust, establish cooperatives, purchase good-quality breeding stock, produce cashmere, conduct primary processing, establish small and medium-sized enterprises, build warehouses for storing raw materials, improve livestock breeds, and provide veterinary services at an annual interest rate of 6% (the average annual interest rate for bank loans in Mongolia is 18%).

The following benefits are expected from this loan:

- By improving the breed of goats, the amount of cashmere obtained from each goat will increase.
- Improvement in goat cashmere fineness and overall fiber quality.
- By improving cashmere quality, the price of raw cashmere will increase, thereby increasing the income of herders.
- The number of intermediaries will decrease, and the profitability of herders and processing plants will increase.
- By selling through cooperatives, processing plants can obtain a stable supply chain of cashmere.
- A reliable continuous supply system will be established. Production waste as well as the cost of production will be reduced.
- The supply of washed and combed cashmere for the world market will increase.

The "Vision-2050," Mongolia's long-term development policy, and the "New Revival Policy," approved by the Mongolian Parliament, aim to strengthen the independence and self-reliance of the Mongolian economy, support the production of value-added final products, and increase exports. Through these policies, cashmere processing was gradually increased to support the production of final products. These policies also supported the approval and enforcement of technical regulations governing the production and export of cashmere that meets established quality standards beyond the stage of basic hair separation. Moreover, they resolved the issue of exempting industrial equipment, used for processing beyond hair separation, from value-added tax and customs duties.

The global cashmere market is worth USD2.7 billion. Mongolia currently accounts for USD404 million and has set a target of reaching USD1 billion (General Department of Customs, 2024).

The Mongolian cashmere market aims to wash and comb 100% of raw cashmere and produce 5,000 tons of pure cashmere. Based on this goal, an added value of USD250 million will be created through the intermediate processes of washing and combing (Figure 20–23).

FIGURE 20

SUPPLY CHAIN/EXPORT OF WASHED CASHMERE (TONS)

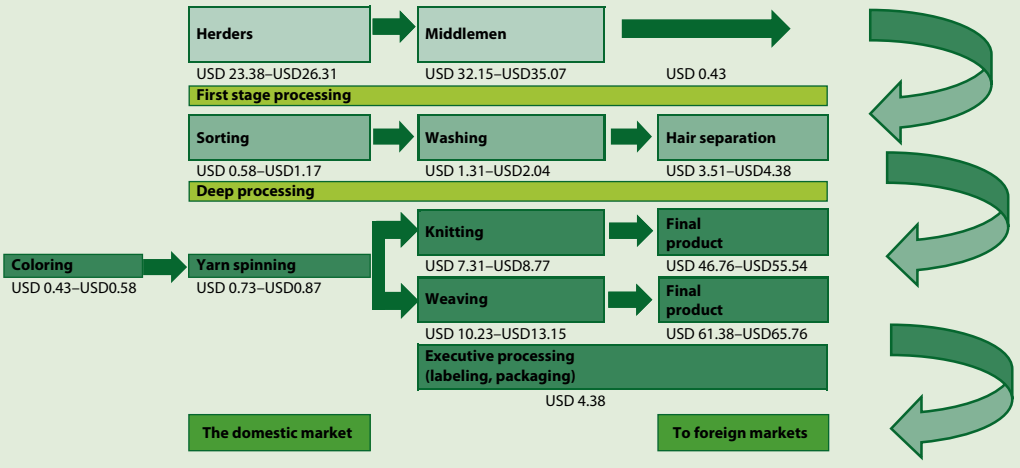


FIGURE 21

SUPPLY CHAIN/EXPORT OF COMBED CASHMERE (TONS)

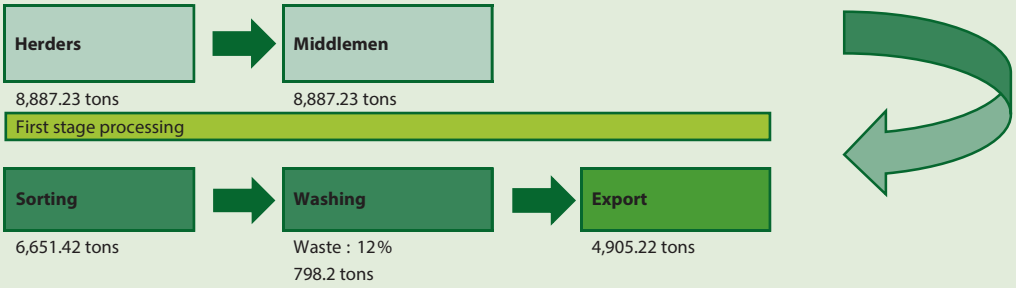


FIGURE 22

SUPPLY CHAIN/EXPORT OF WASHED CASHMERE (TONS)

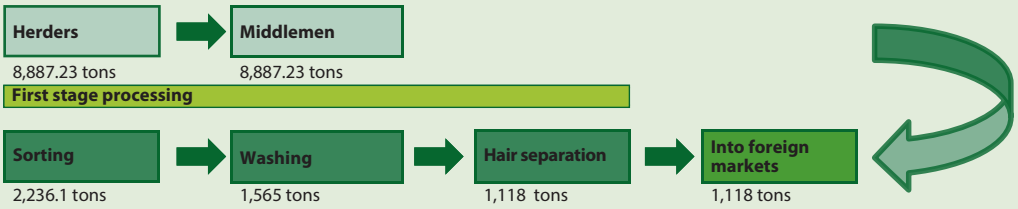
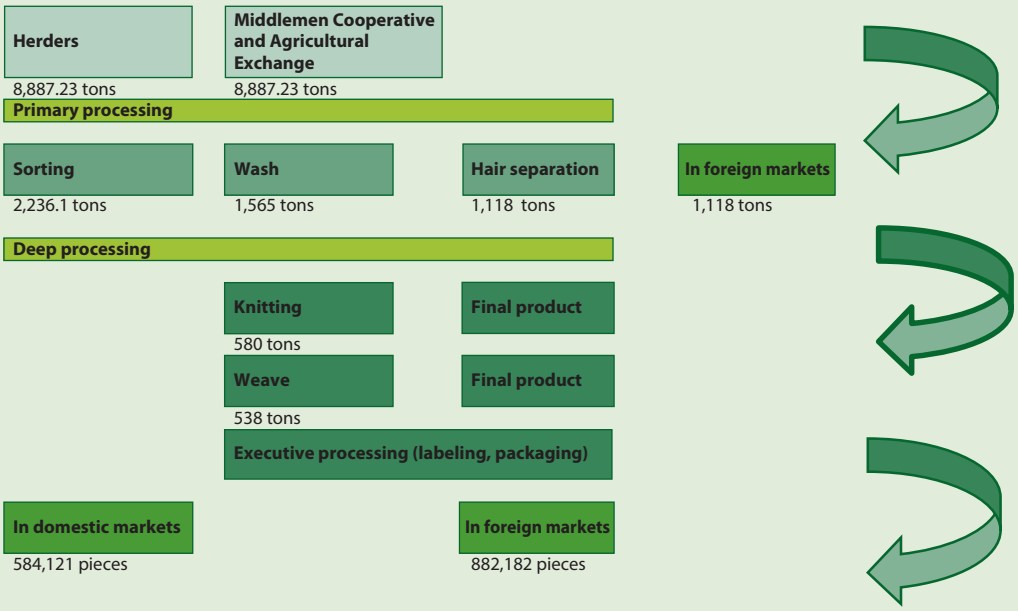


FIGURE 23

SUPPLY CHAIN (TONS)



Recommendations

Based on this study's findings, the following recommendations are proposed.

Shift Focus from Livestock Quantity to Quality: Pastoral households' income is directly linked to livestock numbers, which are highly vulnerable to natural and climatic risks. For instance, due to extreme weather events such as droughts and *zud* (severe winter conditions), Mongolia's livestock population dropped from 71.1 million in 2022 to 64.6 million in 2023 (a decline of 6.5 million), dropping further to 57.6 million in 2024 (loss of 13.5 million compared with 2022). Increasing livestock numbers to offset income losses creates a vicious cycle: higher supply reduces raw material prices (e.g., cashmere), further lowering household income (UNDP, 2019).

Instead of expanding herd sizes, herders should prioritize **improving cashmere quality** and adopting **climate-resilient, high-yield livestock practices** to enhance profitability per animal. Overgrazing (3–5 times above carrying capacity in some regions) accelerates desertification, degrading 70% of Mongolia's pastureland. Therefore, sustainable practices are critical for balancing ecology and livelihoods.

Promote Pastoral Cooperatives to Strengthen Market Linkages: Mongolia has over 250,000 pastoral households, the majority of which are small-scale and fragmented (Bakei A., 2016). These households must **organize into cooperatives** to achieve economies of scale, reduce intermediation costs, and negotiate better prices. Cooperatives can:

- Establish direct supply chains with processors, bypassing intermediaries;
- Invest in collective infrastructure (e.g., storage, transportation, and primary processing facilities);
- Improve cashmere quality control and standardization;
- Share market information and climate adaptation strategies.

Government support is essential for building trust, providing cooperative management training, and creating legal frameworks for fair collaboration.

Reform Legal and Policy Frameworks to Support Value Chain Integration: Revise the *Law on Agricultural Product and Raw Material Exchanges* to:

- Establish regional commodity exchanges for cashmere and other livestock products;
- Mandate quality-based pricing to incentivize premium production;
- Introduce tax incentives, low-interest loans, and subsidies for herders and processors to adopt sustainable practices;
- Develop a certification system for high-quality cashmere to enhance global competitiveness.

Enhance Domestic Processing Capacity and Export Value: Currently, only **20% of raw cashmere** is processed domestically (Bakei A., 2020). Mongolia could increase this to **40%** by optimizing supply chains and cooperatives, raising export revenues from 398 million to 690 million annually. The key steps are as follows.

- Optimize the utilization of existing washing and scouring facilities (already operating at 100% capacity).
- Invest in advanced processing technologies (e.g., spinning, weaving) to move up the value chain.
- Target niche markets for premium, sustainably sourced cashmere.

With global demand for cashmere valued at approximately USD4.7 billion, Mongolia could capture **50% of the market** by ensuring quality and sustainability.

Address Pastureland Degradation Through Climate-Smart Policies: Mongolia's 112 million hectares of pastureland (97% of agricultural land) are under severe stress. Recommendations include the following.

- Enforce strict carrying capacity limits and rotational grazing plans.
- Restore degraded pastures through reseeding and community-led conservation.
- Promote drought-resistant fodder and herd diversification (e.g., reducing goat dominance to mitigate overgrazing and slow desertification).

Strengthen Institutional and Human Capacity:

- Train herders in cooperative management, financial literacy, and climate adaptation.
- Governments should build capacity to monitor pasture health and enforce regulations.
- Foster partnerships between herders, processors, and international buyers to align production with market demands.

Leverage Mongolia's Unique Advantages: Mongolia's nomadic pastoralism, vast territories, and low population density serve as distinct strengths. However, poor infrastructure, harsh climatic conditions, and market volatility remain challenges. By focusing on **quality over quantity**, **cooperative models**, and **policy innovation**, Mongolia can transform its livestock sector into a sustainable, high-value industry.

Implementing these recommendations requires coordinated efforts from herders, cooperatives, processors, and the government. By reducing reliance on raw material exports, investing in processing, and restoring ecological balance, Mongolia can secure long-term prosperity for its pastoral communities while positioning itself as a global leader in sustainable cashmere production.

Conclusion

Mongolia's unique geographical and demographic landscape—spanning 1.5 million km² with a population of 3.5 million, half concentrated in Ulaanbaatar—poses significant challenges for its pastoral economy. Rural areas, where population density averages one person per km², face fragmented infrastructure, limited market access, and isolation from centralized economic hubs. With over 250,000 herder households managing 22.9 million goats (ranking 11th globally by herd size), Mongolia's cashmere sector remains a critical source of livelihood. However, systemic issues—overreliance on raw exports, climate vulnerabilities, and market inefficiencies—threaten ecological sustainability and long-term economic prosperity.

Key Challenges

Fragmented Production and Market Disconnect: Herder households, operating on small scales, place emphasis on competing rather than collaborating, driving down cashmere prices. Middlemen dominate the supply chain, capturing the majority of profits, whereas herders and processors struggle with low margins. Seasonal income (concentrated in March–May) forces herders to prioritize quantity over quality, exacerbating overgrazing. The number of goat herds doubled from 13.8 million (2010) to 27.5 million (2022); however, unregulated breeding resulted in the degradation of cashmere quality. Average yield per goat (361g) masks thinning fiber diameters due to poor genetic selection and an aging herd structure.

Climate and Ecological Pressures: Mongolia's continental climate, marked by harsh winters (*zud*) and droughts, contributes to fluctuating herd sizes. In 2023–24, extreme weather conditions reduced

the size of goat herds by 3 million, decreasing raw cashmere supply from 11,800 to 8,900 tons and significantly impacting herder incomes. Moreover, overgrazing has degraded approximately 70% of Mongolia's pastureland, with herd sizes exceeding the carrying capacity by 3–5 times in certain regions. This accelerates desertification, threatening the very ecosystem that herders depend on.

Value Chain Inequities: Processors, burdened by raw material costs (70% of expenses) and high-interest loans, lack the capital to compete with Chinese buyers. The 2011 *Law on Agricultural Product Exchanges* remains underutilized, failing to create transparent pricing or quality-based markets. Cashmere prices fluctuate regionally based on supply timing, not quality, disincentivizing herders from improving fiber standards.

Government Initiatives and Progress: Recent policies signal a shift toward sustainable value-added production:

- The 2022 parliamentary resolution prioritizes upgrading processing standards, enforcing quality controls and expanding exports of finished goods.
- The **"White Gold" National Program (2024–28)** allocates MNT788.9 billion in loans (300 billion for working capital, 488.9 billion for investments) to boost domestic processing. Subsidized interest rates and grants aim to reduce reliance on foreign intermediaries.
- By 2025, Mongolia plans to process **40% of raw cashmere domestically** (up from 20%), targeting niche markets for premium, sustainably sourced products.

Path Forward

To transform challenges into opportunities, Mongolia must achieve the following.

Strengthen Herder Cooperatives: Consolidating fragmented households into cooperatives would improve bargaining power, reduce middleman's dependence, and enable collective investments in quality breeding, pasture rotation, and climate adaptation.

Enforce Sustainability Metrics: Link subsidies and loans to compliance with carrying capacity limits, pasture restoration, and certified breeding programs. Moreover, herd diversification should be promoted (e.g., reducing goat dominance) to curb desertification.

Build a Quality-Driven Market: Implement the 2022 resolution's quality standards rigorously. Establish regional commodity exchanges to enable transparent pricing of cashmere by grade and reward herders for producing finer fibers.

Leverage "White Gold" Financing: Channel state-backed loans into modernizing processing infrastructure, including spinning, weaving, and dyeing, to capture higher margins. Moreover, it is essential to foster partnerships with international brands to market Mongolia's unique, eco-conscious cashmere.

Improve Rural Infrastructure: Invest in roads, digital connectivity, and storage facilities to integrate herders into supply chains. This would shorten procurement windows, reduce spoilage, and empower real-time market participation.

Outlook

Mongolia stands at a pivotal juncture. It can position itself as a global leader in sustainable cashmere production by prioritizing quality over quantity, fostering cooperatives, and enforcing ecological safeguards. If implemented effectively, the "White Gold" program could elevate domestic processing, shield herders from price volatility, and add value to 100% of raw exports. Success hinges on aligning policies with on-ground realities, including balancing economic growth with pasture restoration and equitable value distribution. With coordinated efforts among herders, processors, and policymakers, Mongolia can secure a resilient future for its pastoral communities and ecosystems.

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ASSESSING BEST PRACTICES IN PRODUCTIVITY GAINSHARING IN THE BEEKEEPING INDUSTRY IN THE CHITWAN DISTRICT OF NEPAL: A VALUE CHAIN ANALYSIS

Executive Summary

Beekeeping in Nepal has been practiced since ancient times, producing honey and related products that contribute to the livelihoods of rural and marginalized farmers. Although the commercialization of beekeeping has been going on for three decades, this enterprise has made a remarkable contribution to the Nepalese economy. To assess best practices in productivity gainsharing in beekeeping, a survey was conducted with beekeepers from the Chitwan District, renowned for commercial beekeeping, especially *Apis mellifera.* A total of 85 respondents were selected, including 65 beekeepers, 5 local traders, 5 wholesalers, 5 retailers, and 10 consumers. A semi-structured pretested questionnaire was administered to assess productivity and profitability by collecting information on honey production volume, the number of beehives, total costs incurred, and revenue generated from beekeeping. Similarly, the marketing channel and value chain actors were identified, and the price spread and market margin were calculated for all marketing channels. The study revealed that most beekeepers harvested honey four times a year on average, yielding around 27 kg per hive yearly. Fixed costs accounted for approximately 25% of the total cost of honey production, whereas 75% comprised variable costs. Among the variable costs, supplementary feeding cost contributed 25%, followed by transportation (20%), labor (14%), and packaging/containers, which accounted for the lowest share (4%). The beekeeping enterprise seems to be highly profitable, with a benefit–cost ratio of 1.95. We found that the producer share accounted for approximately 85%, with a maximum price spread of NPR200. Regarding value addition, beekeepers who produce honey perform other activities such as processing, packaging, and retailing. Thus, to optimize gainsharing, the study recommends strengthening cooperative networks, improving market access, adopting innovative beekeeping techniques, and implementing policies that support fair pricing and sustainable production. Strengthening stakeholder collaboration across the value chain can enhance economic benefits for beekeepers while promoting sustainable honey production in Nepal.

Introduction

Background and Rationale

Beekeeping is an ancient agricultural activity in Nepal where honey bee colonies are managed under favorable environmental and agroecological conditions for a variety of uses, including pollinating crops and producing new colonies, as well as extracting honey, beeswax, pollen, propolis, and royal jelly (Devkota, 2020). Beekeeping holds significant potential for job creation, as it is a type of farming that benefits landless and marginalized communities, offering economic, nutritional, and ecological advantages (Devkota, 2020; Kumar et al., 2018).

Nepal's diverse climatic conditions and rich floral diversity make it a prime location for large-scale beekeeping. The country's wealth of honeybee species and abundant forage resources provide significant opportunities for the expansion of beekeeping (Devkota, 2020). Honeybees are a crucial part of our ecosystem, which is key in maintaining food security and nutrition (van der Sluijs & Vaage, 2016). In Nepal,

five species of honeybees—*Apis laboriosa*, *Apis dorsata*, *Apis florea*, *Apis cerana,* and *Apis mellifera*—are found across diverse landscapes, ranging from the Terai to the Himalayan region (Thapa, Aryal & Jung, 2018). However, the commercialization of beekeeping began in 1989 with *Apis cerena*. Later, in 1992, *Apis mellifera* was introduced to increase honey production. In Nepal, there were 248,995 beehives producing 5,168 metric tons of honey in the fiscal year 2021–22, which doubled in a decade (MoALD, 2023). Although honey contributes only a small portion (0.17%) to the agricultural GDP, beekeeping has been recognized as a valuable agricultural activity for rural and landless populations, providing a source for income generation. It was also prioritized in key national policies, including the Agricultural Perspective Plan, Nepal's 10th five-year plan, and the Agriculture Development Strategy (MoALD, 2023). Honeybees are valued for their products, such as honey, royal jelly, propolis, beeswax, venom, and pollen, as well as their contributions to pollination and ecotourism (Singh & Machathoibi, 2021). These highly nutritious products offer numerous health benefits, making them suitable for effective marketing through various channels with value addition (Bhatta et al., 2020). Beekeeping supplies a steady income to households through honey production and serves as an additional revenue stream for producers by enhancing crop pollination, thereby boosting yield and quality (Devkota, 2020). A linkage between beekeeping, efficient marketing channels, and value addition is crucial, as it has the potential to increase market demand and expand business opportunities within the honey sector (Bhandari & Kattel, 2020).

A value chain refers to the full range of activities required to take a product or service from its initial concept through various production stages (including physical transformation and the input of various producer services), its delivery to end consumers, and its final disposal after use (Kaplinsky & Morris, 2001). The agriculture value chain refers to the production, processing, and marketing processes, where individual and collective actors collaborate in coordinated activities to add value to a specific product or service from its initial production stage until it reaches the end consumer (Nang'ole et al., 2011). Developing the value chain in beekeeping involves creating linkages between production techniques and improved access to the market for honey and other bee products. The various actors in the honey value chain perform value-adding activities crucial for identifying opportunities and constraints, whereas comprehending the flow and allocation of incentives is vital for effective risk management until the honey and bee products reach the final consumer (FAOSTAT, 2015). In general, the primary actors in the honey value chain include input suppliers, producers, traders, processors, and final consumers. Therefore, implementing a robust value chain can significantly upgrade value addition, ensuring higher quality standards and better market prices for Nepalese honey (Bhandari & Kattel, 2020). The factors influencing honey subsector performance, access to markets, and the requirements of end markets can be identified through value chain analysis (Porter, 1985). The low yearly income generated from honey production can be attributed to a lack of good beekeeping practices, insufficient value-addition activities, and cooperation among market chain actors (Bhandari & Kattel, 2020). Therefore, improving the honey value chain will promote bee products at every stage of production, collection, processing, and distribution, by emphasizing interventions that increase participants' ability at each step of the marketing process (Schouten, 2020). Thus, this study examines three aspects of the value chain. First, we investigate the governance structure and mapping of the honey value chain along with the associated cost of production and other functions. Second, we explore the distribution and value added by the various actors involved in the honey value chain. Finally, we identify and rank the problems beekeepers face.

Research Objectives

Overall, this study aims to a) estimate the profitability of honey production, b) map the value chain and assess best practices in productivity gainsharing within the beekeeping industry, and c) identify problems in the beekeeping industry and honey marketing.

Scope and Significance

Nepal has a diverse range of bee floral resources, offering significant potential for the production of high-value honey. *Apis mellifera* and *Apis cerana* are two honey species commercially reared for honey and other bee products derived from various floral sources. These products enjoy high demand in local, national, and international markets, often yielding higher profits. Therefore, the study examines the challenges and opportunities related to best practices in productivity gainsharing within the beekeeping production system by identifying key actors, activities, and marketing channels in the honey value chain. The findings of the study aim to serve as a valuable reference for researchers, producers, and consumers alike.

Literature Review

Productivity Gainsharing Policies in Nepal

The world urgently needs to establish sustainable environments, improve the economic prospects within communities, and offer safe and robust food systems to meet the demands of the growing population. The United Nations (UN) has set SDGs to eradicate poverty and hunger by 2030. In this context, productivity gainsharing can increase agricultural productivity by empowering producers, motivating supply chain actors, providing agricultural employees with a greater sense of ownership, and increasing company profits through increased productivity and improved value chain efficiency (FAO, 2020). The entire spectrum of actors and their interconnected value-adding activities involved in the production, collection, processing, distribution, consumption, and disposal of agriculturally derived food products are referred to as agrifood systems (UN, 2020).

Nepal's productivity movements were marked by its membership in the Asian Productivity Organization (APO) in 1961. Nepal's increasing involvement, dedication, and membership in many regional and international community forums, such as the WTO, have created opportunities and challenges for new Nepalese businesses in the international market. Significant changes were made to labor, trade, industrial, and foreign investment sectors (Paudyal, 2013).

The agrifood sector is a critical component of Nepal's economy, which contributed approximately 24% to the country's GDP in 2023 (MoF, 2024). Despite its significance, the sector faces numerous challenges that hinder its growth and productivity. While around 66% of Nepal's population remains engaged in agriculture and related activities (FAO, 2024), this share has sharply declined since the early 2000s. The shift toward service-based employment, driven by remittance-fueled investments, has further marginalized the agricultural workforce (NEF, 2024). This transformation, coupled with widespread subsistence farming, has contributed to low agricultural productivity, insufficient output, and growing food insecurity.

Nepal's agricultural sector continues to lag behind global advancements in technology and innovation, with low productivity and insufficient output exacerbating poverty, hunger, and food insecurity (Adhikari et al., 2023). The country's dependence on imports of agricultural products and inputs further weakens food security and sovereignty (Adhikari et al., 2023). A key factor in this situation is the insufficient supply of essential agricultural inputs such as chemical fertilizers, modern tools, machinery, improved seeds, and agricultural finance. Nepal lacks the domestic production of chemical fertilizers, relying entirely on imports to meet its demand for fertilizers (Adhikari et al., 2023). In Nepal, implementing productivity gainsharing legislation could aid in resolving economic issues, raising worker productivity, and promoting expansion in important industries. It supports larger national objectives to enhance social and economic outcomes. Nonetheless, several issues such as poor policy execution, ignorance, and insufficient information on productivity improvements remain major issues. By addressing these problems, Nepal can use gainsharing to advance economic development and fair wealth distribution.

Beekeeping in Nepal

Beekeeping has long been a tradition in Nepal and serves as a profitable and highly valued source of income for rural and marginalized communities (Devkota, 2020). Of the nine species of honeybees, five are found in Nepal: *Apis laboriosa* S., *Apis dorsata* F., *Apis florae* F., *Apis cerana* F., and the established exotic species *Apis mellifera* L. (Devkota, 2020). These bees range from the northern Himalayan region to the southern subtropical Terai region. The majority of honey produced in Nepal is derived from various flowering plants, such as butter tree, coral jasmine, chestnut, buckwheat, and mustard (SAWTEE, 2015). In the 1980s, the Beekeeping Development Section was established under the Nepal Agricultural Research Council to advance and promote apiculture. This section was tasked with researching various aspects of applied entomology, including industrial entomology (Thapa, 2006). Scientific beekeeping in Nepal began in 1989 with the native bee *Apis cerana*. However, the commercialization of modern beekeeping accelerated with the introduction of the high-yielding exotic honeybee *Apis mellifera* (European honeybee) in 1992 (Devkota & Thapa, 2006). Beekeping with *Apis mellifera* has since been well established in the Terai regions of the country. However, its adoption in the hilly and mountainous regions remains limited due to several management challenges, including maintaining colony warmth, providing sugar supplements, and migrating colonies for forage. Traditional beekeeping with *Apis cerana* is the most common and widespread form of beekeeping in the rural areas of Nepal (Sirjana et al., 2020).

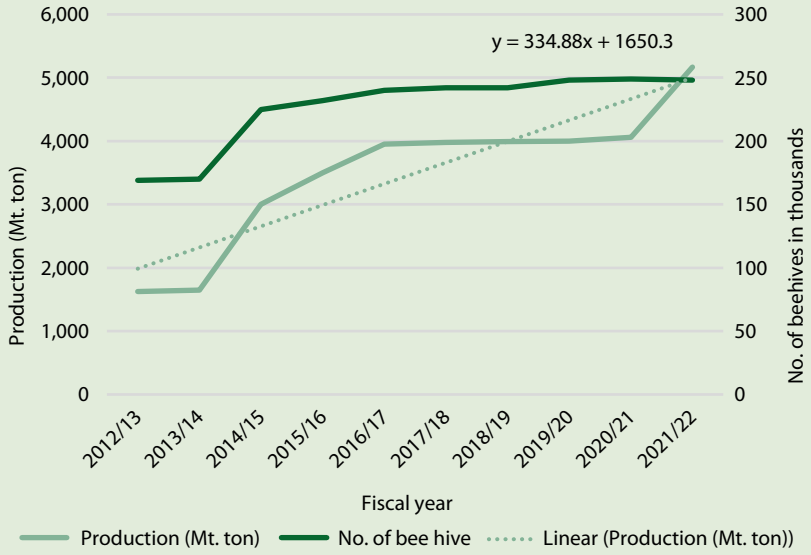
Nepal has a long history of domesticating its native species, *Apis cerana*, using traditional wooden log beehives or by incorporating hives into the walls of houses, a practice that has been passed down through generations. Nepalese honey is divided into five categories: plant-specific, honeybee-specific, location-specific, commercial honey, and honeydew honey. Honeybee diversity is abundant in all geographical areas of Nepal (i.e., Terai, mid-hills, and high hills), with the *Apis mellifera* being specifically reared in Terai and *Apis cerena* in the hilly regions (Bhattarai et al., 2021). Nepal can support up to one million bee colonies, yielding over 20,000 metric tons of honey yearly (BDC, 2023).

Honey Production in Nepal

In Nepal's beekeeping industry, the number of beehives increased from 156,000 in 2012 to 248,000 in 2022, employing 16,500 households (MoALD, 2023). Similarly, as the number of hives increased, honey production also increased over a 10-year period, as shown in Figure 1. Furthermore, the number of beehives increased sharply in 2015. After 2016, the growth in the number of beehives continued at a steady rate. Similarly, honey production increased significantly between 2014 and 2017, after which it remained relatively stable for approximately five years, before increasing again in 2022 (Figure 1).

FIGURE 1

TRENDS OF BEEKEEPING AND HONEY PRODUCTION FROM 2012/13 TO 2021/23 IN NEPAL



Source: MoALD (2023)

Research Methodology

Study Area

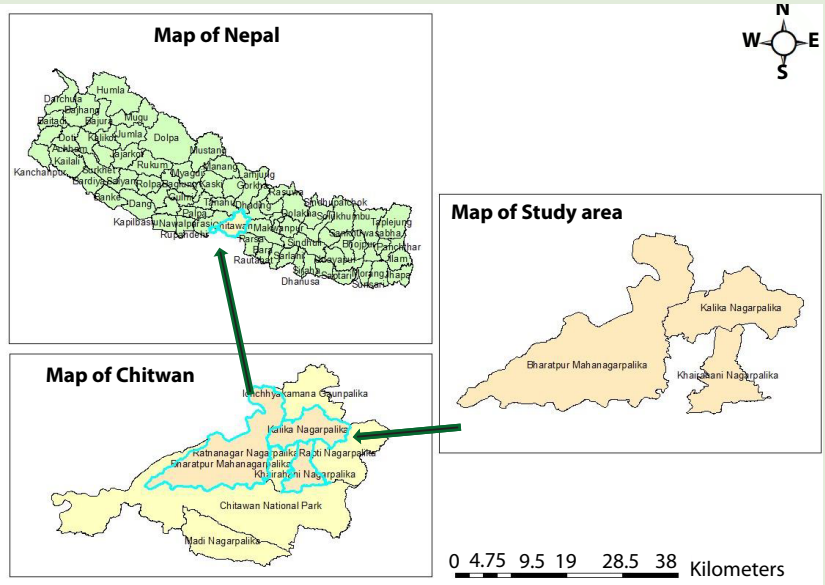
The study was conducted in Bharatpur metropolitan city, Kalika municipality, and Khaireni municipality of the Chitwan District, as shown in the *Map of Study Area* in Figure 2. The Chitwan District is located in the Bagmati Province of Nepal. The district is located between longitudes 83°54'45'' to 84°48'15''E and latitudes 27°21'45'' to 27°52' 30''N. Its elevation ranges from 244 to 1945 meters above sea level, encompassing the Siwalik region (86.5%), followed by the Mid-mountain region (12.7%), and the Terai region (0.8%). The district covers an area of 2,218 sq km, representing 1.5% of Nepal's total area. Chitwan District was purposively selected as it is responsible for producing around 15%–20% of Nepal's total honey production, making it one of the country's key honey-producing regions. The area's suitable climate, rich flora, and closeness to national parks create ideal conditions for honey production.

Population, Sampling Frame, and Sample Size

A list of producers involved in beekeeping was obtained from the Agriculture Knowledge Centre (AKC), Chitwan, and used as the sampling frame. Based on the list of beekeepers provided by AKC, 60 were selected

FIGURE 2

MAP SHOWING THE STUDY AREA



using simple random sampling. Furthermore, information was gathered on the value chain actors (five local traders, five wholesalers, and five retailers) who were selected using the snowball sampling technique, while data from 10 consumers were obtained through accidental sampling. Three institutions actively involved in beekeeping-related activities within the district were selected for key informant interviews (KII). The final sample comprised 85 respondents, including producers, market actors, and consumers.

Methods of Data Collection

Primary and secondary data were collected. The pretested interview schedule was administered to the sampled beekeepers for the collection of primary data. These data were supplemented by the information obtained through a participatory method, focus group discussion, and KII to understand marketing systems, channels, and margins.

Primary source of data

Primary data were collected using a pretested semi-structured questionnaire. The interview schedule was prepared to collect information on the existing production system and various production and marketing problems. Similarly, local traders, wholesalers, retailers, and some consumers were interviewed face-to-face to collect information on the marketing system, market price, product availability, and related problems. These findings were further supplemented by KII with personnel involved in beekeeping and marketing. Informants included representatives from the AKC, small- and medium-sized enterprises, Federation of Nepalese beekeepers, and local government officials of Chitwan District.

Secondary Data Source

Secondary data were collected from published and unpublished materials from different agricultural institutions, including books, journals, research articles, and annual reports from the Central Bureau of Statistics, Ministry of Agriculture and Livestock Development (MoALD), FAO, Ministry of Industry, Commerce and Supply, Trade and Export Promotion Centre, Agriculture Knowledge Centre, and Beekeeping Development Offices.

Interview Schedule Design

An interview schedule was prepared to collect primary information from respondents. Information regarding socioeconomic and demographic characteristics of the beekeeper's household, income

level, source of livelihood, production variables, production practices, productivity, market situation, consumer preference, and production and marketing challenges were included in the interview schedule.

Pretesting of Interview Schedule

Pretesting of the interview schedule was done among five beekeepers from the Kalika municipality (non-sampled household) in Chitwan District. After making the necessary amendments, the final interview schedule was prepared.

Field Survey

A household survey was conducted in the study area from August to October 2024. Various information related to production costs, marketing channels, the contribution of beekeeping to household income, and production and marketing challenges were collected from the survey. Traders and consumers were surveyed regarding the marketing and quality aspects of honey.

Methods and Techniques of Data Analysis

The information collected from the field survey was coded, tabulated, and analyzed using Microsoft Excel and SPSS (version 26.0). Descriptive and analytical methods were used to analyze the data.

The qualitative information collected during the field survey, such as the type of bee species, honey production system, production and marketing problems, dominant marketing channel, marketing intermediaries, etc., was analyzed qualitatively and reported.

Quantitative data, such as the socioeconomic and farm characteristics of the respondents, were analyzed using simple descriptive statistics. The quantitative variables, including the amount of honey produced, cost of inputs, price of honey, marketing cost, marketing margin, price spread, total revenue, and gross and net profit, were analyzed using analytical statistics.

Productivity Metrics and Indicators

Production Status of Honey

The average honey productivity in the study area was 26.88 kg/hive/year. The study reveals that the average honey yield of the sampled household was comparatively higher than the national average of 23 kg/hive/year (MoALD, 2023), indicating ample opportunity for beekeeping productivity.

Source of Information for Beekeeping

The major source of information on beekeepers was obtained through friends (58%). Over 23% of the respondents were engaged in this sector based on their own knowledge, whereas 10% obtained ideas and information through neighbors. Similarly, around 7% of the respondents received information from agriculture technicians or extension officers, whereas very few (2%) acquired information through cooperatives or farmer groups, as shown in Table 1.

TABLE 1

SOURCE OF INFORMATION ON BEEKEEPING IN THE STUDY AREA

Source	Frequency	Percentage
Neighbors	6	10
Friends	35	58.33
Own knowledge	14	23.33
Agriculture technician or extension officer	4	6.67
Cooperative or farmer group	1	1.67

Cost of Production Associated with Beekeeping

We found that the total fixed cost of equipment for beekeeping, comprising hive and hive equipment, was NPR1,258 per hive per year, contributing to around 25% of the total cost of beekeeping.

Similarly, we found that the variable cost contributed to around 75% of the total cost of beekeeping. Among the variable costs, supplementary feeding costs were the highest at NPR1,263 per hive, contributing approximately 25% of the total cost. Transportation costs for foraging/pasture management amounted to NPR980 (20%), labor costs were NPR691 (14%), comb and drugs accounted for NPR439 (9%), and repair and maintenance costs were NPR150 (3%). The study revealed that the total cost of production for beekeeping was NPR4,974, as shown in Table 2.

TABLE 2

COST OF PRODUCTION OF BEEKEEPING PER HIVE PER YEAR IN THE STUDY AREA

Particulars	Cost per hives	Percentage contribution
A. Fixed cost (NPR)		
Hive cost	612.00	12.30
Hive equipment cost	646.00	12.99
Total fixed cost	**1,258.00**	**25.29**
B. Variable cost (NPR)		
Labor	691.00	13.89
Supplementary feeding	1,263.00	25.39
Repair & maintenance	150.00	3.02
Packaging/Container	193.00	3.88
Transportation for foraging/pasture management	980.00	19.70
Drugs	227.00	4.56
Comb foundation	212.00	4.26
Total variable cost	3,716.00	74.71
Total cost (NPR)	4,974.00	100.00

Revenue from Beekeeping Activities

On average, a single beehive produced 26.88 kg of honey per hive per year, with approximately 7 kg produced per hive per harvest. Additionally, the average unit price of honey was NPR361. Based on the average production and unit price, beekeepers earned an average annual revenue of NPR9,713.63 per hive, as shown in Table 3.

TABLE 3

REVENUE FROM BEEKEEPING PER HIVE PER YEAR IN THE STUDY AREA

Particulars	Amount
Average honey per hive per year (kg)	26.88
Unit price of honey (NPR)	361.37
Average honey revenue per hive	9,713.63

Cost-benefit Analysis of Beekeeping Practices

Economic analysis of the economic metrics, including total variable cost, total cost, gross revenue, gross margin, net margin, and benefit–cost ratio (BCR) per hive per year, are presented in Table 4. The total variable cost of beekeeping, total cost of production for beekeeping, and average total revenue were NPR3,716, NPR4,974, and NPR9,714, respectively.

The net margin of beekeeping was NPR4,740, with a gross margin of NPR5,998. Table 4 shows that the BCR for beekeeping was 1.95, indicating that beekeeping enterprises, in the context of productivity gainsharing, are financially viable and profitable ventures, yielding a 95% return on investment.

TABLE 4

BENEFIT–COST ANALYSIS OF BEEKEEPING

Particulars	Amount (NPR)
Total variable cost	3,716
Total cost	4,974
Gross revenue	9,714
Gross margin	5,998
Net margin	4,740
BCR	1.95

Duration of Honey Storage

The study revealed that most beekeepers (31.67%) store their honey for at least 3 months, followed by 15 days (23.33%), 2 months (20%), 1 month (15%), 6 months (7%), and up to a year (3.33%) based on their requirements and market availability (Table 5). These durations indicate that the proper storage of honey directly impacts the productivity gainsharing and profitability of the beekeeping business by preserving the quality of the product.

TABLE 5

DURATION OF HONEY STORAGE AFTER HARVESTING IN THE STUDY AREA

Duration	Frequency	Percentage
15 days	14	23.33
1 month	9	15.00
2 months	12	20.00
3 months	19	31.67
6 months	4	6.67
1 year	2	3.33

Marketing Channel Used

In the study area, beekeepers utilized five main marketing channels to reach consumers, as shown in Table 6. The major marketing channel of honey was Channel V (34%); Channel III (25%) ranked second, whereas Channel II (8%) was the least used.

TABLE 6

MARKETING CHANNELS OF HONEY IN THE STUDY AREA

Marketing channels	Frequency (%)
I. Producers → Consumers	23.69
II. Producers → Retailers → Consumers	8.19
III. Producers → Wholesalers → Retailers → Consumers	24.84
IV. Producers → Local trader → Retailers → Consumers	9.47
V. Producers → Industry → Wholesalers → Retailers → Consumers	33.81

Source: Field survey, 2024

Price Spread and Producer's Share

The average farm-gate price of honey was NPR600, with an average producer's share of 85.71%. The highest price spread (NPR200) was observed when honey moved from the producer to the wholesaler or industry, and subsequently to the consumer. Conversely, the lowest price spread occurred when honey moved from the producer to consumer (Table 7).

TABLE 7

PRICE SPREAD AND PRODUCER'S SHARE OF HONEY IN THE STUDY AREA

Mode of selling	Retail price NPR/kg	Farm-gate price NPR/kg	Price spread NPR/kg	Producers share %
Producer to consumer	600	600	0	100
Producer to retailer to consumer	700	600	100	85.71
Producer to wholesaler/industry to retailer to consumer	800	600	200	75
Overall mean	700	600	100	86.90

Source: Field survey, 2024

Problems in Beekeeping

Beekeepers confronted several problems related to production and marketing. Table 8 shows that most respondents ranked a lack of technical knowledge and skill as the major problem, followed by unusual weather conditions, expensive hive equipment, market and price fluctuations, insect pests, lack of extension services, lack of road and transportation facilities, use of pesticides, and lack of foraging.

TABLE 8

RANKING BEEKEEPING PROBLEMS IN THE STUDY AREA

Problem	Index value	Ranking
Lack of technical knowledge and skill	0.78	I
Unusual weather	0.76	II
Expensive hive and equipment	0.59	III
Market and Price fluctuations	0.58	IV
Insect pests	0.55	V
Lack of extension services	0.51	VI
Lack of road and transportation facilities	0.49	VII

(continued on next page)

(continued from previous page)

Problem	Index value	Ranking
Use of pesticides	0.47	VIII
Lack of foraging	0.24	IX

Value Chain Map of Honey

Beekeepers are engaged in most functions along the honey value chain, such as input supply, beekeeping/production, harvesting, packaging, and marketing. Over two-thirds of beekeepers pack honey in plastic containers without processing after it is harvested. Similarly, over two-thirds sell their honey to wholesalers, industries, or local traders, whereas only one-quarter pack and sell honey directly to consumers.

Input suppliers: These are the first actors within the honey value chain to supply beehives, bee colonies, bee broods, bee veils, gloves, smokers, supplementary feed, technical knowledge, packing containers, honey extractors, etc. In the study area, most beekeepers receive extension services from government organizations such as the Prime Minister Agriculture Modernization Project (PMAMP), the Beekeeping Development Office, or the agriculture division of their local level municipality. Most beekeepers purchase beehives (including beekeeping equipment), whereas few receive subsidies from the government and NGOs.

Producers: Beekeepers serve as primary producers in the honey value chain, performing key functions such as procuring inputs, harvesting, and marketing. In the study area, they are involved in harvesting, packaging, processing, and transporting. Beekeepers directly sell their honey to local traders, wholesalers, retailers, and consumers. About 40% sell to local traders, 11% to wholesalers, and 9% to retailers at an average price of NPR500 per kg. Conversely, approximately 28% of beekeepers sell honey directly to consumers at the price of NPR600 per kg.

Local traders/Collectors/Wholesalers: Occasionally, the roles of wholesalers, collectors and local traders are performed by the same individual, facilitating the movement of honey from producers to consumers. The district's honey collectors include local traders who visit producers directly to collect honey, which they then sell to distant retailers within the same district or in other cities. They typically purchase honey at NPR500 per kg and sell it at NPR600 per kg. Some local traders perform honey processing and packaging functions to add value to the product. The prices at which wholesalers purchase honey does not vary significantly; however, the seasonality of honey production has a significant impact on pricing.

Retailers: Retailers are categorized as distant retailers and retailers who purchase honey from local traders and wholesalers. Similarly, they purchase honey at the same price: NPR600 per kg. Generally, distant retailers purchase honey from wholesalers or local traders and sell 100% of it directly to consumers.

Consumers: Nearly 28% of consumers purchase honey directly from beekeepers at the farm-gate price of NPR600 per kg; however, over two-thirds purchase honey from retailers at NPR800.

Value chain facilitators/supporters: Government institutes such as AKC, PMAMP, municipalities, and a few international NGOs provide beekeepers with training and input supply assistance.

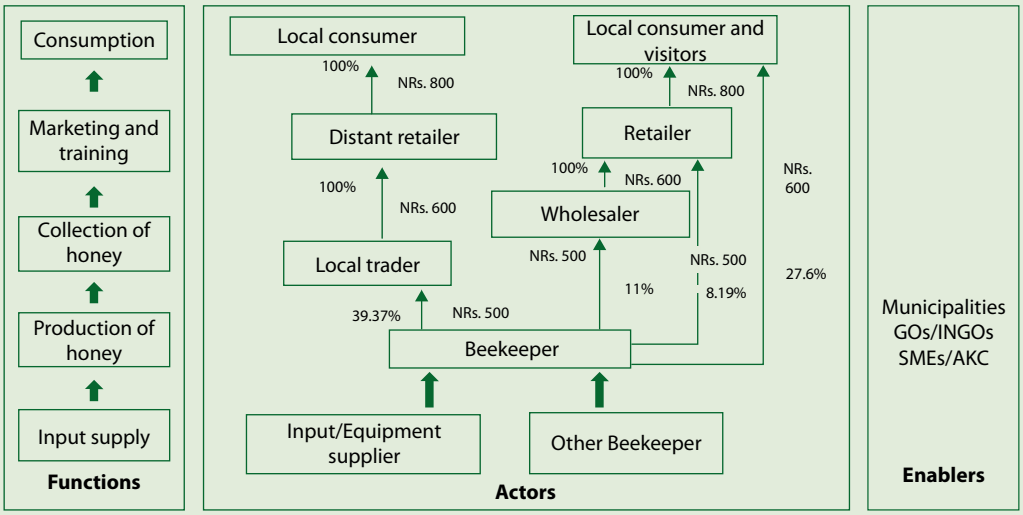
Conclusion

Summary of Key Findings and Insights

The average honey production per hive per year was 26.88 kg, with an average annual price of NPR361.37. An economic analysis revealed that beekeeping is a low-cost and high-return enterprise with a BCR of 1.95. The hives and equipment costs totaled NPR1,258, accounting for 25% of the

FIGURE 3

VALUE CHAIN MAP OF HONEY IN THE CHITWAN DISTRICT OF NEPAL



Abbreviations:
GOs: Government Organizations; INGOs: International Nongovernmental Organizations;
SMEs: Small and Medium Enterprises; AKC: Agriculture Knowledge Centre

total cost of honey production. Similarly, variable costs, including labor, artificial feeding, repair and maintenance, packaging/container, transportation for foraging/pasture management, comb foundation, and drugs, amounted to NPR3,716, comprising 75% of the total cost.

Beekeepers utilized five primary marketing channels to reach consumers, each offering varying degrees of market access. These channels presented distinct advantages and challenges, influencing the profitability and market reach of honey producers. The farm-gate price of honey was NPR600 with a market margin of NPR200, resulting in a producer's share of 86.90%. Producers performed packaging as a marketing function when selling raw honey to consumers or other market actors. Major marketing costs incurred by other market actors included those associated with honey transportation and storage. The marketing cost of local traders, wholesalers, and retailers in Chitwan District was lower, i.e., NPR70 per kg, NPR15 per kg, and NPR10 per kg, respectively.

Conclusions

Beekeeping is one of the major sources of income in the Chitwan District of Nepal, with honey production and colony multiplication serving as beekeepers' major income sources. Although beekeepers are not engaged in the production of bee products such as beeswax, pollen, propolis, and royal jelly, the income generated from beekeeping remains significantly high. Increasing the number of beehives enhances honey production; therefore, beekeepers should invest in expanding their beehives to boost honey production. Beekeeping is a low-investment enterprise with high profitability that has the potential to uplift the livelihoods of beekeepers. Major actors in the honey value chain include input suppliers, beekeepers, local traders, wholesalers, distant retailers, retailers, consumers, and enablers. The producer's share was very high due to the high farm-gate price of honey. Despite several challenges, beekeeping holds immense potential due to the favorable weather conditions and forage availability.

Suggestions for Future Research and Implications for Practice

This study presents an economic analysis of the value chain of beekeeping practices in Chitwan District. Extending research to other beekeeping regions in Nepal, particularly those with *Apis cerena*, can offer a broader perspective of the economic metrics of beekeeping practices.

Furthermore, a study integrating honey production and its contributions to local, regional, and national level economics within the broader context of the agrifood system can provide deeper insights into the importance of the beekeeping sector. In addition to honey production, beekeeping contributes to off-farm activities such as beekeeping, trading, and processing, while generating employment opportunities and economic benefits, which are key components of agrifood productivity gainsharing. Moreover, research on the impact of climate change on the quality and quantity of honey production would contribute to the development of sustainable beekeeping strategies.

Finally, investigating the dynamics of honey and bee product markets through comprehensive value and supply chain analyses can help identify constraints and opportunities, thereby enhancing market access and profitability of the beekeeping sector in the Chitwan District.

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BEST PRACTICES IN PRODUCTIVITY GAINSHARING IN THE AGRIFOOD SECTOR, GILGIT-BALTISTAN IN PAKISTAN

Executive Summary

Pakistan is an agrarian economy that depends on agriculture for food security, employment, and industrial growth. This sector contributes 24% to the GDP, employing 44% of the total labor force and accounting for 60% of the country's foreign exchange earnings. Pakistan's diverse geography and climate favor the cultivation of a wide variety of crops, with fruits occupying a significant share of agriculture. Temperate fruits are primarily grown in the northern hilly parts of the country, including Gilgit-Baltistan (GB). Among these, GB's major cash crops are apricots and cherries, contributing to over 60% of annual fresh fruit production. Both fruits are high-potential commercial entities with substantial national and international market demand. Most of the GB population is dependent on agriculture for their livelihood. The region experiences high poverty levels and is vulnerable to climate change and natural disasters. The average farm size is approximately 0.8 acres, with an average household comprising around eight members. GB's agro-climate cropping pattern is divided into three zones: double cropping, marginally double cropping, and single cropping. While subsistence remains predominant, commercial farming is gradually expanding, supported by government and private sector initiatives and development partners such as the Aga Khan Rural Support Program, United States Agency for International Development, and IFAD. These efforts aim to improve farming practices to promote sustainable farm incomes, reduce poverty, and strengthen food security. The region faces multiple challenges related to its geography, limited knowledge, market access, and technological support. Nonetheless, the diverse climate and strategic location present immense potential for the growth and sustainability of the agrifood sector. The vital areas of improvement include energy and communication infrastructure, value addition facilities, agro services, financial support, and certification to boost the sector's performance for better economic returns through improved productivity gainsharing practices across stakeholders in the apricot and cherry fruit industry value chain. Off-season crops, tunnel farming, solar drying, green technologies, and agro-service sector businesses are emerging as key income sources. Under emerging business avenues, a strong value chain, certification, compliance with international standards, and a vibrant regulatory system are required to sustain international market trust.

Key Findings

In GB, sustainable production and gainsharing practices in the agrifood sector are evolving with inclusive efforts across the value chain. Government and partner agencies focus on framing uniform policies and strategies to support sectoral growth. Investment in human resources, infrastructure, and allied services are becoming eminent focus points to ensure sustainable farm income, promote local businesses and exports for food security, and enhance the share of the national economy. Better financial gains depend on integrating key gainsharing elements, ownership, involvement, and communication with value chain stakeholders. The value-addition components (productivity, grading, processing, packaging, and marketing) are crucial for maximizing profits but require substantial investment, especially for smallholders. Given GB's isolation, facilitation of enhanced services is essential to strengthen the value chain. To achieve export-quality produce, good agricultural practices, continued research, stringent quality control, continued support, and international certifications must be ensured across all stages from farm to market.

Key Recommendations

Based on the significant agricultural potentials and challenges in Pakistan, particularly in GB, the following recommendations are proposed for policy planning and inclusive development.

1. Establish quarantine systems, particularly in GB, to promote the sector's sustainability
2. Regulate input costs, ensure availability, and monitor quality and malpractices.
3. Ensure the availability of certified planting materials through strict legislation.Introduce improved irrigation methods and efficient use of water resources.
4. Promote continued research for innovation and climate-resilient farming approaches.
5. Introduce green technologies for disease and pest control to protect biodiversity and the environment.
6. Collect annual production and market data and ensure farmers' access to updated information.
7. Provide small farm machinery to improve efficiency and productivity.
8. Enforce sanitary and phytosanitary standards (SPSS) to meet international market requirements.
9. Establish regional quality control, process validation, and certification facilities.
10. Strengthen extension services in all regions for knowledge and technology sharing.
11. Promote value addition and processing in village cooperatives to enhance profits and empower local labor.
12. Introduce IT tools and e-marketing strategies to keep producers informed of marketing decisions.
13. Create farmer cooperative markets to reduce intermediary exploitation of farm profits.
14. Improve road and energy infrastructure to boost production and value addition.
15. Build cold storage and cold supply chains for perishable goods.
16. Focus on capacity building for the agricultural workforce to meet emerging market demands.
17. Encourage Public–Private Partnerships to leverage regional agricultural potential.
18. Provide financial support to farm communities to promote value addition and economic sustainability.

Introduction

Pakistan's Agricultural Sector at a Glance

Pakistan's agricultural sector contributes approximately 24% to the country's GDP and employs 37.4% of the national workforce. Around 70% of the national exports are directly or indirectly linked to agriculture. With 30.5 million hectares of agricultural land, nearly 47% of Pakistan's total land is dedicated to farming, surpassing the global average of 38%. Within the agricultural sector, livestock plays a dominant role, contributing 62%, followed by essential crops (4.1%), other crops (3.3%), forestry (0.5%), and fisheries (0.3%). Pakistan experiences two primary cropping seasons, Kharif and Rabi, with a total water availability of 72.7 million acre-feet. Over 82% of cultivated land is irrigated, whereas the remaining 18% relies on rainfall. Around 60% of rainfed areas are used for growing rabi crops such as wheat, barley, gram, lentils, rapeseed, and canola mustard. The primary staple crops are wheat and rice, accounting for 37% and 11% of the total crop area, respectively. Sugarcane and cotton constitute the major cash crops, contributing 0.9% and 0.3%, respectively, to the GDP. With an estimated livestock population of 225 million, Pakistan's livestock sector generated a value of PKR5.5 trillion in 2023. Moreover, it is the fifth largest milk-producing country globally,

with an annual production of 67 million metric tons (Mt). Additionally, the country's large livestock population generates USD950 million in leather exports, making it the fourth-largest exporter of leather apparel (PBS, nd).

Pakistan's diverse geography and climate favor the cultivation of a wide variety of crops, with fruits occupying a significant share in the agricultural sector. Pakistan cultivates more than 35 types of fruits throughout the country. Key tropical and subtropical fruits include mango, dates, banana, oranges and lemons, and guava. Temperate fruits such as apricot, apple, cherry, almond, peach, pears, and grapes are primarily grown in the northern hilly parts of the country, including Gilgit-Baltistan (GB). Pakistan ranks sixth worldwide in apricot production (0.1745 Mt), with 90% of the country's produce originating from GB. Pakistan's global share in cherry production is currently negligible. However, the commercial potential of cherries is gaining traction due to its high national and international market demand. The new business avenue for Pakistani cherry export in the Chinese market is enormous, estimated to be around USD6 billion, thereby encouraging producers, in addition to the export potential in the UAE and other Middle Eastern states. The "Cherry Cluster Feasibility and Transformation Study" (Hunzai et al., 2020) indicates that GB is the country's central cherry production hub and the leading producer of apricots in Pakistan.

Horticulture growth in GB, particularly concerning apricots and cherries, is gaining increased attention due to emerging business opportunities associated with the China–Pakistan Economic Corridor (CPEC). This region serves as a strategic gateway for exports between China and Pakistan, presenting optimal opportunities for marketing high-value fruits in China. Both countries have agreed to extend cooperation in agriculture trade, value addition, processing, information sharing, technology transfer, and joint ventures. According to the Trade Development Authority of Pakistan, the cherry business in the inland market was valued at PKR2.45 billion in 2024, and 73 Mts of fresh cherry was exported to China. The prospects for export business in the fruit sector are enormous; thus, strengthening the horticultural sector can ensure economic sustainability and food security.

TABLE 1

AGRICULTURE GROWTH (BASE = 2015–16), PAKISTAN ECONOMIC SURVEY 2023–24.

Agriculture Growth (Base = 2015–16) (%)						
Sector	**2018–19**	**2019–20**	**2020–21**	**2021–22**	**2022–23 (R)**	**2023–24 (P)**
Agriculture	0.94	3.91	3.52	4.21	2.27	6.25
1. Crops (i + ii + iii)	–4.38	6.32	5.83	8.22	–1.03	11.03
i) Important Crops	–8.59	5.24	5.82	5.50	0.34	16.82
ii) Other Crops	3.62	9.21	7.95	11.90	–0.92	0.90
iii) Cotton Ginning	–11.23	–4.06	–13.08	9.22	–22.84	47.23
2. Livestock	3.65	2.80	2.38	2.25	3.70	3.89
3. Forestry	7.22	3.36	3.35	0.70	16.63	3.05
4. Fishing	0.78	0.63	0.73	0.35	0.60	0.81

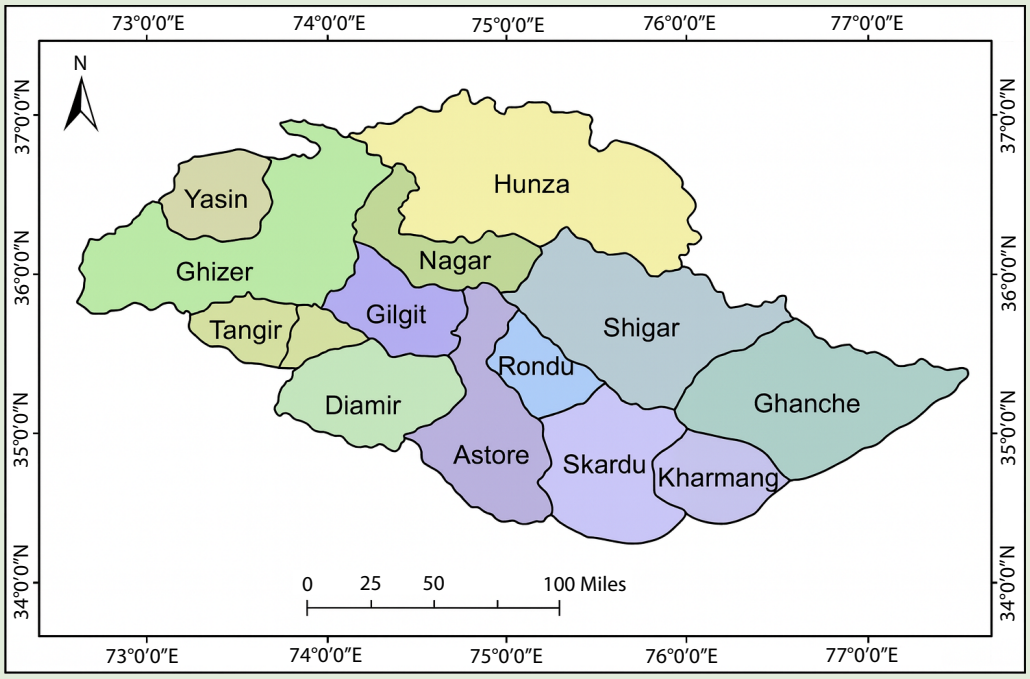
R: Revised, P: Provisional
Source: PBS (nd)

Background of Gilgit-Baltistan

Agriculture forms the backbone of GB's economy, with 80% of the population engaged in subsistence farming, growing cereals, fruits, vegetables, and fodder crops (Shigri, 2023); however, a significant portion of surplus produce is wasted due to insufficient awareness, skills, and processing technologies. The region's fragile agro climate is vulnerable to floods, avalanches, landslides, and seismic activities affecting livelihoods. Socio-economic indicators show a high poverty rate of 17.9% and low per capita income compared with the rest of Pakistan (MICS, 2017), while its complex geographical features, extreme weather conditions, weak infrastructure, and accessibility threaten food security and economic sustainability.

FIGURE 1

THE MAP OF GILGIT-BALTISTAN, FOREST WILDLIFE & ENVIRONMENT DEPARTMENT GOVT. OF GILGIT-BALTISTAN (FWED, ND)



The challenging terrain, small land holdings, high input costs, pre and postharvest losses, limited market access, and lack of processing facilities have made it challenging for farmers in GB to achieve economic sustainability and food security. The region's agroecological diversity and pest-free conditions offer great potential for producing healthy, high-value fruits. A holistic and integrated approach toward sustainable development, comprising increased agricultural output, value addition, and market access, are key features to achieving a sustainable farm income. The mountainous terrain of GB and its varying climatic conditions support the cultivation of key cash crops such as apricots and cherries, temperate fruits, and a large variety of vegetables. Besides being important as local food commodities, apricots and cherries significantly contribute to farm income (ZTBL, nd).

Purpose of the Report

Agricultural productivity gainsharing could benefit the region by fostering cooperation and resource sharing among farmers, workers, and stakeholders to improve farming practices. This system promotes innovation, enhances yields, and increases income as all parties collaborate to optimize agricultural methods. The key cash crops, i.e., apricots and cherries, are central to its economy, and best practices in gainsharing can help maximize production and profitability. Although modern agricultural practices are gradually being adopted, considerable efforts are still required to improve productivity and sustainability of farm income.

This study comprises two parts. The first part explores the current apricot and cherry value chain as well as the existing gaps while proposing sustainable gainsharing models to improve farm productivity in GB. The second part presents a case study of the Economic Transformative Initiative (ETI) being implemented by the GB government and IFAD as a best practice in gainsharing. This part is based on the 4Ps model in the agriculture sector and discusses opportunities for improving crop yields, reducing wastage, and expanding market access for these crops. The study identifies key strategies for achieving sustainable production and value chains that enhance cooperation and ensure equitable resource sharing among stakeholders.

Methodology: This study was conducted using a combination of literature review, field surveys, interviews, questionnaire responses, expert panel discussions, and personal observations.

Survey: Information was acquired through structured questionnaires, face-to-face discussions, observations, and interviews (a copy of the questionnaire is attached as Annex II).

Sample size: Sixty progressive farmers were randomly selected from six village agriculture cooperatives (VACs); each VAC comprised 100 members (600 study population). A sample comprising 10% of the study population was selected for interviews and questionnaire surveys.

Data analysis: The data were analyzed using the Excel software, employing the cost-benefit analysis formula.

Agricultural Landscape and Agroecology of Gilgit-Baltistan

Geography, Climate, and Ecological Zones

GB lies at the northernmost tip of Pakistan, with elevations ranging from 1,404 to an average of 12,989 feet above sea level. Covering an area of 74,496 sq km, it has a population of approximately 2 million. The region is divided into 3 administrative divisions (Gilgit, Diamer, and Baltistan) and 10 districts (Table 2; Figure 1), with a population density of 24 people per square kilometer (Khan, 2021). It is strategically located at the intersection of the Himalayas, Karakoram, and Hindukush Mountain ranges, forming the watershed for the Indus basin. It serves as Pakistan's water reservoir, with 5,100 glaciers, 3,400 glacial lakes, and 34 rivers feeding the Indus River, crucial for hydroelectric power generation and agriculture. GB is home to 5 of the world's 14 highest peaks, each over 8,000 m. It shares borders with China (Xinjiang), Afghanistan (Wakhan Corridor), and India and serves as a gateway for the CPEC. The region experiences a temperate climate, characterized by hot summers (up to 40°C) and extremely cold winters (below –10°C). Climatic conditions vary significantly, ranging from moist temperate zones in the Western Himalayas to arid and semi-arid cold deserts in the Karakoram and Hindukush (Baig et al., 2022).

TABLE 2

LOCATION AND AREA (SQUARE KILOMETERS) OF DISTRICTS

S.No.	District Name	Area (sq km)	Latitude	Longitude
Baltistan Division				
1	Ghanche	8,531	35.1625° N	76.336° E
2	Kharmang	6,144	34.7416° N	76.1592° E
3	Shigar	4,173	35.4765° N	75.6964° E
4	Skardu	10,168	35.3247° N	75.5510° E
Diamer-Astore Division				
1	Astore	5,411	35.3570° N	74.8624° E
2	Diamer	7,234	35.4381° N	73.9360° E
Gilgit Division				
1	Ghizer	12,381	36.2797° N	73.2765° E
2	Gilgit	4,208	35.8819° N	74.4643° E
3	Hunza	10,109	36.3167° N	74.6500° E
4	Nagar	4,137	36.252337° N	74.535871° E
	Total area	**72,496**		

Source: Agroecological Zones and Agricultural Potential (Nizami et al., 2023)

Precipitation in GB is minimal, averaging around 200 mm annually at elevations below 3,000 m; however, at higher altitudes (around 6,000 m), annual precipitation can reach up to 2,000 mm, primarily in the form of snow. Historically, Pakistan's agroecological zoning (1980) classified GB and parts of upper Khyber Pakhtunkhwa (KPK) into a single zone, known as the "Northern Dry Mountains." (Nizami (nd). More recently, the GB government has developed a comprehensive agroecological zoning report, dividing the region into seven distinct zones: warm and cold temperate, transitional warm and cold temperate, hot and cold temperate, cold temperate, sub alpine cold temperate, alpine temperate, and high alpine glacial zone (Nizami et al., 2023).

The region's highly diversified landscape and climate, characterized by extreme variations in altitude, enables the cultivation of a wide range of food crops and vegetation (Nizami, nd). These variations create a microclimate with varying production potentials that can be strategically harnessed to reap socio-economic benefits. Concerning the broader concept of agro-climate, the area comprises three cropping zones, i.e., double crop (3600–4800 ft), marginally double crop (4800–7200 ft), and single crop (7200–9000 ft). GB is characterized by its mountainous terrain, rivers, and glaciers, with land holdings averaging only 0.6–0.8 acres, and approximately 1.5% of the total area is under cultivation (ZTBL, 2024). The agroclimatic conditions ensure that agriculture has peculiar features linked with its geophysical structure and climate. The high peaks intervening with deep valleys give rise to an assorted climate pattern ranging from intensely cold winters to relatively moderate summers. This diversified climate supports a range of agricultural practices, allowing the cultivation of crops suited to specific local conditions.

Major Crops and Farming Practices

Almost all types of temperate fruits and a vast variety of vegetables are grown in GB. The primary potential, therefore, lies in the horticulture sector. Key fruit crops include apricots, apples, cherries, almonds, and grapes, while potatoes, tomatoes, and capsicum are vegetables primarily grown for commercial purposes (Hunzai et al., 2020; AKRSP, 2017). However, apricots and cherries occupy a dominant position in the region owing to their production potential and market demand (Table 1).

TABLE 3

AREA AND PRODUCTION OF APRICOTS AND CHERRIES IN GILGIT-BALTISTAN*

Years	Apricots		Cherries	
	Area (hectare)	Production (tons)	Area (hectare)	Production (tons)
2014	12000	125186	1323	3779
2015	12375	126200	1349	3855
2016	12750	127286.2	1364	3898
2017	12838	128300	1375	3900
2018	12926.81	129268.1	1386	3990
2019	13088	131200	1398	4143
2020	13250	135166.1	1410	4200
2021	13425	136700	1420	4240
2022	13600	138255.1	1435	4600
2023	13775	139000	1560	5000

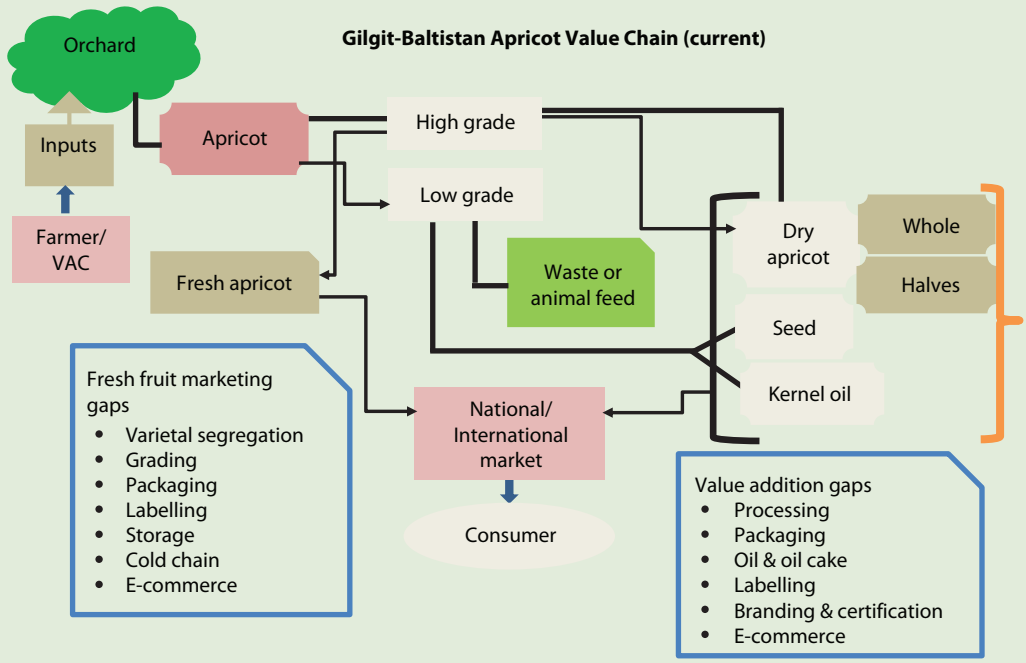
*Estimates based on Agri-statistics survey report, 2014 (GB ASSR (nd)).

Current data and updated information regarding the sector's performance are crucial for informing strategic planning decisions and design interventions. However, updated data on annual production

trends, marketing, and utilization of food crops in the area is unavailable. The sustainability model for best practices in gainsharing proposed in this study is tailored to the regional context and addresses challenges to revitalize the horticulture sector, aiming to transform it into a profitable venture for all stakeholders. GB's fruit sector, particularly apricots and cherries (Table 3), has significant potential for value addition and international trade, as dry apricots and fresh cherries are in high demand in Europe and China. Local entrepreneurs have been exporting dry apricots to Europe for the past two decades, while the successful export of cherries to China in 2024 has created new opportunities for regional growers. The cherry market in China, valued at USD6 billion, presents a highly lucrative opportunity; however, challenges such as inconsistent quality, and a lack of storage infrastructure and certification standards must be addressed to capitalize on this potential. The enormous potential of the horticulture sector remains underutilized due to the lack of quality and safety standards, market access, quarantine, certification, branding, and technological support. Figures 2 and 3 illustrate the current value chain of apricots and the proposed sustainable model.

FIGURE 2

APRICOT CURRENT VALUE CHAIN MODEL IN GILGIT-BALTISTAN

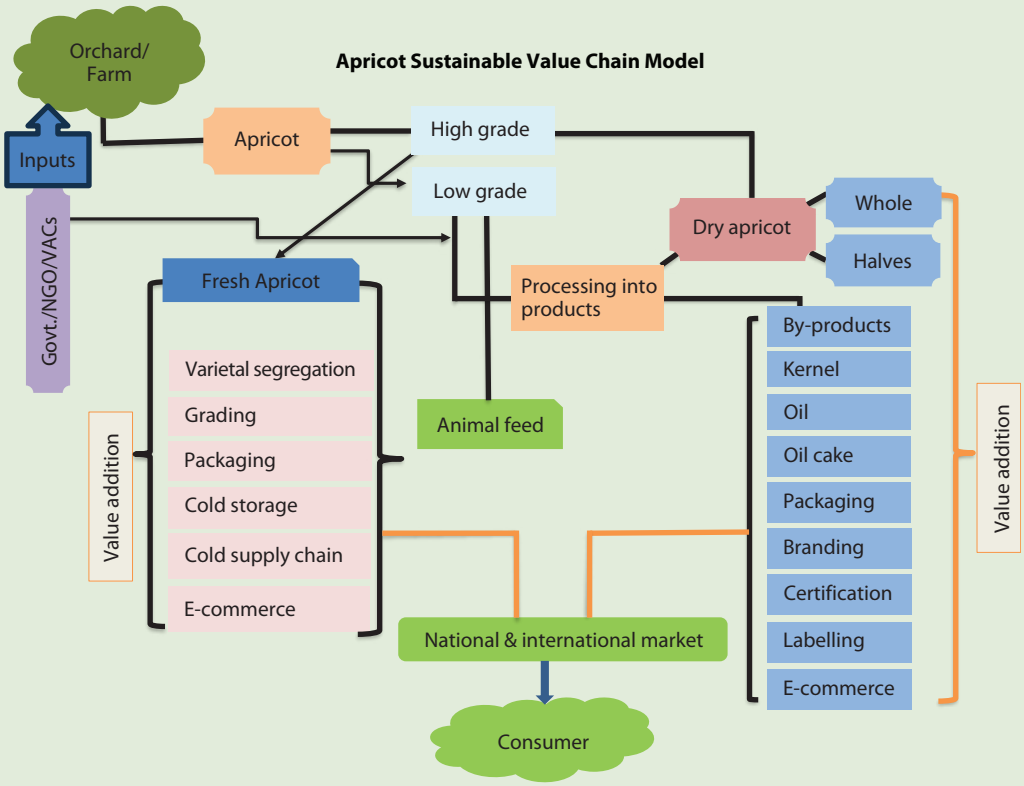


Notes: The current apricot value chain has missing components, i.e., varietal segregation, grading, packaging, labeling cold storage, cold supply chain, and e-commerce in the case of fresh apricot marketing. Additionally, processing low-grade apricots into value-added products, utilizing kernel oil and oil cake in food and cosmetic products, and the lack of branding and certification remain critical value addition gaps hindering the profitability of these ventures.

Cherry is a high-potential cash crop for the country with high consumer demand in the international market (Tables 3, 4). Turkey leads global cherry production; the US and Chile are the largest exporters of cherry. Cherry production in Pakistan was 0.06 million tons in 2014–15, with GB contributing the majority of the share. Since then, production has increased fivefold due to rising national demand and growing export opportunities in China. However, to access this vast market, Pakistan cherries must adhere to strict quality, safety, and phytosanitary standards along with necessary certifications requirements that are currently lacking in the region.

FIGURE 3

SUSTAINABLE APRICOT VALUE CHAIN



Notes: A sustainable apricot value chain includes the missing gaps in the value addition of fresh fruit and byproducts to economize apricot farming for sustainable development. The proposed model provides sustainable growth options for best practices in gainsharing across the value chain.

TABLE 4

MAJOR CHERRY-PRODUCING REGIONS IN PAKISTAN (2016)

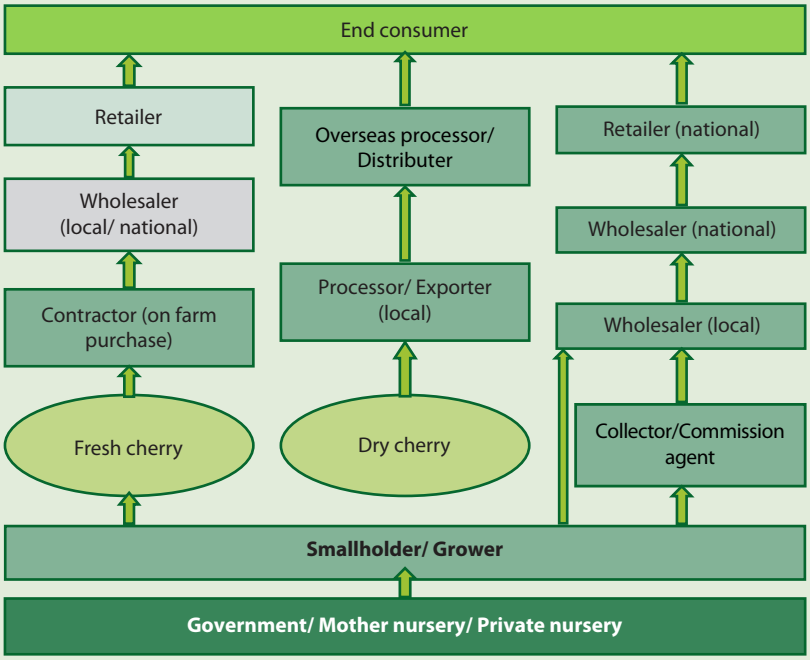
NO.	Province	Production (tons)	Production share (%)	Area (ha)	Area share (%)	Yield (t/ha)
1	Balochistan[1]	1,981	32.92	1,065	42.38	1.86
2	Other[1]	139	2.31	84	3.34	1.66
3	Mainland Pakistan[1]	2120	35.23	1149	4572	1.841
4	Gilgit-Baltistan[2]	3,897	64.77	1,363	54.28	2.86
TOTAL	6,018	6,018	100	2,513	100	2.39

Source: [1]MNFS&R (nd) Ministry of National Food Security & Research and [2]GB ASSR (nd) Government of Gilgit-Baltistan; Agriculture Statistics Survey Report

Significant gaps exist in the capacity of local farmers and entrepreneurs within the current cherry marketing systems regarding awareness or knowledge about desired fruit size, hydro-cooling, cold storage, refrigerated transport, and market research. The flow chart proposed in Figure 4 better explains the marketing process for fresh cherry exports. Addressing these gaps through targeted support and investment at the farm and entrepreneurial level is essential (Figure 5).

FIGURE 4

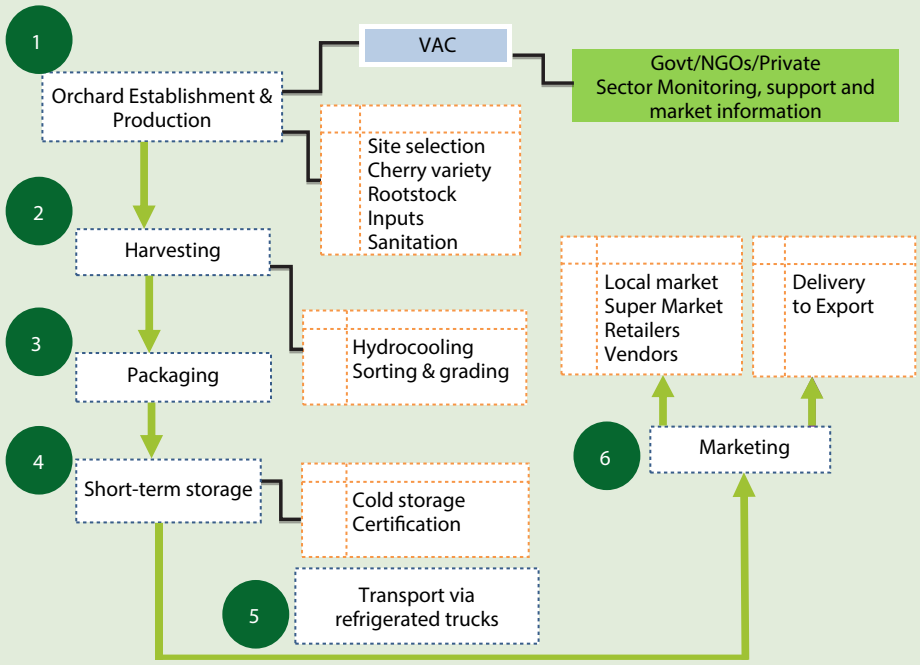
CURRENT VALUE CHAIN FOR CHERRIES (ADOPTED FROM HUNZAI ET AL. (2020))



Notes: The current value chain for cherries exhibits significant gaps in segregating the best export varieties for planting, grading, packaging, labeling, cold treatment, cold storage, and refrigerated transport.

FIGURE 5

SUSTAINABLE GAINSHARING MODEL FOR CHERRIES



Certain gaps exist in the flow of information between the market and farms within the current apricot and cherry value chains (Figures 2, 3), which are often exploited by local contractors, leaving producers with limited opportunities to negotiate or select the best prices for their produce. A field survey of village agriculture cooperatives (VACs) revealed that a contractor made a purchase agreement with a cherry orchard owner at a lump sum amount of one million rupees and received 2.4 million on the sale of the same in the national market. It was noted that nine different cherry varieties are cultivated in GB; however, no varietal profiling has been conducted to date. A similar report also revealed that different cherry varieties respond differently to cold treatment prior to the final shipment of fresh cherries. While some varieties sustain refrigerated water treatment, others rupture when soaked in cold water for two to four minutes. This evidence underscores the need for targeted research and innovations to harness the horticultural potential of the area.

Notes: The proposed model covers the existing gaps in government and partner linkages with farmers through VACs. It outlines various components at each stage of the value chain to promote sustainable production and best practices in gainsharing (indicated sequentially through arrows, dots, and numbering in the flow diagram). VACs organize producers, foster linkages and cooperation among value chain actors, create opportunities, build the capacity of individual farmers, and establish marketing linkages that ensure better outputs and equitable gainsharing.

Concept of Gainsharing and its Relevance to Gilgit-Baltistan

Principles of Gainsharing

Food and nutritional security are key goals for agricultural development and economic progress. Sustainable food systems are essential to continuously supply safe, healthy food. Effective resource mobilization is vital for societal well-being, enabling people to meet basic needs and sustain their livelihoods. Challenging circumstances such as the COVID-19 pandemic and climate change have highlighted the need to strengthen food supply chains using proven management approaches and new technologies, ensuring equitable benefits for all stakeholders, including farmers, suppliers, and distributors. Gainsharing is a model where agricultural benefits are equitably distributed among all stakeholders by encouraging cooperation, innovation, productivity, and profitability, benefiting farmers and the broader agricultural community.

Models of Gain Sharing in Agriculture

Globally, the agrifood sector is a crucial industry, providing livelihoods and economic sustenance. Gainsharing and business models, such as contract farming, management contracts, sharecropping, joint ventures, and farmer-owned businesses, aim to create value through partnerships and resource sharing. Smallholder farming is a common feature of GB, where families manage their fields for subsistence income. The region also utilizes models such as contract farming and joint ventures, particularly for commercial crops. Contract farming involves agreements between producers and buyers, whereas management contracts and sharecropping provide land access to smaller farmers, often with profit-sharing arrangements. These models help improve production efficiency and market access.

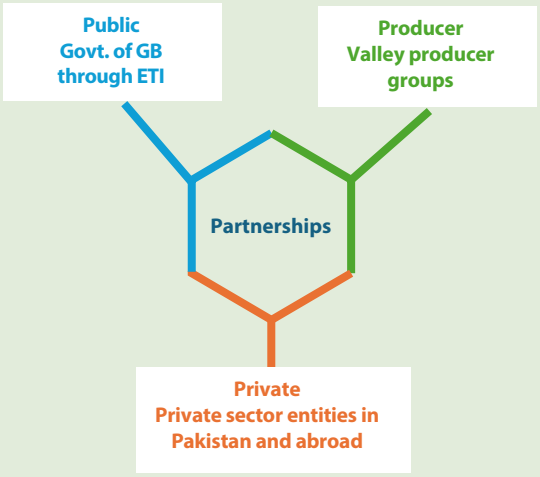
The public–private producer partnership (4Ps) business development model introduced by the ETI is a strategic adaptation aimed at improving agricultural practices. The 4Ps model promotes collaboration between the government, businesses, and small-scale producers (Figure 6). This model focuses on shared risks, responsibilities, and benefits, aiming to improve production efficiency, market access, and quality control. By organizing farmers into groups and developing a comprehensive value chain, this model provides a basis for increased productivity, enhanced income, and equitable gain sharing.

Expected Outcomes

GB's 4Ps business development model aims to enhance farmer incomes resulting from increased productivity and value addition through more efficient marketing strategies. This model emphasizes best production practices and collaboration among all actors, from producers to government bodies,

FIGURE 6

A PUBLIC–PRIVATE PRODUCER PARTNERSHIP (4PS) MODEL EPITOMIZES PARTNERSHIP BETWEEN PRODUCERS, PUBLIC SECTOR BODIES, AND PRIVATE SECTOR PLAYERS



Source: ETI (nd); Serebrennikov et al. (2020)

bound together by common goals for mutual benefit. Additionally, the 4Ps model eminently focuses on grassroots involvement, highlighting the empowerment of local farmers. The model attempts to develop the capacity and endowments necessary for farmers to rise resiliently and self-sufficiently. Grassroots engagement is vital to ensure that agricultural development's effects are widespread and equitably distributed in the long term.

Benefits and Challenges

The benefits of gainsharing in agriculture include improved productivity and quality, particularly in the context of apricots and cherries, resulting in better returns for all actors within the production and marketing chain. Farmers will have access to better inputs, technologies, and market opportunities, which can enhance profitability and reduce wastage. However, several challenges persist including geographical isolation, underdeveloped infrastructure, and difficulties in ensuring equitable benefit-sharing among stakeholders with varying resources. Additionally, resistance to changing traditional farming practices may hinder full model adoption (Nizami, nd). Despite these challenges, gainsharing promises significant dividends, including increased productivity, quality, and economic returns to the horticulture sector. By promoting shared responsibility, the model ensures that the benefits of enhanced farm outputs are distributed fairly. The integration of the 4Ps model marks a milestone in GB's agricultural development, addressing critical sector challenges and offering a framework for sustainable growth. Through this model, the region can experience increased productivity, improved farmer incomes, and overall economic growth.

Comparison of Existing Value Chain with 4Ps Model

Several gaps exist within the current value chain regarding market information, quality input supply, finances, lack of coordination among farmers, technology, value addition, certification, safety, and quality standards. Individual farmers are manipulated by the intermediary or contractor who decides the produce price and supplies inconsistent quality inputs. The proposed ETI 4Ps model provides a platform for the farm community by establishing VACs. These VACs empower individual farmers through disseminating market information, ensuring the supply of quality input, collective marketing, organizing training for capacity building, and collaborating with government and development agencies, thus establishing a chain of coordination and support among all stakeholders. It ensures a fair deal between all actors, from the farm to the market, ensuring each stakeholder receives a fair share while contributing positively to the sector's sustainable growth.

Economic Transformative Initiative Gainsharing Model: A Case Study

Program Background and Overview

The ETI GB is a seven-year development program aimed at boosting agricultural income and employment for at least 100,000 rural households in GB. Jointly funded by the government and the IFAD, the program costs PKR12 billion. It addresses economic and agricultural challenges by increasing productivity, income generation, and strengthening economic infrastructure through sustainable agriculture. VACs play a key role in the program's success. ETI's objectives include enhancing agricultural productivity, improving market linkages, and creating opportunities for marginalized communities, particularly women and youth. The program's components include the following.

1. **Economic Infrastructure and Value Chain Development:** ETI focuses on improving agricultural infrastructure, including irrigation, farm-to-market roads, and crop storage. This approach enhances productivity, reduces transportation costs, and improves market access. The program brought 42,000 acres under irrigation, expanding productive land and facilitating market accessibility.

2. **Support Services/4Ps:** The program fosters partnerships between public institutions, private businesses, and local farmers. Through VACs, farmers receive technical training and financial support, particularly in vertical farming techniques for crops such as cucumbers and tomatoes at high altitudes.

3. **Program Management and Policy Support:** Managed by the Economic Affairs Division and local organizations, ETI ensures effective fund utilization and policy support, including land titling and infrastructure development to promote sustainable agriculture practices. The program also facilitated the construction of farm-to-market roads and the development of policy frameworks aimed at promoting long-term agricultural sustainability.

4. **Community Organizations and Growth Incentives:** ETI emphasizes community organization as a means to strengthen cooperation among farmers, fostering collective growth and capacity building through shared roles and benefits. Additionally, it has supported farmer societies by providing financial support and agricultural inputs to maximize farm income, improve market access, and ensure more equitable gainsharing among all actors within the value chain

Cooperative Societies

VACs played a central role in the ETI program, consolidating small informal farming groups into legally registered entities. A total of 162 VACs were established across GB, encompassing over 40,600 farmers. These VACs were registered with the Cooperative Department and developed business plans to ensure increased farmer incomes, which were implemented during the 2021 and 2022 agricultural campaigns. VACs supported over 20 agricultural commodities, including apricots, cherries, and vegetables.

Financial Sustainability

To ensure financial sustainability, ETI distributed over PKR1.5 billion through VACs via a matching grant system. This type of funding helps manage pre and postharvest losses, improve product quality, and ensure collective marketing. Additionally, modern farming techniques such as vertical farming boost productivity and economic viability. Each VAC also received office management support to enhance its operational efficiency.

Key Achievements of ETI

- Approximately 42,000 acres of irrigated land have contributed to improved livelihoods for over 8.64% of low-income households.

- An estimated PKR1.5 billion invested through VACs resulted in significant income gains for farmers.

- Over PKR1 billion was invested in community-led construction projects, including farm-to-market roads, irrigation channels, and storage facilities, thereby contributing to the rural economy.

- Over 50,000 farmers provided were provided with technical and financial support, resulting in a 44% increase in high-quality, value-added produce.

- Over 40,600 farmers were organized into 162 VACs in GB, aimed at empowering communities through the establishment of village-level institutions, which serve as platforms for capacity building, financial management, enhanced agricultural production, and improved market access.
- About 29% of the farmers among the VACs were women, and 15 women-led cooperatives were established.
- About 320 professional graduates have been engaged in cooperative management so far; youth account for 27% of membership within the VACs.
- Private sector institutions have increased collaboration.
- The Vertical Farming Techniques Pilot, involving 907 farmers, aimed to enhance crop yields such as cucumbers and tomatoes.
- A total of 513 orchards and 25 nurseries were established to increase fruit productivity, with the added value of apricot production expected to benefit 5,915 farmers.

Anticipated Economic Benefits

The investment expected from ETI and VAC's operationalization will likely have long-term economic benefits. The long-term sustained growth in agricultural production, primarily through vertical farming, will enable farmers to take advantage of high altitude and off-seasonal cropping. Increased mechanization of farming and vertical farming techniques will increase agricultural productivity, reduce work burdens, and increase farmers' incomes. The constructed infrastructures, including potato storage facilities and farm-to-market roads, will decrease transportation costs and reduce postharvest losses, increasing farmers' economic returns.

Challenges

This program faced critical issues, including rugged terrains and climatic conditions across GB in the initial stages, that directly affected agricultural output. Securing long-term financing to support VACs and market linkages for all produce was another critical issue that required special attention, Nonetheless, the program still benefited from robust policy support, infrastructural development, and capacity building, although most of these problems could have been more effectively addressed.

TABLE 5

COST–BENEFIT ANALYSIS OF TUNNEL FARMING (PER TUNNEL/SEASON)

Tunnel Income of Cucumbers/Tunnel/ Season				
Actors	**Production Volume (kg)**	**Revenue (PKR)**	**Cost (PKR)**	**Profit (PKR)**
Farmer	500	42,500	18,000	24,500
Wholesaler	500	55,000	42,500	12,500
Retailer	500	65,000	55,000	10,000
Cucumber Cost Benefit Analysis (Valley-Wide for 250 Tunnels)				
Actors	**Production Volume (kg)**	**Revenue (PKR)**	**Cost (PKR)**	**Profit (PKR)**
Farmers	125,000	10,625,000	4,500,000	6,125,000
Wholesalers	125,000	13,750,000	10,625,000	3,125,000
Retailers	125,000	16,250,000	13,750,000	2,500,000
Tomato Cost Benefit Analysis (Per Tunnel)				
Actors	**Production Volume (kg)**	**Revenue (PKR)**	**Cost (PKR)**	**Profit (PKR)**
Farmers	1,200	54,000	18,000	36,000

(continued on next page)

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Wholesalers	125,000	78,000	54,000	24,000
Retailers	125,000	108,000	78,000	30,000

Tomato Analysis (Valley-Wide for 250 Tunnels)				
Actors	**Production Volume (kg)**	**Revenue (PKR)**	**Cost (PKR)**	**Profit (PKR)**
Farmers	300,000	13,500,000	4,500,000	9,000,000
Wholesalers	300,000	19,500,000	13,500,000	6,000,000
Retailers	300,000	27,000,000	19,500,000	7,500,000

Notes: The data are based on questionnaire responses from tunnel owners (60 farmers) from different VACs. The overall value chain is gradually evolving, driven by initiatives from the government and its partners; however, marketing and value addition gaps still persist, necessitating targeted interventions. There are 250 tunnels on average in each valley under a VAC (some farmers own more than one tunnel). Cucumber production typically spans 3–4 months, whereas tomato production extends over 5–6 months. Despite obvious losses during handling and marketing, there is a lack of reliable data to quantify them.

Ways Forward

Continually supporting VACs in terms of finance and capacity building can lead to long-term sustainability. Providing tunnels and mechanized farming tools will further boost productivity. Strengthening partnerships between VACs and the private sector regarding market linkages and value addition is a crucial policy reform. The GB Works Department should reinforce land titling and infrastructure management to ensure considerable progress on the program's interventions. Success with VACs has highlighted community-led models of agriculture. Building long-term strategies, such as ensuring financial sustainability and achieving greater efficiencies in the operational performance of VACs, must be emphasized. Moreover, quality assurance systems such as sanitary standards and SPSS on the part of the government are crucial as access to the international market is only possible with the desired certifications.

Key Findings, Strategic Challenges, and Recommendations

GB's horticulture sector employs 70% of the population but contributes a lower-than-average share to the region's GDP. Its full production potential remains untapped, necessitating short-term and long-term policies from the government and development partners to maximize production, ensure food security, and improve livelihoods. Investment in human resources, infrastructure, and services is essential to enhance production and create business opportunities. Financial gains will be realized through ownership, involvement, and information sharing across the value chain. Focused efforts on optimizing quality production, removing supply chain bottlenecks, enhancing value addition, and providing continuous support are key to achieving financial success.

A community-led development approach by ETI has proven effective in fostering cooperation, engagement, infrastructure development, and capacity building through farmer cooperatives. This approach unites all actors in the value chain, promoting ownership, dialogue, and information sharing. Better communication with cooperatives about market trends and consumer behavior motivates stakeholders to produce higher-quality goods. The sector has significant export potential with opportunities for international market access, quality control, and certification of value-added products. Sustainable practices can be achieved through fair regulatory processes and stakeholder involvement, ensuring continued growth and improved sector performance in the future.

Strategic Challenges

Climate Change and Water Shortages

1. GB experiences late frost during the blossoming season, significantly affecting cherry yield and quality.

2. Climate change is contributing to the emergence of new diseases and shifts in the crop cycle.

3. Water availability in GB is sufficient but transporting it up to mountainous areas for irrigation is expensive. Water shortages are exacerbated during the energy crises in winter and autumn due to insufficient water supply for energy generation.

4. The use of surface irrigation in tunnel farming results in significant water wastage; adopting drip irrigation systems is required to prevent water wastage.

Preharvesting Constraints

1. **Lack of Orchard, Nursery, and Tunnel Management Training and/or Workshops:** Farmers have limited access to appropriate training on proper orchard management, including pruning, disease control, and soil management.

2. **Fertilizers and Pesticides:** Certified fertilizers and pesticides are not readily available, and uncertified products may compromise crop health.

3. **Disease Outbreaks:** Production of cherries, apricots, and potatoes is affected by gummosis and shot hole, reducing quality and yield. Additionally, most diseases are caused by quarantine pests.

4. **Lack of Quarantine Facilities:** GB has no quarantine departments, increasing the risk of disease and pest outbreaks.

5. **No Government Support or Subsidies:** There is minimal government support or financial assistance for farmers, making it difficult to invest in modern agricultural tools and techniques.

6. **Building Capacity for Garden Establishment:** Farmers need capacity-building support to establish and maintain orchards that can thrive and meet international standards.

Postharvest and Farm-to-Market Challenges

1. **Poor Road Conditions:** Inadequate road infrastructure hampers the transportation of cherries from farms to markets, leading to product deterioration.

2. **No Storage Facilities:** GB's lack of cold storage facilities leads to significant postharvest losses.

3. **Corrupt Intermediaries:** Intermediaries often exploit farmers, manipulate prices, and reduce farmers' profits.

4. **Energy Crisis:** GB experiences energy shortages during winter and autumn, further complicating postharvest processing and storage.

5. **Postharvest Loss Reduction:** Postharvest losses must be reduced from 20% to 10% by implementing better handling, storage, and processing systems.

Production Level Constraints

1. **Limited Access to Genetic Material:** The cultivated cherry varieties are degenerated, and acquiring new germplasm poses significant challenges.

2. **Weak Extension Services:** The agricultural extension services in GB are underdeveloped and offer little support to farmers.

3. **Small Orchards:** Most farms are small and mixed, lacking the necessary scale and infrastructure to produce modern, certified orchards.

4. **No Support for Training Programs:** Farmers lack access to training in modern agricultural techniques, orchard management, and nursery management, thereby limiting productivity.

5. **Certified Orchards under International Standards:** Promoting orchards that are certified under the International Standards for Phytosanitary Measures is essential to improve the quality and marketability of cherries.

Processing Constraints

1. **Lack of Cold Chain Infrastructure:** The absence of cold chain infrastructure for cherries results in poor handling and a lower market price.

2. **Limited Processing Technologies:** Processing technologies remain rudimentary, with minimal grading, packaging, or branding, resulting in high postharvest losses.

3. **Training in Processing:** Farmers and processors require appropriate training in postharvest management, processing technologies, and value addition to improve quality and reduce losses.

Trading and Marketing Constraints

1. **Traditional Marketing Channels:** Farmers in GB rely on outdated marketing methods, with no access to modern platforms such as e-commerce.

2. **Export Limitations:** GB lacks the infrastructure, certifications, and branding needed for cherry, potato, and apricot exports, limiting its access to international markets.

3. **Phytosanitary Certification:** Establishing ISPM-certified orchards will enhance the ability to meet international market standards and facilitate exports.

Natural Disasters and Landslides

The area is mountainous, and natural disasters such as landslides are common, which block the roads, destroy infrastructure and villages, and make roads inaccessible to markets; thereby exacerbating postharvest losses.

Conclusion

The agrifood sector in GB is improving as national and international markets show increasing interest in regional commodities; however, isolation, remoteness, and limited government focus have hindered the region's integration into mainstream markets. Key challenges include insufficient quarantine centers, limited market access, quality inputs, uncertified varieties, small land holdings, water scarcity, natural disasters, and climate change. Most farmers are smallholders; hence, promoting the "one village, one product" model could enhance commercial viability. Improved irrigation systems are needed to conserve water and adopt climate-resilient farming practices to cope with climate change impacts. Green technologies (biocontrol agents for pest and disease management) should replace harmful pesticides. Annual production data collection, subsidies for small farm machinery, and enhanced phytosanitary practices are needed for better market access and to maintain the trust of the international buyer. The government's active involvement in extension services, training, and capacity building for farmers and VACs is crucial for maximizing productivity. Additionally, improved road and energy infrastructure and cold storage facilities will enhance market access and farm income for the region's economic sustainability and food security.

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EVALUATING BEST PRACTICES IN GAINSHARING TO IMPROVE COMMERCIAL BROILER CHICKEN PRODUCTIVITY IN THE PHILIPPINES

Executive Summary

The chicken broiler industry plays a pivotal role in the Philippine economy, contributing significantly to food security and agricultural employment. However, despite consistent growth, significant deficits persist in local supply chains, exacerbated by rising production costs, competition from imports, and insufficient integration between small-scale producers and large commercial players.

Despite growing demand, the industry faces critical challenges, including a shortage of local production capacity. A strengths, weaknesses, opportunities, and threats (SWOT) analysis revealed several key weaknesses, such as pricing disparities between smallholders and large integrators, inefficiencies in the supply chain, lack of accessible market information creating pricing disconnects, high transport costs and logistical challenges reducing competitiveness, and inadequate disease control due to weak regulatory compliance. However, opportunities arise from technological advancements, stronger collaborations, and active participation of academic institutions in fostering innovation and improving farm productivity practices.

A core recommendation for improving productivity lies in implementing gainsharing models across the poultry supply chain, incentivizing large- and small-scale producers to improve operational efficiency. Hence, the poultry sector can address systemic inefficiencies by adopting performance-based incentives, enhancing stakeholder collaboration, and ensuring transparent pricing mechanisms. Inclusive models (such as the "plan-do-check-act" approach) can further help integrate small-scale farmers into commercial market chains, improving their access to resources and providing better market linkages.

This study aims to validate the current situation of the poultry industry through comprehensive industry scanning and review. By analyzing key parameters and evaluating existing SWOTs, the Department of Science and Technology (DOST) is leading efforts to connect poultry stakeholders in Central Luzon. Through collaborative initiatives with other agencies and partners, DOST seeks to provide technological interventions to address challenges across the industry value chain. These initiatives will enhance productivity and resilience, ultimately contributing to national food security goals and facilitating the industry's long-term growth.

Urgent policy reforms are needed to ensure the sustainable growth of the poultry sector. These reforms include providing easier market access for smallholders, improving market transparency, and supporting innovation in production technologies. Collaboration between policymakers, industry leaders, and academic institutions will be key to creating a more efficient, equitable, and resilient poultry industry in the Philippines.

Introduction

Overview of the Poultry Industry in the Philippines

The agrifood sector is vital to the economy, ensuring food security and employment. In the Philippines, poultry plays a significant role in food production, providing essential proteins. The country ranks among the highest consumers of poultry meat in the Asia-Pacific region (Agriculture and Horticulture Development Board, n.d.), with poultry remaining the preferred choice of meat among Filipinos (Acosta, 2022).

In 2019, the Philippines produced 1.93 million metric tons (MMT) of chicken, generating USD3.31 billion in gross value and total earnings of USD3.41 billion. Central Luzon leads poultry production, with chicken remaining the most consumed meat in the region. Data from Philippine Statistics Authority (PSA) cited by the the Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (PCAARRD) indicate a 7.67% rise in chicken production, from 470,207.84 MT in Q1 2023 to 506,277.23 MT in Q1 2024. This growth resulted in an 8.23% drop in farmgate prices and a 4.51% decline in retail prices (Business Mirror, 2024); however, by July 2024, a supply shortage in Metro Manila caused prices to rise from PHP160–220/kg to PHP190–250/kg due to reduced broiler stocks and producer losses. The Department of Agriculture (DA) attiributed this phenomenon to rising feed costs, poultry diseases, and supply chain issues (DA, 2024; Montemar, 2019; Lagare; 2023).

By June 2024, the Philippines had imported nearly 222 million kilograms of chicken products, including cuts, leg quarters, and whole chickens. While imports help stabilize supply, they also create competition among local producers. During periods of peak supply, imports tend to lower prices; however, when supply tightens, they contribute to inflation. The USDA Foreign Agricultural Service projects Philippine chicken consumption to reach 1.998 MMT in 2024, whereas production is expected to reach 1.54 million MMT, necessitating imports of approximately 465,000 MMT (Menxias, 2024; Halili, 2024b). Despite accounting for 34.5% of total chicken meat imports (Halili, 2024a), the domestic supply remains insufficient with a 23% shortfall (USDA FAS, 2024). See Appendix 1 for details.

Industry Definition

The Philippine broiler industry comprises backyard, commercial non-integrator, and commercial integrator farms. Commercial operations dominate, accounting for 80% of production (USDA, 2020). Large integrators control pricing and supply chains, whereas small-scale farmers struggle with access to inputs, disease control, and markets (Food and Agricultural Organization, 2015). Medium- and large-scale integrators benefit from contract growing, supporting small-scale producers (Gonzales et al., 2012; Philippine Rural Development Project, 2017; Gordoncillo et al., 2020). Despite industry integration, small- and medium-sized farms remain essential to sustain rural livelihoods (DA, 2022); however, their fragmented structure, weak infrastructure, and reliance on informal trading limit profitability and growth (Food and Agricultural Organization of the United Nations, 2015; DA, 2022). See Appendix 2 for details.

Supply and Value Chain Structure

A study by the Central Luzon State University Socioeconomic Research and Data Analytics Center (CLSU-SERDAC) (2024, unpublished), commissioned by DOST-III, found that Central Luzon's poultry industry is highly integrated, with broiler farms in Nueva Ecija, layer farms in Bulacan, and hatcheries in Bataan. Moreover, Zambales contributes to broiler breeding. Figure 1 shows that the industry follows a vertical integration model, streamlining production and reinforcing major players' dominance. The study identified four industry models. First is the integrator-driven industry, where integrators control feed milling, consolidation, dressing, processing, and distribution, while farmers primarily focus on the growing phase. Second is the three-segment integrator-handled model, where integrators manage feed milling, consolidation, and processing, while retailers handle distribution. In this structure, growing and processing may be outsourced. Third is the two-segment plant operator-handled model, in which integrators oversee feed production and logistics while outsourcing growth operations, leaving processors to manage distribution. Fourth is the key player distributed model, where integrators control feed milling and logistics, while consolidators and processors manage distribution (Figure 2).

FIGURE 1

INDUSTRY MAPPING IN CENTRAL LUZON (CLSU-SERDAC, 2024, UNPUBLISHED)

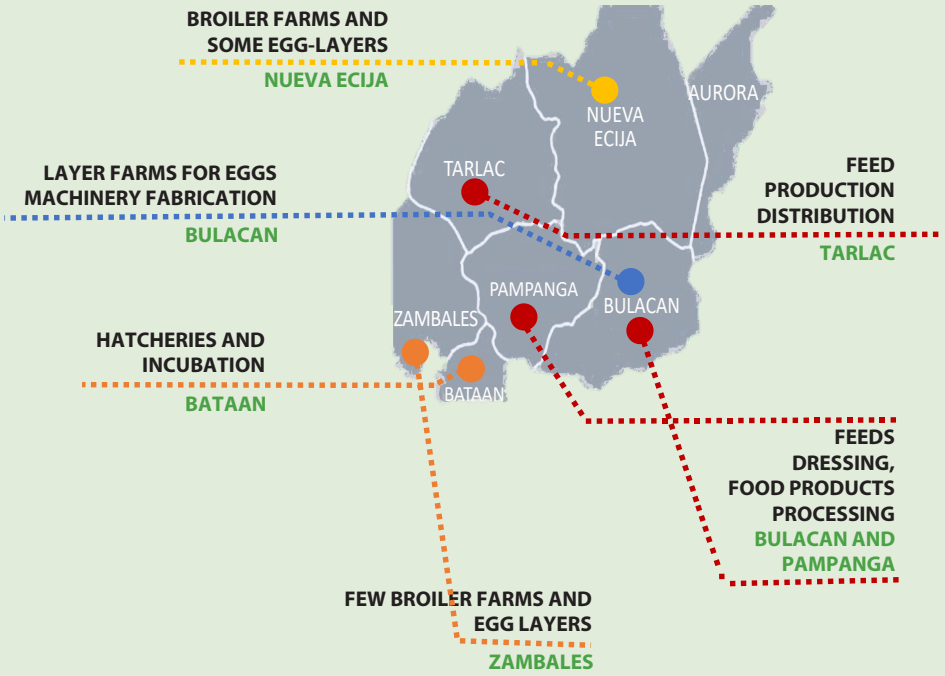
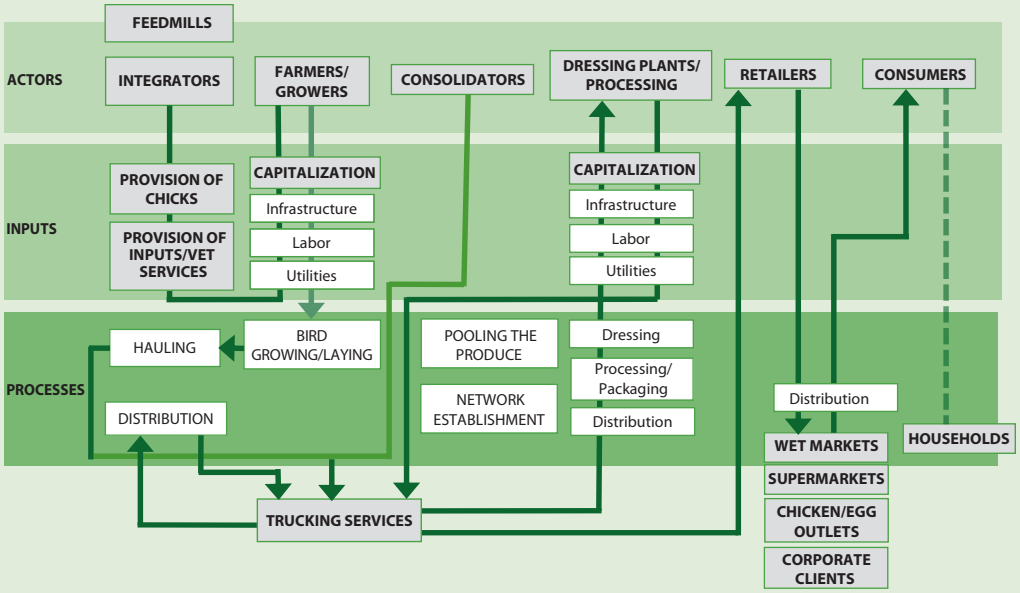


FIGURE 2

COMPILED INDUSTRY SUPPLY AND VALUE CHAIN STRUCTURE (CLSU-SERDAC, 2024, UNPUBLISHED)



Market Dynamics and Distribution Chain Analysis of Broiler in Central Luzon

As illustrated in Figure 3, profit margins in the poultry sector vary across stakeholders (Siervo, 2016). Growers earn between PHP0–16.6 per kg, traders add PHP4–5 per kg, and wholesaler-retailers markup PHP49.71–51.61 per kg. Retailers further increase prices by an additional PHP5–10 per kg. Government

FIGURE 3

INDUSTRY SEGMENT PRICE DISTRIBUTION (PHILIPPINE POULTRY BROILER INDUSTRY ROADMAP 2022–40) (*SIERVO, 2016)

STAKEHOLDERS	PRICING*	SALES/head	PRODUCT COST/head	PROFIT/head	% PROFIT SHARE	REALIZATION PROFIT
FARMERS/ GROWERS	+PHP 0-16.6/kg	PHP 144.50	PHP 109.11	PHP 35.39	65%	32–25 days
TRADERS/ CONSOLIDATORS	+PHP 4-5/kg mark-up	PHP 165.54	PHP 153.35	PHP 11.89	22%	Every day
WHOLESALERS-RETAILERS	+PHP 49.71-51.61/kg mark up	PHP 179.60	PHP 167.60	PHP 7.13	13%	Every day
RETAILERS	+PHP 5-10/kg mark up					

agencies, such as the DA and the Department of Trade and Industry (DTI), intervene occasionally to safeguard producers and consumers. In 2021, the poultry market experienced a 74.10% increase in price distribution, highlighting its volatility. Challenges include supply fluctuations, rising costs, and import dependence, stressing the need for policy interventions and industry support to ensure stability and growth.

Study Objectives

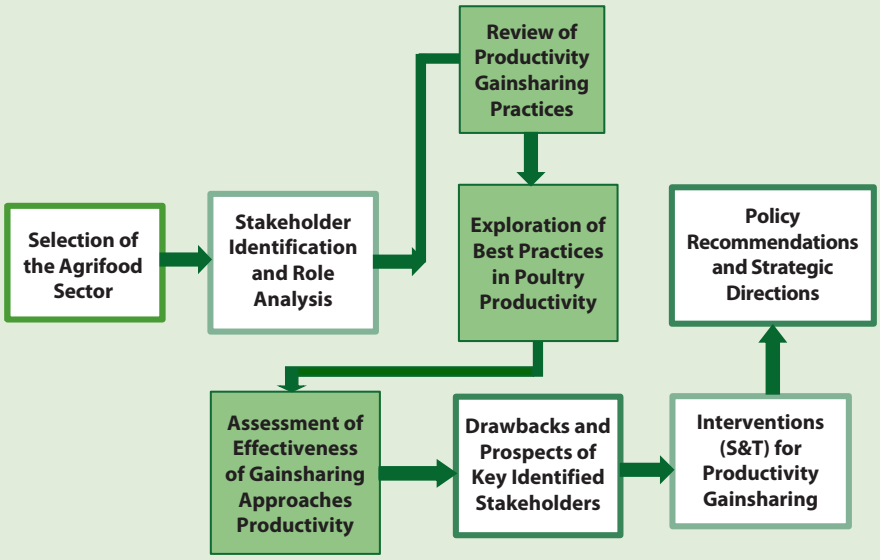
This study aims to assess, validate, and enhance productivity gainsharing practices within the Philippines Poultry Industry chain by analyzing the challenges, opportunities, and strategies for sustainable and inclusive growth. Specifically, this study examines inefficiencies in the supply chain, pricing disparities between smallholders and large integrators, and the impact of rising production costs and import competition. Through industry scanning, SWOT analysis, and stakeholder collaboration, the study will explore technological advancements, policy reforms, and inclusive business models (such as gainsharing and performance-based incentives) to improve operational efficiency and ensure fair market participation. The findings will contribute to ongoing efforts led by DOST and its partners to strengthen the poultry sector, enhance national food security, and promote long-term industry resilience.

Specifically, this study aims to:

1. Identify and analyze practices of selected poultry industry players in Central Luzon, including:
   - ✓ Established poultry integrators;
   - ✓ State universities and colleges (SUCs), higher education institutions (HEIs), and agricultural universities conducting research and development (R&D) for the poultry industry;
   - ✓ Individual small-scale holders;
   - ✓ Regulatory and monitoring agencies in the poultry industry chain.
2. Evaluate the roles of selected poultry stakeholders in the industry chain.
3. Review existing productivity gainsharing models in the industry through desk review, survey interviews, and agency report analysis.
4. Review and validate the existing SWOT of the local poultry supply chain in Central Luzon, the Philippines.

FIGURE 4

RESEARCH FRAMEWORK



5. Propose actionable recommendations and technological interventions to promote stakeholder collaboration and policy reforms through SWOT analysis and current situation validation.

Literature Review

The Philippines aims to enhance economic growth, competitiveness, and productivity to reduce poverty and increase employment opportunities. Productivity gainsharing, as emphasized by Tabladillo-Yanson (2013), can improve business efficiency and global competitiveness, yet its adoption remains a challenge. Businesses require encouragement to implement and understand gainsharing as a tool for enterprise growth.

The National Economic and Development Authority (NEDA) emphasizes labor productivity and job creation as vital factors for sustaining the labor market and improving overall welfare. Key drivers supporting these objectives include economic reforms, infrastructure projects, and human capital investments, particularly in health, education, and innovation. The Philippine Digital Workforce Competitiveness Act (RA 11927) supports workforce upskilling, whereas the "Build-Better-More" program complements human capital investments (NEDA, 2023).

The Productivity Incentives Act of 1990 promotes higher productivity, industrial harmony, and a shared sense of responsibility between workers and employers. It mandates that at least 50% of productivity gains be distributed to employees in the form of bonuses every six months, independent of any salary increases (Arellano Law Foundation, n.d.). In 2017, Senate Bill No. 1427 proposed amendments to the law to encourage broader business participation (Senate of the Philippines, n.d.).

DOST-PCAARRD supports poultry industry development through various initiatives. The Native Chicken Industry Strategic Plan has enhanced poultry production by increasing egg output to 120 eggs per hen annually and reducing mortality rates to 20% per cycle (Gomez, 2024a). These improvements contribute to economic efficiency and sustainability within the poultry sector.

Productivity Analysis

Productivity in the poultry industry is crucial for maintaining competitiveness and socioeconomic sustainability. Parry and Lacy (2002) define productivity as the optimal use of resources to maximize

output per unit of input. The Asian Productivity Organization (APO) describes productivity as the relationship between output (goods and services) and input (labor, materials, machinery, and energy), emphasizing efficiency in production processes (APO, 2015).

Concepts of Productivity and Gainsharing

Productivity: Smart management practices are critical to the success of the poultry industry. Productivity depends on input–output management, requiring an integrated approach that combines principles from economics and engineering. Holistic industry management considers factors such as market factors, economics, environment, and engineering, all of which influence economic efficiency.

Gainsharing: Gainsharing strategies enhance market performance and profitability in the poultry industry. These strategies foster collaboration through incentive systems that benefit all stakeholders. Chopra and Meindl (2016) highlighted that supply chain members align incentives to enhance profitability, ensure shared financial interests, and improve efficiency and productivity.

Productivity Gainsharing Models

Traditional Gainsharing: Traditional gainsharing measures overall productivity improvements within specific operations. In poultry farms, metrics such as feed conversion rates and production output determine the financial gains that will be distributed among employees. This reward system lowers costs while incentivizing workers (Armstrong et al., 2010).

Scanlon Plan: The Scanlon Plan involves employee participation in decision-making. Bonuses are based on labor costs relative to production value. This model promotes frequent suggestions from employees, thus enhancing workplace innovation. Studies indicate that firms implementing the Scanlon Plan exhibit higher levels of employee participation compared with those who do not (White, 1979).

Collaborative Contracting: This model establishes formal stakeholder agreements, defining shared goals and responsibilities. Contracts specify performance metrics and gainsharing arrangements, thereby fostering cooperation. McKinsey (2018) found that contractual relationships about industry-wide contracting models fostering cooperation, shared goals, and gainsharing between poultry growers and suppliers contributed to significant industry growth and improved business performance.

Interenterprise gainsharing fosters trust and communication among businesses in pursuit of shared objectives. Porter (1990) argued that comparative advantage drives performance when enterprises collaborate to manage risks and share rewards. Moreover, studies have demonstrated that effective interbusiness collaboration improves productivity (Fynes et al., 2005).

Shared Technology and Innovation: Joint investments in technology and research promote innovation, improving efficiency and reducing costs. The shared gains from technological advancements create a cycle of reinvestment in further research. Collaborative efforts to develop disease-resistant poultry strains or efficient feeding techniques benefit all stakeholders (Multistate Research Project NE2442, 2024).

Productivity Gainsharing in the Poultry Industry

In poultry management, increased expenses do not always result in higher levels of productivity. Competitive strategies focus on productivity gainsharing to enhance efficiency while reducing costs. The poultry sector in the Philippines uses productivity gainsharing models that incentivize employees and supply chain stakeholders (producers, suppliers, and distributors).

Productivity is measured by an organization's ability to efficiently produce goods that meet market demand while satisfying stakeholders' requirements. The fundamental aspects of productivity include inputs, several processes, and outputs (APO, 2022); however, a lack of stakeholder coordination limits innovation opportunities, thereby lowering productivity and restricting market growth.

Poor collaboration among industry players forces reliance on government and NGOs to resolve systemic challenges, undermining sustainable development. Inadequate coordination affects low-income

stakeholders, limiting their financial capacity and business growth. Collective resource pooling can address these challenges, enhance investments, and foster industry-wide expansion (Shrestha, 2010).

Recognizing these challenges, the Philippine Statistics Authority (PSA, 2023) launched the Integrated Survey on Labor and Employment to assess work practices. The survey collects data on unionism, collective bargaining, occupational safety, productivity programs, and the impacts of remote working during the COVID-19 pandemic. This initiative aims to improve employment conditions and worker well-being across sectors.

Various businesses in the Philippines implement gainsharing schemes and incentive programs. In 2019, 30.2% of companies adopted cash-based gainsharing, whereas 12.5% provided noncash incentives. Profit sharing was implemented by 5.6% of firms through direct cash payouts and 3.6% through a combination of cash and other benefits. Noncash incentives, including grocery items, were also commonly used. By 2021–22, many businesses had implemented productivity improvement programs (PIPs), with 66.1% adopting cash-based gainsharing and 33.9% using noncash incentives. Companies also prioritized continuous process improvement and customer satisfaction initiatives.

TABLE 1

TYPES OF GAINSHARING SCHEMES AND INCENTIVES

Particulars	2019–20		2021–22	
No establishment implemented PIPs	39.7% of the 38,305 establishments		40.7% of the 36,342 establishments	
Programs Implemented				
7S of Good Housekeeping	54.9%		64.3%	
Continuous Process Improvement	-		54.6%	
Client Satisfaction Measurement	45.0%		51.5%	
Suggestion/Feedback Scheme	45.0%		-	
Types of Gainsharing Schemes and Practices	***Cash***	***Noncash***	***Cash***	***Noncash***
Gainsharing	30.2%	12.5%	66.1%	33.9%
Profit Sharing	5.6%	3.6%	11.4%	5.7%
Employee Stocks/Option Plan		5.3%		
Grocery Items		42.3%		

Source: PSA (2021-22)

Methodology

Research Design

This study adopts a qualitative research design to explore the intricacies of productivity gainsharing within the poultry industry, focusing on the Central Luzon region. This studyexamines real-world practices and perspectives from key industry stakeholders, providing a nuanced understanding of the factors influencing productivity and collaboration in the sector.

Data Collection

A multifaceted approach was employed for data collection, combining desk reviews, surveys, and interviews to capture a comprehensive overview of the poultry industry's dynamics as follows:

Desk Review: A thorough review of existing literature, industry reports, and case studies from established poultry integrators was conducted to provide foundational insights into current practices and challenges within the industry.

Surveys: Targeted surveys were distributed to key institutions, including SUCs, HEIs, and agricultural universities conducting R&D focused on poultry. These surveys assessed the role of academic and research entities in driving innovation and productivity improvements within the sector.

Interviews: In-depth interviews were conducted with individual small-scale poultry holders, providing qualitative insights into the challenges and opportunities encountered by grassroots producers within a fragmented industry.

Agency Reports: Analyses of regulatory and monitoring agencies' reports provided regulatory perspectives on poultry industry practices, highlighting compliance challenges and potential areas for improvement.

Data Analysis

This study uses descriptive statistics to analyze data and identify trends, patterns, and key findings from the collected information. This approach enables a practical synthesis of qualitative and quantitative data, offering actionable insights into productivity gainsharing in the regional poultry industry.

Current State of Productivity Gainsharing in the Poultry Industry

Analysis of the Industry at the Regional Level

Through a study commissioned by DOST-III, the CLSU-SERDAC highlights key stakeholders in Central Luzon's poultry sector, including producers, integrators, researchers, and policymakers. Producers ensure product quality, while integrators provide essential inputs and streamline operations. University researchers drive innovation through R&D, with policymakers shaping regulations to improve industry standards. Moreover, small-scale poultry holders face challenges associated with market access, emphasizing the need for improved coordination and support.

The contract grower scheme connects small- and medium-scale broiler growers with large integrators (Appendix 3). Consequently, growers receive technical support, training, and access to high-quality inputsbased on their production performance. Incentives include free supplies and tailored support, leading to improved productivity; however, certain growers opt out owing to financial constraints and rely on traders and intermediaries for market access (Appendix 4).

Philippine Poultry Enterprises

The Philippine poultry industry attracts significant investments from large integrators that dominate the market. Large Integrator A, the country's biggest poultry producer, ranks 10th in Asia and 25th globally (Graber, 2023). Large Integrator B is the second largest in the country and a top broiler producer in Asia (WATT Poultry, 2022).

Both integrators are key members of the Philippine Association of Broiler Integrators (PABI) and the United Broiler Raisers Association (UBRA), managing the entire value chain from egg production to market distribution. They operate contract-growing schemes, supplying bulk chicken to urban centers, and account for approximately 75% of PABI's total output (Gonzales et al., 2012). Additionally, their collaborations with the government support food security efforts and contribute to improving livelihoods.

These integrators implement gainsharing incentives, such as performance-based bonuses, salary increases, and efficiency rewards. Sustainability efforts focus on solar energy, waste management, and antibiotic-free poultry. Investments in mega-farms, hatcheries, and processing plants further strengthen food security. Moreover, employee programs promote gender diversity, well-being, training, and innovation. CSR initiatives include disaster aid, feeding programs, and environmental efforts such as tree planting. Appendices 6 and 7 present details on productivity and pricing policies, respectively.

Optimizing Poultry Management in Universities in the Philippines

Universities in Central Luzon engage in diverse poultry farming practices, integrating instruction with income-generating activities (IGP). University A runs a layered project (1,000–2,000 heads) for faculty, staff, and institutional buyers. University B focuses on broiler farming (600 heads) and free farmer

training, and University C uses broilers for instruction but does not sell them to the market. University D manages broiler and layer operations, producing 2,000–4,500 eggs daily and offering discounts to bulk buyers. University E operates a layer farm that supports IGPs and academicsbut does not offer discounts. University F raises free-range, native, and broiler chickens, offering modest discounts and training. Finally, University G runs a large broiler operation (10,000 heads), focusing primarily on training and offering no pricing discounts.

Best practices highlight cost efficiency (University C), biosecurity, waste management, and sustainable feed sourcing (University D). University D also supports farmers through research grants and market assessments, whereas University E emphasizes organic, cage-free production. These universities contribute to sustainable, profitable, and community-oriented poultry education (Appendix 8).

Issues and Challenges in Productivity Gainsharing

This section outlines the challenges in implementing productivity-based pay (PBP) and gainsharing schemes. Employers often resist labor representation in pay determination due to concerns over financial transparency and the potential escalation toward unionism. At the same time, many believe incentives should be at the management's discretion. Effective implementation requires stronger labor-management consultations and well-defined productivity measures; however, head ratio (HR) officers sometimes resort to across-the-board PBP due to limited expertise. Establishing productivity parameters for support roles (e.g., admin, accounting) remains challenging, and cost measure data are often unavailable. Furthermore, companies commonly provide incentives based on overall performance rather than individual productivity.

The effective implementation of gainsharing practices are hindered based on the identified bottlenecks of the regulatory and monitoring agencies within the poultry industry chain in Central Luzon. This situation suggests that challenges, such as price fluctuations, access to information, regulatory barriers, geographic location, price volatility, and consumer preferences, are crucial to achieving regional poultry objectives and must be addressed immediately (CLSU-SERDAC, 2024, unpublished).

Furthermore, poultry growers, integrators, and other industry stakeholders are often bound by strict confidentiality agreements, limiting their ability to share critical data and insights related to productivity gainsharing. These agreements create significant barriers to transparency, making it difficult to obtain accurate and comprehensive information on farming practices, productivity metrics, and financial performance, which are key components of gainsharing models. Without access to these data, conducting a thorough analysis and successfully implementing productivity gainsharing strategies becomes a significant challenge.

Table 2 highlights key issues across three critical components of the poultry industry: feeds, veterinary services, and the market. These components were identified in a recent survey conducted by the regulatory and monitoring agencies within the poultry industry chain. Among the concerns, feed price fluctuations were cited as the most significant, affecting 67% of respondents. For veterinary services, the primary issue is geographic location, as identified by 38% of respondents. For the market, a significant concern is price volatility, cited by 42% of respondents.

TABLE 2

SECTORAL NEEDS AND URGENCY OF RESOLUTIONS

Key Issues in Feeds		Key Issues in Veterinary Services		Key Market Issues	
Supply Chain Disruptions	14%	Cost Constraints	29%	Limited Market Channels	25%
Price Fluctuations	67%	Geographic Location	38%	Price Volatility	42%
Quality Concerns	33%	Lack of Qualified Veterinarians	8%	Lack of Market Information	13%

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Key Issues in Feeds		Key Issues in Veterinary Services		Key Market Issues	
Access to Information	48%	Language Barriers	17%	Quality Standards	33%
Regulatory Barriers	41%	Availability	17%	Geographic Location	26%
Geographic Location	45%	Lack of Awareness	8%	Competition	17%
				Consumer Preferences	29%

Note: Values represent the percentage of respondents who rated the challenges as highly urgent and important.
Source: CLSU-SERDAC, 2024, unpublished.

Assessment of Best Practices

The following best practices were identified among key identified stakeholders:

Gainsharing Practices

Profit-Sharing Programs and Schemes: Integrators structure profit-sharing schemes annually based on a grower's performance metrics, specifically the feed conversion ratio (FCR) and HR. Typically, growers must achieve a minimum FCR of 1.6 and an HR of at least 95%.

Performance Bonuses and Incentives: Growers who meet or exceed the agreed-upon FCR and HR per grow cycle are often rewarded with performance bonuses in the form of monetary compensation or poultry equipment, such as vaccines and vitamins. Additionally, exceptional performers may receive year-end awards, including titles such as "Grower of the Year" and "Partner of the Year," alongside complementary incentives.

Continuous Improvement Programs: Integrators maintain rigorous management supervision by deploying a veterinary representative to each contracted farm on a weekly basis or more frequently if needed.

Output-Based Bonuses and Rewards: Farm owners offer incentives and bonuses to employees who meet the integrator's required quotas. Similarly, integrators reward contracted growers who achieve and sustain their performance targets. Typically, these rewards are given in the form of monetary compensation or gifts at the end of the year.

Resource Utilization Programs: The farm optimizes the use of input materials provided by the integrator to reduce additional input costs.

Wellness and Well-Being Programs: The farm implements wellness programs for its employees, focusing on health and fitness by offering exercise programs for onsite residents.

Lean Agriculture Practices: The farm adheres strictly to standards set by government agencies, such as the Department of Environment and Natural Resources and the Department of Health.

Cross-Training Programs: The farm actively engages in seminars and training sessions organized by integrators to advance their skills and expertise in poultry management and biosecurity measures. This support enables growers to refine their practices and improve production efficiency.

Gainsharing Pricing Policies

Profit-Sharing Agreements: Profit-sharing agreements are typically defined by the integrator's policies and practices but are carefully designed to ensure favorable returns for the grower. Under these agreements, the integrator provides essential inputs, such as chicks, vitamins, vaccines, and feed, while the grower contributes land, facilities, materials, labor, utilities, and other operational resources. Based on the grower's experience, while some integrators take time to release payments, others are prompt and supportive, enabling growers to smoothly transition into their next production cycle.

Performance-Based Contracting: Bonuses are contingent on meeting established HR and FCR targets, with performance-based rewards structured accordingly.

Volume-Based Pricing Tiers: Pricing tiers are generally based on the farm's HR performance.

Flexible Pricing Linked to Market Fluctuations: Although pricing is usually fixed based on FCR, integrators offer flexible prices in response to unforeseen market fluctuations to help mitigate potential losses for growers.

Technology Adoption Incentives: Although growers often initiate technological innovations independently, integrators encourage the adoption of production-efficient technologies. These initiatives are sometimes incorporated into farm performance evaluations and may be recognized through additional incentives.

The following gains can be realized by assessing productivity management strategies (Appendix 9).

Large Integrators A and B can lessen the impact of local disruptions by securing a stable supply of raw materials through the adopted multifaceted approach. Furthermore, local sourcing of corn reduces transportation costs and import duties, thereby lowering overall feed cost. Large Integrators A and B foster community relationships, potentially leading to better prices and more reliable supply chains. Moreover, repurposing by-products from poultry processing, flourmills, and breweries minimizes waste disposal costs while enhancing feed nutritional value, potentially increasing output and profitability. This practice also enhances their sustainability profile, serving as a key market differentiator.

For partner stakeholders (local farmers and suppliers), stable demand ensures a consistent market, providing local farmers with the confidence to invest. Furthermore, it creates opportunities for innovation and crop diversification.

Assessing Productivity Gainsharing in Central Luzon Universities: Knowledge Sharing and Community Engagement

Universities A, B, and C demonstrate diverse approaches to poultry production while enhancing educational outcomes and economic viability. University A integrates income-generating activities to enhance learning, University B engages the community through free training for local farmers, and University C prioritizes educational outreach through seminars. Similarly, Universities D and E implement innovative strategies to increase productivity, with University D focusing on a dual production model that prioritizes biosecurity and sustainability to enhance profitability. At the same time, University E adapts to market trends by producing organic chicken to meet the growing demand for ethically sourced poultry.

SWOT Analysis

The DA's Broiler Roadmap integrates a comprehensive SWOT analysis of the poultry industry (DA, 2022), revealing a mix of strengths, weaknesses, opportunities, and threats. Strengths include technical expertise that aligns with international standards and its ability to rapidly expand production by importing hatching eggs. Nonetheless, several weaknesses persist, such as heavy reliance on imported breeding stocks and feeds, inadequate disease surveillance, and high transportation costs, thereby diminishing competitiveness.

Growth opportunities exist due to rising chicken demand driven by population growth and protein shortages. Additionally, the country's relatively low per capita meat consumption indicates significant potential for increased chicken intake. The expanding domestic and export markets, particularly those with HACCP certification, further enhance this potential. Furthermore, the growing preference for ready-to-cook and niche products such as free-range and halal poultry presents promising avenues for market diversification and growth.

Conversely, the poultry industry faces several threats, including land use conflicts caused by urban encroachment, competition from cheaper imports, and ongoing disease risks, particularly avian influenza. Additionally, the rise of online selling raises food safety concerns, while shifting consumer preferences toward healthier, plant-based options challenge traditional poultry sales. Climate change and supply chain disruptions further complicate the landscape, alongside a notable trend of veterinary professionals moving away from poultry practice. Please see Appendix (10) for the SWOT summary analysis.

Recommendations

Tabladillo-Yanson (2013) identified several challenges in implementing PBP and gainsharing systems in the Philippines. Employers often resist labor representation while determining pay due to concerns over financial transparency and the risk of increased unionism and collective bargaining. Some employers prefer to control additional incentives themselves, whereas HR officers may oversimplify PBP by applying it uniformly due to limited expertise. Additionally, setting relevant productivity parameters for support areas and measuring improvements remains challenging, hindering widespread adoption.

Gomez (2024b) emphasized the need for legislative, administrative, and scientific measures to improve the poultry industry. A proposed livestock bill aims to allocate PHP15 billion to the Livestock, Poultry, and Dairy Competitiveness Enhancement Fund to support disease control, repopulation, and food safety programs, addressing challenges such as rising costs and disease outbreaks. Administrative measures, such as simplifying transport procedures for broiler chickens, seek to improve supply chain efficiency, whereas scientific innovations focus on tackling antimicrobial resistance in poultry farms. This approach includes stricter antibiotic use policies and the implementation of environmental monitoring and disease surveillance systems. Governmental interventions, potential pricing adjustments, and stronger public support for locally produced poultry are crucial to stabilizing the market and ensuring the industry's sustainability.

Stakeholders in Central Luzon at the municipal and provincial levels acknowledge the impact of regulatory policies on the poultry industry, particularly in areas such as disease control, feed safety, environmental management, and trade guidelines. However, the regulatory and monitoring agencies within the poultry industry chain are encouraged to enhance awareness campaigns to improve communication about existing regulations and their benefits. Additionally, policy reviews are recommended to address gaps in coverage and increase stakeholder involvement in policy development, ensuring that regulations are more aligned with industry needs (DOST-III-SERDAC, 2024, unpublished).

Government Technological Intervention

Given the pressing challenges faced by the poultry industry, government intervention is essential to promote efficiency and sustainable practices. DOST-III has undertaken efforts to upgrade technological advancements to boost food production and enhance food security. To address various socioeconomic issues, industries are continually evolving through innovation. A key driver of this evolution is ongoing modernization, characterized by the adoption of Industry 4.0 technologies, such as IoT and data analytics, which are transforming industries and facilitating growth.

In Central Luzon, the poultry industry significantly contributes to the local economy but faces challenges in its supply and value chain (SVC). To address these issues, DOST-III developed the Integrated Information Network System for Real-Time Industry Forecasting (iINSERT, iForecast). This ICT-driven system enhances real-time connectivity across the poultry network, providing industry players with up-to-date supply–demand data and forecasting tools for improved decision-making.

Designed specifically for small-scale poultry farmers, it includes an e-marketplace that facilitates secure market access, thereby expanding their reach and income potential. The system strengthens the industry's overall sustainability by bridging gaps in supply chain knowledge, disease control, production efficiency, and market intelligence.

This initiative supports technological adoption in the poultry sector, aligning with the goals of sustainable rural development, poverty reduction, and food security in Central Luzon. Increased access to real-time data and market opportunities empowers small-scale poultry farmers to boost productivity, profitability, and regional economic contribution, fostering a more resilient and inclusive poultry industry.

Project Purpose and Technology Roadmap

The iINSERT iForecast project aims to establish a cloud-based web system that integrates SVC mapping and analysis data. This system provides stakeholders with real-time insights into the poultry industry's daily operations, serving as a vital resource for understanding supply and demand trends and improving decision-making among poultry farmers and associations.

The SVC mapping aligns with DOST-III's initiative to enhance competitiveness through Industry 4.0 technologies as part of their Small Enterprise Technology Upgrading Program (SETUP). SETUP focuses on sustainable economic growth, market competitiveness, capable human capital, and responsive science and technology support infrastructure.

Research on the poultry industry in Central Luzon is expected to yield valuable outcomes, such as identifying efficiency gaps in the SVC. Stakeholders can optimize resource allocation, reduce costs, and improve productivity by understanding resource flows, such as feed and vaccines. Mapping production stages enhances quality control and ensures product safety and consistency. Market opportunities can also be explored through trend analysis, leading to better product diversification and targeted marketing strategies. Strengthening collaboration among farmers, processors, distributors, and retailers will promote coordinated efforts to tackle industry challenges. Additionally, research insights may inform policymakers on necessary regulatory reforms and infrastructure investments that support sustainable growth.

Furthermore, understanding industry risks—such as disease outbreaks—will enable the development of risk mitigation strategies and contingency plans. This initiative may also highlight opportunities for adopting automation and data analytics technologies to improve efficiency and competitiveness. Environmental impact assessments of poultry production will guide sustainability initiatives, such as waste reduction and minimizing carbon footprint, while identifying training needs to enhance industry stakeholders' resilience. Through a comprehensive industry review and technology-driven intervention, all participants in the poultry sector benefit from DOST-III's strategic efforts (Appendix 11).

Conclusion

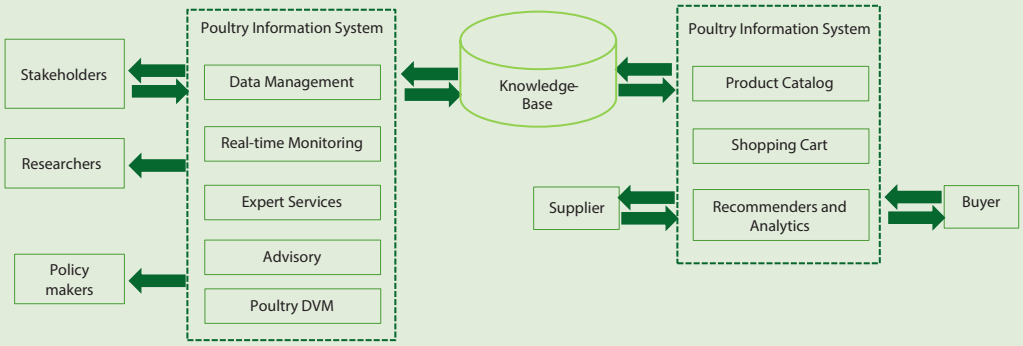
The SVC mapping and analysis of the poultry industry in Central Luzon aim to address market inefficiencies through strategic interventions under the National S&T Plan. This initiative supports regional economic growth by addressing industry and firm-level constraints, recognizing the poultry sector as a crucial driver of Central Luzon's economy. Establishing a more efficient supply chain will improve stakeholder coordination, lower input costs, increase operational flexibility, and reduce production expenses. These enhancements will stabilize the prices of poultry products and feed inputs, fostering continued investment and long-term sustainability among poultry producers.

A key component of this initiative is the proposed Poultry Industry Information System (iINSERT, iForecast), which is designed to improve industry efficiency and support stakeholders. This system will feature a personalized dashboard for farmers, processors, and distributors, offering real-time market data, product listings, and an online marketplace with secure payment and logistics services. It will also include training resources and industry updates tailored to the specific needs of Central Luzon's poultry sector (Figure 5).

The system's database will store critical industry information, including stakeholder data, product specifications, market trends, and transaction records. A blockchain-powered traceability system assigns

FIGURE 5

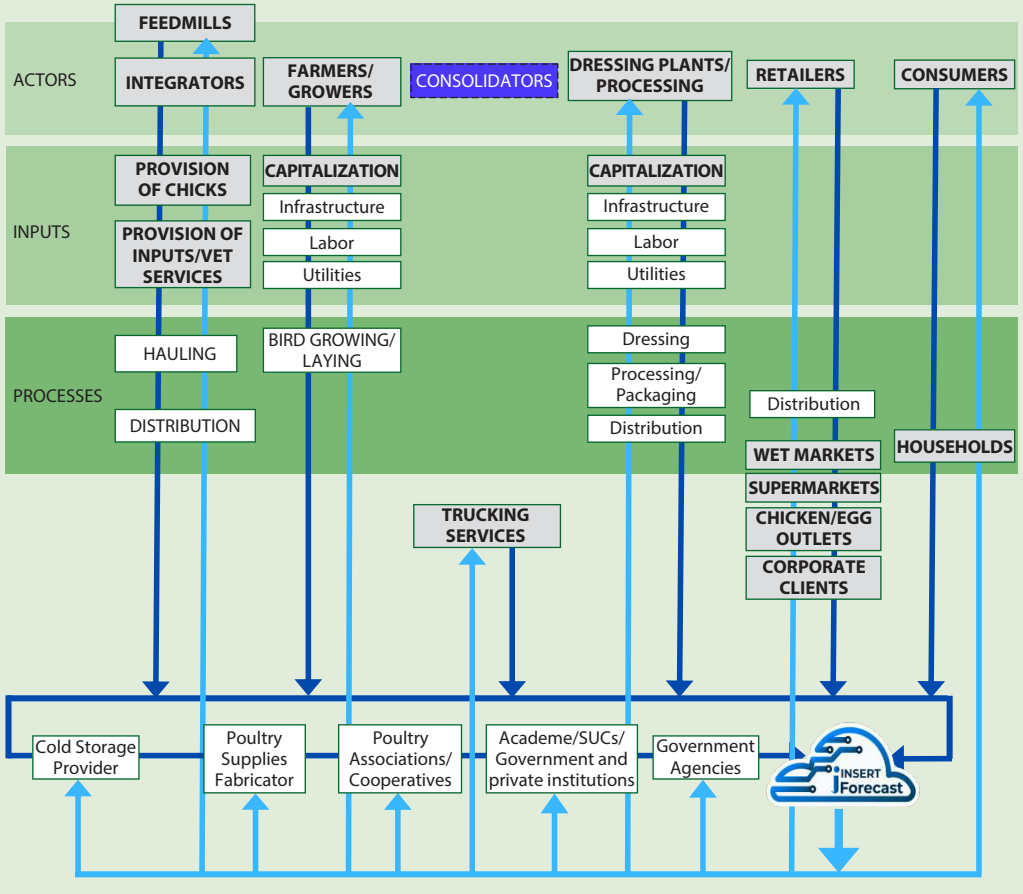
DATA FLOW CHART OF THE SYSTEM



QR codes to poultry products, enabling seamless tracking from farm to table. This feature enhances transparency, strengthens food safety measures, and improves consumer confidence in the poultry supply chain.

FIGURE 6

INTEGRATED SUPPLY AND MAPPING OF THE INDUSTRY WITH TECHNOLOGICAL INTERVENTION



Industry players will receive comprehensive training and technical support to maximize the system's effectiveness. Stakeholders will be encouraged to subscribe and actively participate to ensure the platform's sustainability and long-term impact. By expanding market access, increasing productivity, and fostering collaboration, this initiative will significantly enhance the resilience and competitiveness of the poultry industry in Central Luzon.

Chopra and Meindl (2016) highlighted the importance of accurate forecasting in optimizing supply chain performance. Improved collaboration among industry players leads to better demand predictions and minimizes inefficiencies and disruptions. While establishing strong partnerships requires time and effort, long-term benefits (such as reduced volatility and increased profitability) far outweigh the costs, reinforcing the need for a well-coordinated supply chain.

DOST-III's initiative to integrate poultry industry stakeholders in Central Luzon serves as a model for nationwide implementation. The program strengthens food security, enhances sustainability, and boosts productivity by fostering collaboration and leveraging digital tools. This holistic approach addresses immediate industry challenges and lays the foundation for long-term innovation and economic growth (Figure 6). The poultry sector can serve as a benchmark for other agricultural industries through technology-driven interventions and efficient supply chain management, driving sustainable rural development and economic resilience.

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Appendices

APPENDIX 1. CHICKEN MEAT PRODUCTION

Chicken Meat Production (1,000 Metric Tons Ready-to-Cook Equivalent)						
Year	Production	Domestic Consumption	Variance		Imports	Exports
2020	*1305*	*1615*	*310*	*–19.20%*	*336*	*0*
2021	*1343*	*1781*	*438*	*–24.59%*	*437*	*0*
2022	*1437*	*1917*	*480*	*–25.04%*	*496*	*0*
2023	*1499*	*1942*	*443*	*22.81%*	*438*	*0*
*2024**	*1540*	*1998*	*458*	*–22.92%*	*465*	*0*

Note: Chicken feet are excluded.
*As of July 2024
Source: USDA FAS

APPENDIX 2. CLASSIFICATION OF BROILER FARMS IN THE PHILIPPINES

	Smallholder	Commercial	
Type of Operation	Small	Modern technology (non-integrator)	Modern technology (integrator)
Number of Birds	<1,000	20,000/cycle	40,000 birds/cycle
Sources of Feeds and DOCs	Buys feeds	Purchase of DOCs and feeds with feed mixing	Import GP/PS (parent stock) with breeder farm and feed mills
Record Keeping	Lacking	Good	Excellent
Business Permits	Absent	Present	Present
Type of Operation	Backyard	Modern technology (non-integrator)	Modern technology (integrator)

Sources: PSA email communication on definitions (November 2020; USDA FAS, 2020; Gonzales, 2012)
Note: Adopted and enhanced the term "Smallhold" as standardized by the PSA in 2020, previously "Backyard"

APPENDIX 3. KEY POULTRY STAKEHOLDERS IN CENTRAL LUZON

Terms	Definition
Poultry Industry Stakeholders:	Individuals, businesses, or organizations directly or indirectly involved in the poultry industry in Central Luzon
Registered Poultry Farms:	Farms officially recognized and licensed by the relevant government authorities to operate as poultry farms in Central Luzon
Poultry Integrator:	Companies or entities integrate various stages of the poultry production process, often owning or controlling multiple stages from breeding to processing.
Researchers:	Individuals or teams engaged in academic or applied research related to the poultry industry in Central Luzon, Philippines
Policymakers:	Individuals or government entities responsible for developing regulations, policies, and initiatives affecting the poultry industry in Central Luzon

Source: Central Luzon State University Socioeconomic Research and Data Analytics Center. Value Chain Analysis and Forecasting of the Poultry Industry in Region III, 2024 (Unpublished)

APPENDIX 4. BENEFITS AND DYNAMICS OF THE CONTRACT GROWER SCHEME

Aspect	Details
Relationship	Small and medium broiler growers with large integrators
Influencing Factors	Quality of support and access to quality inputs (chicks, feeds)
Benefits Received	Technical support, training, access to quality inputs, marketing support, and subsidies for other raw materials
Performance Determinants	The volume of production, timely reporting, length of the contract, and quality standards compliance (FCR must be 200–300 grams below the live weight; ideal FCR is 1.6 kg)
Incentives	Free supplies (feeds, chicks), additional technical training sessions, and subsidies, such as: a. Best performance = 50% discount for other input materials, such as vaccines, medication, and LPG b. Moderately best performance = 25% discount on other input materials, such as vaccines, medication, and LPG
Disincentives	If the grower was unable to meet the requirements set by the integrator, a payment deduction may be applicable, negatively affecting the grower's sales productivity.
Access to Support	Based on productivity levels, support is received weekly or as needed.
Management Feedback	Integrators and growers are constantly communicating their feedback with each other to improve productivity levels.
Feedback Action	A specific grower raised a concern regarding delays in the pick-up schedule initially agreed upon with the integrator. Following an investigation by the integrator management, the issue was analyzed, leading to improvements in pick-up timing. Subsequently, the integrator consistently adhered to the agreed schedule. Additionally, there was an adjustment for payment (an additional USD0.089/PHP5.00). In contrast, the integrator relayed their feedback to the grower via a representative (usually a veterinarian) during each weekly analysis. The primary feedback given to growers focuses on facility improvements. To address this, the grower is currently exploring the potential adoption of solar technology to enhance production efficiency.
Outcome	Significant improvement in farm productivity

Source: DOST-III Survey (2024)

APPENDIX 5. BASIC CONCEPT OF BROILER INTEGRATOR PRODUCTIVITY

Enterprise	Inputs	Processes	Outputs
Large Integrator A	(Raw Materials) Day-old chicks Feeds Vaccines and vitamins Disinfectant (Direct Materials) Capital *Labor *Materials *Utilities -Logistics	**Rearing** Owned farm or contract growers ↓ **Harvesting** Dressing plants (Owned/Toll)	**Poultry and fresh meats** -Chicken (three-way, whole, cuts, and timplados) -Range chicken and processed meats (chicken nuggets, hotdogs, etc.)
Large Integrator B			**Fresh chicken** (whole cut-ups) *Ready-to-cook chicken, roasted chicken, vegan chicken, and range chicken*

Note: For the rearing of chicks, a contract growing system is implemented (shoulder the Direct Costs), usually called bought-in services.

APPENDIX 6. GAINSHARING PRACTICES EMPLOYED BY LEADING POULTRY COMPANIES IN THE PHILIPPINES FOR INTERNAL STAKEHOLDERS

Gainsharing Practices	Large Integrator A^	Large Integrator B^
1. Performance Bonuses, Incentives, and Shared Risk and Reward Structure	Employee Hiring and Benefits Diversity and Equal Opportunity	Encourage employees to participate in developing leadership and communication skills under the guidance of Toastmasters International. The reward for employees for any advancement certification is based on salary increases ranging from 5% to 15%. Performance bonus incentives are given to employees within a farm based on the volume of chicken produced per harvest period. Various factors are considered, and bonus incentives are computed based on the broiler productivity index, with the corresponding incentives distributed to the total number of employees. The computation of the broiler productivity index is as follows: BPI = [(HR x ALW) / FCR] x Age wherein, HR = harvest recovery; ALW = average live weight; FCR = feed conversion ratio; Age = growth stage.
2. Cost Savings: Sharing Cost-Reduction Programs and Incentives	Use solar power energy and efficient waste management systems to reduce electricity bills and vulnerability to energy price fluctuations. Modern feeding and watering systems enhance the FCR, yielding healthier flocks and maximized productivity.	Large Integrator B employs Controllers 1 and 2. Controller 1 is a much more conventional controller, whereas Controller 2 is an automated controller. Depending upon the employee's care management, incentives are given to the employee as they achieve their desired target with certain controller settings that establish their parameters.
3. Continuous Improvement Programs and Initiatives	Invest in a mega poultry farm to boost and support the country's food security.	Continuously investing in company-owned facilities in Philippines, such as grandparent farms, parent stock farms, hatcheries, dressing plants, feed mills, and cool-cell broiler complexes.
4. Sustainability Programs and Initiatives	Employs a sustainability governance structure that ensures the company pursues a sustainable business model with a positive impact on society and the environment	Continuous commitment to producing "No Antibiotics Ever" and initial commitment to "No Medications Ever" are implemented
5. Resource Utilization Programs		Continuous improvement is reflected in expanded product offerings, innovative solutions, and employer brand value.
6. Cultural Adaptation	Promotion of Gender Diversity and Inclusion	

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Gainsharing Practices	Large Integrator A^	Large Integrator B^
7. Wellness and Well-Being Programs	Continue to promote employees' health, well-being, and personal development through various programs. These include personal effectiveness training, the Code of Champions initiative, work–life harmony workshops, and Malasakit learning sessions. Alternative topics include financial wellness, fostering creativity at work, and effective communication and presentation skills.	Promotes and inspires a healthier and happier workforce in the Fit for Life Program - Zumba Lessons - Onsite check-ups - Biking - Running
8. Lean Agriculture Practices	Use of animal waste for biomass energy production Poultry processing of by-products, such as feathers, offal, and blood, are rendered and used as raw materials for feed manufacturing. Certification of Good Manufacturing Practices, Hazard Analysis, and Critical Control Points (HACCP) Providing opportunities to local farmers for chicken feed production, primarily as suppliers of raw materials such as cassava and corn	The company adheres to global poultry farming standards, ensuring the chickens are free from antibiotics and growth hormones.
9. Cross-Training Programs	Employee Training and Development Offers courses on leadership and management, sales, logistics, poultry and livestock slaughtering, and feed milling Talent development is reinforced by establishing employee development plans that are based on performance and competency gaps as well as ensuring their effective implementation.	An innovation summit is an annual internal gathering of various departments to share insights and perspectives to shape a brighter future for the company. It is a dynamic platform for employees to train and channel their passion and industry expertise.
10. Corporate Social Responsibility	Malasakit Programs - Regenerative agriculture for cassava farmers - Disasters aid - Partnership with government feeding programs nationwide (NutriBun) - Tree planting initiatives - Direct corn buying program - Donation drives	BC Foundation - Donation drives - Partnership in feeding programs - Webinars and training for chicken and egg resellers - Anti-rabies campaign program (free vaccination for dogs and cats) - Tree planting initiatives

Sources: ^Integrator A 2023 Sustainability Report/Integrator B Official Website
Note: The identities of the integrators were withheld to ensure confidentiality.

APPENDIX 7. GAINSHARING PRICING POLICIES OBSERVED BY ENTERPRISES FOR EXTERNAL STAKEHOLDERS

Large Integrator A		Large Integrator B		Gainsharing Pricing Policies in Agribusiness Enterprises
Micro-Enterprise Program		**Reseller Program**		
Chicken Community Reseller Program *Onsite Selling and Community Reseller Program*		Large Integrator B Fresh Reseller	Provides discounts and benefits by reselling Large Integrator B's fresh chicken products *(Discount values were not published.)*	Profit Sharing Agreements Performance-Based Contracting Quality Premium Programs
Franchise Program	The duration to achieve a return on investment (ROI) varies by location; however, on average, it is approximately 18 months. The percentage range for the cost of goods sold is 55%–65%. Free cooking training	Large Integrator B: Agro Reseller Partner reseller of Chooks-To-Go, using roasters and other frozen chicken products		
Chicken Contract Growing Offers opportunities for contract growth to agri-entrepreneurs. An agreement will be made between Large Integrator A and the business partner to grow broiler chicks to produce grown broilers at a marketable size, at the right volume, and at the right time. Quality standards must be met at the least possible cost, and income can be derived from farm production efficiencies through harvest recovery, average live weight, and feed conversion ratio.	Large Integrator A undertakings Day-Old Chicks Feeds Vaccines and Medicines Technical Support Laboratory Services Delivery and Hauling Services Competitive Payment Scheme	Contract growing consistently improves performance (HR%, ALW, and FCR) Unparalleled experience from internal grow-out farms modern technologies used in internal facilities ISO-certified feed mills and hatcheries Can connect you with banking institutions	Large Integrator B undertakings High-quality day-old chicks High-quality feeds Animal health and diagnostic services Highly competitive payment scheme Assistance from professional technicians Broiler management guide Providing technical advice on farm operations	Technology Adoption Incentives Quality premium programs Profit sharing agreements Performance-based contracting

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Large Integrator A	Large Integrator B		Gainsharing Pricing Policies in Agribusiness Enterprises
Micro-Enterprise Program	Reseller Program		
	Contract Breeding: Contract breeder will provide the infrastructure, while Large Integrator B supplies broiler breeder chicks, feeds, medicines, vaccines, and technical guidance for efficiently growing and raising breeder hens and cockerels.	Bond Requirements Site Inspection Requirements Documentary Requirements	Profit Sharing Agreements Performance-based contracting Quality premium programs technology adoption incentives
	Cage-Free Eggs: Large Integrator B offers cage-free egg partnerships that offer healthier eggs through sustainable, ethical, humane, cage-free farming practices, producing happy and healthy chickens, resulting in high-quality eggs and products. This initiative also aims to help business partners embrace a more socially responsible and environmentally sustainable approach to egg production.		

Note: The identities of the integrators were withheld to ensure confidentiality.

APPENDIX 8. POULTRY MODULES FROM CENTRAL LUZON AGRICULTURAL UNIVERSITY

Aspect	Type of Operation	Volume of Operation	Operational Structure	Practices			
				Management	Market Customers	Incentives	Knowledge Transfer
University A	Layer	1,000–2,000 heads	IGP*	Faculty	Faculty, Staff, Students, and Institutional Buyers	PHP4–5/ tray	Extension Activities
University B	Broiler	600 heads	Partnership with a Government Agricultural Agency	Faculty	Farmers and Beneficiaries	Free**	Training
University C	Broiler	2,000 heads	Instructional Purpose	Faculty	not specified	None	Seminar
University D	Broiler/ Layer	2,000–4,500 eggs/day	IGP*	University Business Affairs Program	University Employees, Students, and nearby Barangays	Discounts apply only to wholesal-ers or those who buy 1,000 eggs or more	Benchmark-ing Activities
University E	Layer	-not provided	IGP*	Faculty	University Employees, Students, Market Vendors, and Community	No Discounts	Webinars
University F	Layer, Broiler (Free-Range and Native Chicken)	2,000 heads	IGP*	Business and Auxiliary Services	University Staff and Employees, Students	Discount (PHP1–2 from SRP)	Training and Seminars
University G	Broiler	10,000 heads	IGP*	Office of Business Affairs	General Public	not provided	Training and Seminars

Note: *Simultaneously supports the research and academic activities of the Agriculture program
**Funded by a partnered Agricultural Government Agency
The identities of the universities were withheld to ensure confidentiality.

APPENDIX 9. SAMPLE PRODUCTIVITY MANAGEMENT CYCLE OF LARGE INTEGRATORS

Productivity Management Cycle of Large Integrators			
PLAN	**DO**	**CHECK**	**ACTION**
Raw material sourcing and supply chain risk mitigation: Partner with local farmers to reduce dependency on imports	Stable supply Local and international sourcing: Continuous partnerships with existing and new suppliers through regular negotiations and contracts with renewal options	Local partnerships: Regularly review and ensure the effectiveness of local sourcing and supplier agreements.	Maximized resource utilization: Poultry processing wastes, flourmill wastes, and brewery wastes are repurposed as raw materials.
Risk management of raw materials supply chain	Disruption preparedness: Implementation of internal controls and policies to manage risks, as well as daily monitoring and strategic positioning of facilities.	Control Assessment: Effective monitoring and performance evaluation of risk management controls	Control Implementation: Effective maintenance practices and strict biosecurity measures to manage significant operational problems and occasional disease outbreaks
Food safety and environmental compliance	Regulatory Oversight: Establish systems to manage food safety risks during processing.	Quality assurance: Ensure adherence to quality and safety standards through system maintenance.	Established distribution infrastructure: Cold storage facilities and third-party vehicle contracts ensure efficient product distribution.
Innovative product development focuses on improving innovation and efficiency to meet market demands and strengthen its market position compared to competitors.	R&D Investment: The food segment develops and tests new products, improves operational efficiency through technology, and enhances feed conversion and harvest recovery.	Market adaptation: Extensive distribution and dealer network for local and export markets with continuous assessment and adaptation to maintain competitiveness and address market conditions.	Food segment establishment: The food segment sells its products through three main channels: general trade, modern trade, and institutional accounts. Prepared and packaged food products are exported abroad.

Source: Large Integrator Annual Report/Official Website

APPENDIX 10. SWOT ANALYSIS AT THE POULTRY INDUSTRY LEVEL

ASPECT	PARAMETERS
Strengths	- Technical expertise aligned with international standards - High level of self-sufficiency with quick expansion capabilities via the importation of hatching eggs
Weaknesses	- Dependence on imported breeding stocks, feeds, and veterinary supplies - Weak compliance with veterinary regulations and inadequate reporting and feedback mechanisms - Limited accredited poultry dressing plants affecting sanitation - High transport costs and logistical challenges reduce competitiveness - Lack of accessible market information creates pricing disconnects - Competition from cheaper imports and changing consumer preferences - Challenges in waste management and environmental impact - Confusion in regulatory oversight of chicken meat and processed products
Opportunities	- Rising demand for chicken due to population growth and protein shortages - Low per capita meat consumption allows for increased chicken intake - Expand domestic and export markets with HACCP certification - Shift toward ready-to-cook and online delivery options - Niche markets for free-range, halal, and organic poultry products - Collaboration with academic institutions to enhance innovation in production
Threats	- Land-use conflicts due to zoning policies and urban encroachment - Influx of cheaper imports undermining local production profitability - Ongoing disease risks, particularly avian influenza - Food safety issues arising from increased online selling - Changing consumer preferences for healthier and plant-based options - Impacts of climate change and rising costs of raw materials - Supply chain disruptions highlighted by the pandemic - The shift of veterinary professionals to companion animal practice affects poultry support

Note: This summary is based on the SWOT analysis of the poultry industry presented in the Philippine Poultry Association. Broiler Industry Roadmap 2022–40 by the Department of Agriculture, Bureau of Agricultural Research (2022)

APPENDIX 11. BENEFITS OF SYSTEM DEVELOPMENT TO INDUSTRY

Operational Terms	Benefits of System Development
Poultry industry stakeholders:	• Gain insights into the dynamics of the poultry value chain in Central Luzon and identify opportunities for optimization and growth. • Understand market trends and forecasting data to make informed decisions about production, distribution, and investment. • Identify potential areas for collaboration and partnership within the industry value chain to enhance efficiency and competitiveness. • Access information about best practices, technological advancements, and regulatory developments that can impact operations.
Registered poultry farms:	• Obtain valuable market intelligence to optimize production planning and resource allocation. • Identify potential gaps or inefficiencies in operations and the supply chain to enable targeted improvements. • Understanding consumer preferences and market demands to tailor products and services accordingly. • Access forecasting data to make informed decisions about future expansion, diversification, or specialization.
Hatchery: Breeder (Broiler): Layer breeder: Poultry integrator:	• Gain insights into the demand for their products and services, allowing for better capacity planning and resource management. • Identify opportunities for vertical integration and diversification within the poultry value chain. • Understand market trends and consumer preferences to optimize breeding programs and product offerings. • Access forecasting data to anticipate future demand for chicks, breeding stock, and related services.
Poultry supply: Egg distributors: Dressing plants:	• Obtain valuable market intelligence to optimize inventory management and procurement strategies. • Identify potential opportunities for expansion or diversification within the poultry supply chain. • Understand market trends and consumer preferences to tailor product offerings and distribution channels. • Access forecasting data to anticipate fluctuations in demand and plan production and distribution schedules accordingly.
Poultry association: Cooperative:	• Gain insights into industry-wide trends and challenges to advocate for policies and initiatives that benefit members. • Identify collective action and collaboration opportunities to address common issues or pursue shared objectives. • Access research findings and data to support advocacy efforts and decision-making processes. • Forecasting data are used to anticipate future market conditions and plan collective resilience and growth strategies.

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Operational Terms	Benefits of System Development
Researchers:	• Access valuable data and insights to support academic or applied research projects related to the poultry industry. • Identify gaps in existing knowledge and areas for further investigation. • Collaborate with industry stakeholders to conduct field studies, experiments, and evaluations. • Disseminate research findings to industry stakeholders, policymakers, and the broader academic community to contribute to knowledge dissemination and innovation.
Policymakers:	• Gain a deeper understanding of the structure, dynamics, and challenges faced by the poultry industry in Central Luzon. • Use research findings and data to inform the development of policies, regulations, and initiatives that support the industry's growth, sustainability, and competitiveness. • Identify opportunities to streamline regulatory processes, remove barriers to entry, or incentivize investment and innovation. • Collaborate with industry stakeholders and researchers to develop evidence-based policy solutions that address key industry challenges and opportunities.

Source: Central Luzon State University Socioeconomic Research and Data Analytics Center. Value Chain Analysis and Forecasting of the Poultry Industry in Region III, 2024 (Unpublished)

BEST PRACTICES IN SHRIMP PRODUCTIVITY GAINSHARING IN THAILAND: A CASE STUDY OF THE SOUTHEASTERN REGION

Executive Summary

Best practices in gainsharing among farmers in the Thai shrimp industry (TSI) value chain are extensive and complex, involving the use of technology that is essential for enhancing productivity. Data development in the present study has necessitated collaboration among agencies and authorities at multiple levels, including the implementation of accurate traceability throughout the value chain, which can significantly benefit the study. This study employs a value chain approach to address the price/cost gap across different actors involved in the value chain. Specifically, it aims to: (1) depict the value-added chain modeling approach to measure and evaluate best practices in the southeastern Thailand shrimp sector and (2) provide recommendations based on the findings.

Our study includes a compendium of the research results and an examination of farm and intermediary decision-making that may affect benefit flows and resources in the industry. The data in this study reveal the role of the shrimp industry in Thailand, including market actors such as retail vans, intermediaries, wholesalers, and retailers, as well as their interactions with one another.

To develop and assess the applicability of the generic model, the impact of various interventions on the economic performance of 154 micro-, small-, and medium-sized farms were examined by administering a questionnaire to farms in the southeast. The surveyed farms had pond sizes ranging from 0.12 to 56.00 hectares and operated between 1 to 30 ponds. They were classified based on farm size: (1) small farms = 0.12 hectares, (2) medium farms = 16.00 hectares, and (3) large farms = 56.00 hectares.

The policy implications for policymakers, industry stakeholders, and practitioners in the TSI are as follows. (1) The successful implementation of gainsharing practices requires a clear definition of the role of each actor within the shrimp supply chain. Each actor is expected to clearly identify their responsibilities and areas of accountability that are pivotal to the effective implementation of gainsharing practices. (2) Suitable funding and investment planning, along with resource allocation, should be implemented to support gainsharing practices and ensure their long-term success. (3) The adoption of gainsharing practices is limited owing to a lack of long-term obligation, insufficient incentive structures, and a shortage of successful models for replication

Introduction

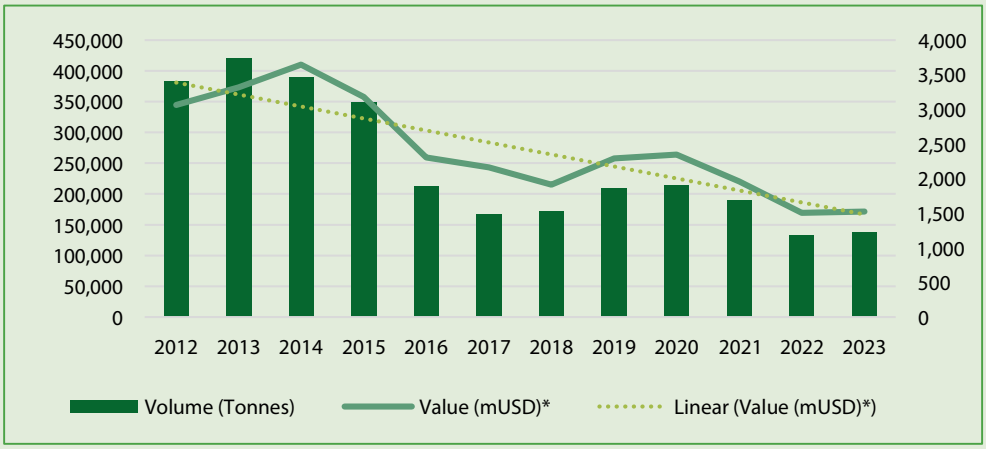
With the outbreak of COVID-19, the Thai shrimp industry (TSI) faced several obstacles and challenges, including rising raw material prices, decreased consumption, and a decline in exports due to disruptions in the value chain. Micro-, small-, and medium-sized shrimp farms experienced challenges related to low productivity and increased vulnerability to shrimp diseases. These factors contributed to the exit of several farmers from the industry. Therefore, implementing best practices in productivity gainsharing across the shrimp industry supply chain may help mitigate the effects of low productivity, high costs, and low income within the shrimp industry.

The TSI's value chain is crucial to farmers and other stakeholders. With such gainsharing practices, the TSI has contributed to sustainable income generation for farmers and economic growth, promoting efficiency, innovation, and competitiveness within the sector, aligning with the UN SDGs and supporting the development of a world-class food system.

In 2023, Thailand exported 137,297 tons of shrimp to the global market, valued at USD1,525 million, with the following regional breakdown: 4.80% to ASEAN countries, 25.10% to Japan, 22.77% to the People's Republic of China, and 25.35% to the United States.

FIGURE 1

VALUE OF THAI SHRIMP EXPORTS TO TRADING PARTNERS, 2012–23



Note: The exchange rate was USD1 = THB30.00 on 10 September 2024.
Source: Department of Fisheries, 2024

Data development for this research necessitated collaboration with various agencies and authorities at multiple levels. Accurate traceability throughout the value chain offers several benefits, particularly for shrimp production in the southeast of Thailand. Such traceability can accelerate Thailand's progress toward the SDG targets, including Goal 1 (poverty eradication), Goal 3 (health and welfare), and Goal 8 (economic growth) (United Nations Foundation, Sustainable Development Goals, 2012).

Research Objectives

This study (1) evaluates best practices in productivity gainsharing using the value chain modeling approach as a tool to measure and compare selected practices within the TSI. It also(2) provides recommendations for other value-added components and their related contributions to the industry, particularly under conditions where the exchange rate remains fixed.

Scope and Significance of Assessing Gainsharing in the Shrimp Sector in Thailand

Over the last two decades, shrimp farmers in Thailand have shared knowledge on improving shrimp productivity on small, medium, and large farms using a profit-sharing model to monitor, forecast, and assess shrimp productivity. The researcher interviewed 154 shrimp farmers and key stakeholders in their value-added chains in the southeastern region of Thailand. As of 2023, the region accounted for 7,173 shrimp farms, covering a total culture area of 11,904.48 hectares, comprising 25.95% of the country's total shrimp farms and 21.43% of the total culture area.

The value chain of the TSI, from farms to consumers, accounted for 0.70% of Thailand's GDP in the fisheries sector in 2023. Hence, analyzing best practices in productivity gainsharing within the southeastern TSI is important for farmers and the government. This study aims to understand how gainsharing affects each actor in the shrimp sector, explore the effectiveness of gainsharing practices, and provide policy recommendations for the government sector to adopt.

FIGURE 2

RESEARCH FRAMEWORK

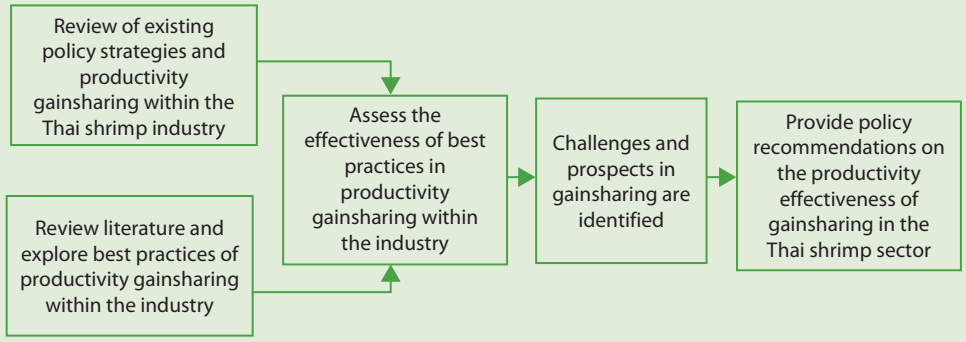


Figure 2 presents the research framework of this study, which aims to review existing policy strategies in the TSI while also examining the literature on best practices in gainsharing. Subsequently, the effectiveness of best practices in the southeastern TSI was assessed. The researcher was then required to identify the challenges and prospects associated with gainsharing and provide policy recommendations on best practices for productivity gainsharing in the TSI.

Literature Review

Review of Literature on Gainsharing Practices

Nath et al. (2011) reviewed an economic analysis of Australian seafood chains (1) to develop a generic value chain model for Australian seafood industries. They aimed to apply the model to quantify the impacts of the intervention on the industries' economic performance. Furthermore, they intended (2) to apply the model on a trial basis with three participating companies in Western Australia (WA), aiming to (3) understand their respective value-added contributions to the economy throughout the supply chain. The value chain model is a series of value-adding activities connecting a company's supply chain with its demand side. This model treats information as a supporting element in the value-adding process rather than as a source of value itself. Generic ASI modeling offers an overview of the industry and its linkage to related industries within the economy. The value chain model also specifies product-specific information for each industry sector, including fishing, wholesale, retail, and export. In this way, it specifies financial information for each sector in the industry. By describing these linkages, the model illustrates the contributions of each sector, such as production, processing, and marketing, to the relevant economy. The primary application of this value chain modeling was to estimate value-added components and quantify the industry's relative contribution to the economy. Applying the generic model (Islam, 1997), the value chain spreadsheet model proved to be a simple, transparent, and robust analytical tool that provided critical information to support management and strategic planning decisions. The results from applying this model enable stakeholders to analyze their value-adding performance and identify strengths and weaknesses, thereby enhancing their competitiveness in the market.

Islam and Deb Nah (2012) explained that Porter (1985) developed the value chain concept in business management. The idea was extended to various levels within small to large business entities and across local to global links (Kaplinsky and Morris, 2000; Chang and Makatsoris, 2001; Olla and Patel, 2002; Gereffi, 2003). Porter (1985) defined "value" as the number of buyers willing to pay for what a firm provides. Value occurs when needs are met by providing products, resources, or services; value flows from customers or institutions that receive resources (Feller et al., 2006). A value chain is a series of activities that add value to primary products or raw materials. Products that pass through all activities of the chain gain the same value. Feller et al. (2006) emphasized that the primary focus of the value chain is on the benefits that accrue to customers, resulting in demand

and fund flows. The value chain framework categorizes generic value-added activities within an industry. The greater the outsourcing and collaboration, the stronger the link between multiple firms, which generates more value in the creation process, or "value chain." Porter (1985) defined the more extensive interconnected value chain system as the "value system." A value system encompasses the value chains of a firm's suppliers, the firm itself, its distribution channels, and its buyers, which extend to the buyers of its products (Sing and Tyagi, 2009). Therefore, while both the value chain and supply chain involve the same network of activities through which products move from producers to consumers, the concepts of value and supply chain are not synonymous. Both chains overlay the same network of entities that interact to provide goods and services (Ramsay, 2005). From a demand-side perspective, the customer is the source of value, and value flows from the customer to the supplier. Supply chain management, conversely, refers to a set of approaches that effectively integrate suppliers, manufacturers, and retailers to produce merchandise in the right quantities and at the correct locations (Simchi-Levi et al., 2003). Cost-effectiveness and customer satisfaction are also important factors. Consumer expectations for lower prices and higher quality services prompt retailers, manufacturers, and distributors to strive for cost efficiency throughout the supply chain (Quayle, 2003).

Review of Literature on Snowball Sampling

Kirchherr and Charles (2017) reviewed snowball sampling as a quantitative research method, which can be employed when a sampling frame is unavailable and researchers face difficulties in reaching the target population. Sample sizes in snowball sampling were small, and the population was specific. They employed snowball sampling to study the structure of social networks, utilizing face-to-face interviews to help generate the trust necessary to obtain referrals from the interviewees. Chan (2020) argued that snowball sampling is a network sampling method that preserves information about the network structure and offers several advantages over random sampling. Shafie (2024) also argued that to eliminate bias inherent in snowball sampling, due to the unequal probability of selection, the sample data must be appropriately weighted.

Review of Literature on Thai Government Funding Initiatives for Enhancing Shrimp Farmer Liquidity and Regulatory Standards for Shrimp Farms and Exported Products

The Department of Fisheries of Thailand (2020a) implemented a government project to enhance liquidity for marine shrimp farmers during the COVID-19 pandemic. The production volume of Thai marine shrimp did not exceed 300,000 tons per year, resulting in insufficient production for processing and export. As a result, Thailand lost its global competitiveness compared with other shrimp-producing countries. In response, the Department of Fisheries established guidelines for spatial operations to restore marine shrimp production in Thailand and provide low-interest funding sources for farmers. In 2022, the Department of Fisheries initiated a project to enhance liquidity for marine shrimp farmers, in line with the Minister of Agriculture and Cooperatives' policy to urgently revive marine shrimp production. The project aimed to provide funding to successful shrimp farmers who lacked a stable source of funding to maintain their operations. The project duration was three years from the date of receipt of the loan from the Farmers Aid Fund, and the loan period for farmers was not to exceed two years from the date of signing the loan contract with the Fisheries Department. The total allocated budget amounted to USD17.0 million.

Moreover, in 2008, the Department of Fisheries encouraged shrimp farmers to apply for Good Aquaculture Practices (GAP) certification for feedstock and aquatic animal farms and to use GAP on marine shrimp farms (Department of Fisheries, 2008a, 2008b).This initiative aims to help participating farmers comply with GAP standards, enabling their farms to adhere to quality requirements and sell high-quality shrimp products to domestic and international markets. Furthermore, Thai shrimp exporters must comply with the chemical reference criteria for Thai frozen and canned fishery products exported to other countries (Department of Fisheries, 2020b). Each country has its own import standards, such as those established by the Aquaculture Stewardship Council and the Marine Stewardship Council (Department of Fisheries, 2020c); therefore, shrimp products that can be exported and sold in a foreign country must adhere to the import standards of that specific country.

Methodology

Research Design

This study employed snowball sampling, which generally facilitated farmer cooperation in providing relevant data; however, data collection was somewhat limited due to concerns about confidentiality.

Data Collection

To develop and understand the application of the generic model for the TSI, Figure 3 reviews the impacts of interventions on the economic performance of 154 small-, medium-, and large- shrimp farms based on questionnaire data from the southeastern regions of Thailand. These farms have pond areas ranging from 0.12 to 56.00 hectares and between 1 and 30 ponds.

Data Analysis

The quantitative technique, known as the value chain modeling approach, was used to analyze questionnaire data from 154 farms in the southeastern region of Thailand. The data were categorized into three groups based on farm size: (1) small farms = 0.12 hectares, (2) medium farms = 16.00 hectares, and (3) large farms = 56.00 hectares. This approach enabled us to analyze the costs of production, revenue, and profit of each actor within the TSI chain. Guided by the structure of the generic model in Figure 3, the value-adding sectors and subsectors specific to shrimp were first identified. Then, a linkage between these sectors and subsectors was established through interviews and questionnaires involving the respective farmers to determine their product flows. Furthermore, data on prices and quantities were collected during the interviews; however, data on transport and processing were not readily available for the intermediate level. The selection of farms was based on willingness to participate voluntarily. The three farms identified in this research were "Farm 1," "Farm 2," and "Farm 3." Despite their willingness to cooperate, relevant data were unavailable due to confidentiality policies. Therefore, applicable data were collected through visits to retail stores, fresh markets, wholesale stores, and export statistics.

Current State of Productivity Gainsharing within the Shrimp Industry

Stakeholder Engagement

To develop a generic shrimp industry model, the first step involved identifying the value-added sectors of the TSI. Figure 3 presents the basic structure of the TSI, comprising six broad value-adding sectors, where shrimp products flow from the shrimp harvest to the export and retail sectors through transportation, processing, and wholesale. Based on interviews with industry experts and the collection of information and data, the number of sectors and subsectors representing the value-adding stages of shrimp products were identified, from harvesting and transport to intermediary processing, wholesale, and ultimately retailing and exports.

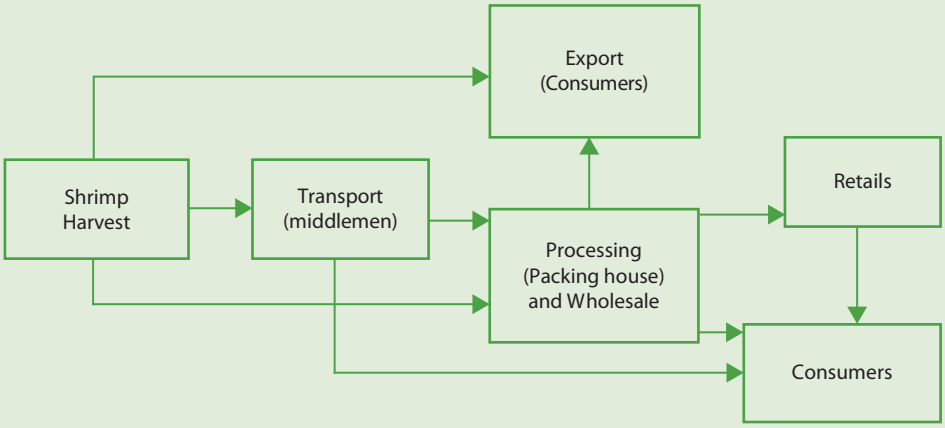
The generic value chain model presented here differs in its composition of sectors and subsectors when applied to a specific model. The accuracy of the model will vary according to the value chain modeling related to inputs and outputs for each industry. Figure 3 quantifies the impact of the intervention on the TSI performance of the three shrimp farms. The value-added calculation can be conducted based on identifying sectors, subsectors, their linkages, and the flow of products within the supply chain. The calculation was performed by developing a structured Excel spreadsheet for each identified sector and subsector (Islam, 1997; Xayavong et al., 2009) (Figure 3).

Challenges and Barriers to Implementation

There are several challenges and barriers to implementation. First, in this setting, the researcher specified a fixed exchange rate; however, exchange rates tend to fluctuate in the real world. This makes it difficult to accurately predict how exporters might respond to varying market conditions for shrimp. Second, some farmers, intermediaries, retail vans, and small retail stores needed to improve their accounting skills to apply the value chain modeling approach using an Excel spreadsheet. Finally, farmers needed more funding to expand their shrimp farming operations following the negative impact of the COVID-19 pandemic on their harvest, unless the government was willing to help by supporting them with soft loans.

FIGURE 3

A GENERIC SHRIMP INDUSTRY MODEL



Source: Adapted from Islam and Deb Nah, 2012

Cultural, Economic, and Systematic Challenges Affecting Gainsharing Uptake

Researchers have found that no formal rules or guidelines currently exist in Thailand's shrimp industry concerning best practices for gainsharing. Each actor acts in accordance with market requirements, making decisions based on personal benefit. Adam Smith explained that the best economic benefit for all is typically achieved when individuals act in their self-interest. Smith's explanation of the "Invisible Hand" reveals that when dozens or even thousands of individuals act in their self-interest, goods and services are created that benefit consumers and producers (Rothschild, 1994). Furthermore, this theory suggests that when entities make economic decisions in a free-market economy based on self-interest and rational self-interest, they manifest unintended, positive financial benefits. However, actors usually lacked long-term responsibility, making it necessary for the government to approach each actor to identify their responsibilities and accountability, which were vital for gainsharing practices. From this perspective, Thai shrimp export prices remained higher than those of competitors, such as the Republic of Ecuador, Republic of India, and Socialist Republic of Vietnam, due to premium pricing included at each stage of the value chain. In seasons when shrimp production was low, domestic shrimp prices increased significantly, which, in turn occasionally hindered export activities.

Productivity Metrics and Indicators

Conceptual Framework

TABLE 1

THE GENERIC SHRIMP INDUSTRY STRUCTURE

No.	Industry sectors	Subsector
1	Shrimp Harvest	Shrimp net
		Hand gathering
2	Transport	Transporter/Middlemen
3	Processing/Wholesale	Processing center type 1 (for supermarkets, food services, and wholesalers)
		Processing center type 2 (for retail stores, supermarkets, and fishmongers)
		Processing center type 3 (for retail vans, food services, and contract processing)

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No.	Industry sectors	Subsector
4	Export	Export (international)
5	Retail	Supermarket
		Food services (restaurants, catering)
		Fishmongers
		Retail vans

Source: Adapted from Nath et al., 2011

Table 1 identifies five significant sectors and their corresponding subsectors; the number of subsectors may vary depending on farmers' geographical and economic circumstances. Two shrimp harvesting methods were practiced in the TSI (shrimp net and hand gathering), which are considered subsectors of the "shrimp harvest" sector. Shrimp harvested at this stage are directly transported to different processing centers or exporters. The subsequent four rows indicate the directional flow of products through the value chain. The retail industry encompasses a wide range of products that flow through this chain.

After identifying the sectors and subsectors, their linkages, and the flow of products within the value chain, a structured Excel spreadsheet was developed for each identified sector and subsector to facilitate the calculations of the value chain modeling approach (Islam, 1997). The structure of the value-added spreadsheet was adapted from Bowman (1980). (Tables 2–4).

TABLE 2

FARM 1'S KEY PRODUCTIVITY METRICS (UNIT: USD/TON)

Input/cost items	Farm 1	Packinghouse/ intermediary	Processors	Wholesalers	Retailer	Exports	TOTAL
Shrimp fry	2,850						2,850
Land cost	5,833						5,833
Pond cost	3,000						3,000
Pond material cost	2,850						2,850
Irrigation system cost	4,878						4,878
Transport	150	167					317
Energy cost	90,180	2,000					92,180
Feed mill	7,730						7,730
Medicines	1,443						1,443
Building	1,667	200,000					201,667
Freight							-
Other costs		187					187
Wages	27,400	300					27,700
Interest	0	0					1
Rents	274	24,000					24,274
TOTAL COST	148,255	202,654					350,909
GROSS VALUE OF TOTAL OUTPUTS	495,000	258,000					753,000
PROFIT	346,745	55,346					402,091
WAGES	27,400	328,500					355,900
INTEREST	0	0					1
RENTS	274	24,000					24,274
VALUE-ADDED	374,419	407,847					**782,265**

Source: Research results

Table 2 indicates that Farm 1 sold their produce exclusively to local intermediaries, i.e., retail vans. The value-added for Farmer 1 was USD0.37 million, and the value-added for intermediaries was USD0.40 million. Therefore, the productivity gain and share distribution for Farm 1 amounted to USD0.03 million. The recorded wages for Farm 1 were lower than the reported profit as household labor was not accounted for in the calculations. In comparison, wages in the retail van segment exceeded reported profits, as each van employed approximately two workers, with each earning an average of USD10 per day, suggesting that labor cost structures in the retail van segment may require further optimization.

TABLE 3

FARM 2'S KEY PRODUCTIVITY METRICS (UNIT: USD/TON)

Input/cost items	Farm 2	Packinghouse/ intermediary	Processors	Wholesalers	Retailer	Exports	TOTAL
Shrimp fry	2,913						2,913
Land cost	500,000						500,000
Pond cost	59,289						59,289
Pond material cost	69,622						69,622
Irrigation system cost	69,221						69,221
Transport	8,280	6,000	7,875	9,844	15,000		46,999
Energy cost	11,593	10,000	15,700	25,000	20,000		82,293
Feed mill	720,306						720,306
Medicines	220,000						220,000
Building	3,333	66,667	166,667	200,000	220,000		656,667
Freight							-
Other costs	42,167						42,167
Wages	9,000	10,500	20,658	50,000	55,000		145,158
Interest	0		0				2
Rents	590		500				1,090
TOTAL COST	1,713,402	93,167	211,400	284,844	310,000		2,612,813
GROSS VALUE OF TOTAL OUTPUTS	2,500,000	225,000	350,000	426,000	550,000		1,551,000
PROFIT	786,598	131,833	138,600	141,156	240,000		1,438,187
WAGES	9,000	10,500	20,658	50,000	55,000		136,748
INTEREST	0	0	0	0	0		
RENTS	590						
VALUE-ADDED	796,188	142,333	159,758	191,156	295,000		**1,584,436**

Source: Research results

Table 3 indicates that the total value-added for the shrimp value chain in Farm 2 was USD0.79 million. The farm's production was sold through provincial packinghouses, processors, wholesalers, and retailers. Specifically, the value-added at each stage was as follows: USD0.14 million for packinghouses, USD0.15 million for processors, USD0.19 million for wholesalers, and USD0.29 million for retailers. Therefore, the total productivity gain and share distribution for Farm 2 amounted to USD1.57 million. Again, due to confidentiality concerns, some data from packinghouses, processors, wholesalers, and retailers may be missing from the spreadsheet. Additionally, the reported wages for Farm 2 were lower than the profits, as household labor contributions were not included in the wage estimates. In comparison, wages for small packinghouses were lower than the profits due to the adoption of machine-based, less labor-intensive methods. This situation reflects the extensive use of

technology throughout their value chain, similar to processors, wholesalers, and retailers. Therefore, their building and energy costs were higher than those of Farm 1.

TABLE 4

FARM 3'S KEY PRODUCTIVITY METRICS (UNIT: USD/TON)

Input/cost items	Farm 3	Packinghouse/ intermediary	Processors	Wholesalers	Retailer	Exports	TOTAL
Shrimp fry	2,768,860						2,768,860
Land cost	4,666,667						4,666,667
Pond cost	1,325,833						1,325,833
Pond material cost	100,833						100,833
Irrigation system cost	2,249,183						2,249,183
Transport	10,000					13,000	23,000
Energy cost	544,200						544,200
Feed mill	1,806,741						1,806,741
Medicines							
Building	5,000					20,000,000	20,005,000
Freight						1,200,000	1,200,000
Other costs							
Wages	60,000					150,000	210,000
Interest	0					0	1
Rents	274						274
TOTAL COST	10,768,731					21,363,000	32,131,732
GROSS VALUE OF TOTAL OUTPUTS	2,000,000					32,200,000	52,200,000
PROFIT	9,231,269					10,837,000	20,068,268
WAGES	60,000					150,000	
INTEREST	0						
RENTS	274						
VALUE-ADDED	9,291,542					10,987,000	**20,278,542**

Source: Research results

For Farm 3, production was sold exclusively through the exporter, as it was a private company and a prominent exporter of shrimp from Thailand to the global market. Due to confidentiality concerns, some information may be missing from the spreadsheet. The value-added for Farmer 3 was USD9.29 million, whereas the value-added for packinghouses and the exporter were USD0.14 million and USD10.98 million, respectively. Therefore, the total productivity gain and share distribution amounted to USD20.27 million. Again, Farm 3's wages were lower than its profits due to the use of machinery in the farming process.

Stakeholder Perspectives

Shrimp Farmers: The interviewees believed that participating in gainsharing practices might reduce their profits compared with those who do not adopt such practices. This suggests that Thai shrimp farmers require sufficient awareness or understanding of the long-term benefits of gainsharing, which could contribute to the overall growth of the industry.

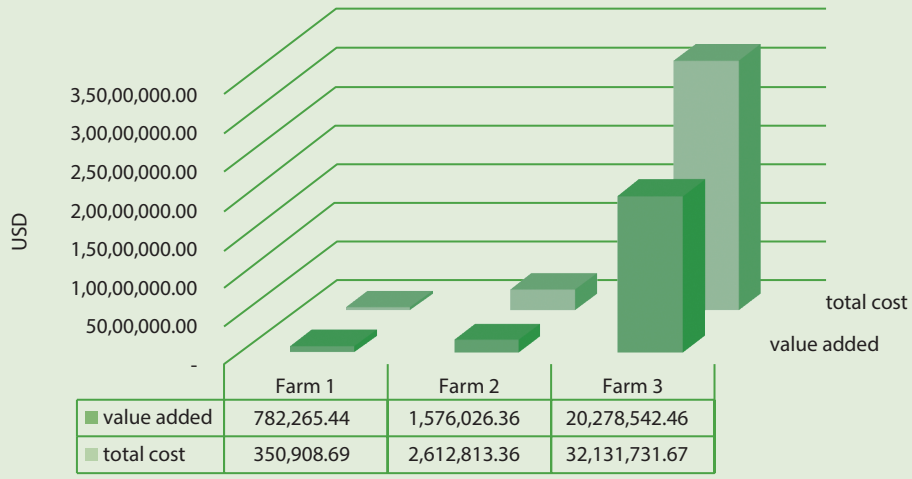
Retail vans: The interviewees required assistance in understanding the concept of best practices in gainsharing. Their sales decisions were primarily driven by immediate profit margins.

Assessment of Best Practices

To assess best practices in the TSI, the policy implications for policymakers, industry stakeholders, and practitioners were as follows. (1) The successful implementation of best practices in gainsharing involved defining a clear role for each actor within the shrimp supply chain. Each actor must identify their responsibilities and accountability, as these elements are vital to achieving effective and sustainable gainsharing practices. (2) Appropriate funding and investment planning, along with resource allocation, should be undertaken to support the implementation of best practices in gainsharing and ensure their long-term sustainability. (3) The adoption of best practices in gainsharing was not widespread due to a lack of long-term obligations, such as financial commitments beyond a year, the scale of incentives (i.e., funding), and the absence of successful, replicable models within the shrimp industry. Enhancing knowledge about best practices in gainsharing among actors would be a strategic method for improving productivity, collaboration, and performance within the industry. Actors should be aware that best practices can be achieved through collaboration among actors. Furthermore, all necessary farms should enhance their technological advancements to improve productivity and reduce the use of human resources, thereby lowering wage costs. Additionally, skilled labor is more valuable compared with unskilled labor in retail, wholesale, and export markets. Therefore, providing targeted training for employees in these markets would help increase productivity. However, shrimp farmers continue to require additional unskilled labor to support various on-farm activities.

FIGURE 4

THE SOUTHEASTERN THAI SHRIMP FARM VALUE CHAIN SUMMARY (2023)



	Farm 1	Farm 2	Farm 3
value added	782,265.44	1,576,026.36	20,278,542.46
total cost	350,908.69	2,612,813.36	32,131,731.67

Source: Research results

Figure 4 illustrates that the shrimp farm sectors were categorized into three groups to compare micro, small, and medium-sized farms. Transport was grouped as "transporter/intermediaries," whereas the wholesale and processing sectors were categorized as "wholesale/processing," and the exports and retail sectors were categorized as "retailing." Sectors such as transporters/intermediaries, exports, and retail were rare in these three farms. The profit sharing for these farms was estimated at 6.08% for Farm 1, 8.47% for Farm 2, and 0.58% for Farm 3. Farm 1's value-added was USD0.78 million, with a total cost of USD0.35 million. For Farm 2, the value-added was USD1.57 million, with a total cost of USD2.61 million. For Farm 3, the value-added was USD20.27 million, with a total cost of USD32.13 million. Farms 1 and 2 had less value-added compared with Farm 3, which exported

its products to other countries. In contrast, Farm 1 only sold through retail vans in provinces, whereas Farm 2's value chain halted at retail stores. This situation may also explain why Farm 2's value-added chain was greater than that of Farm 1, as its value chain involved more actors. Farm 1 sold its production exclusively to local intermediaries, i.e., retail vans. The value-added at each farm was used as a performance indicator to measure productivity gains and share distribution.

Recommendations

Given the limitations of the models' results (confidentiality of data, shortage of funding, fixed exchange rate, and inferior accounting), future research should select farms that voluntarily provide accurate information across the supply chain. Future research can develop a generic TSI value chain and apply it to selected farms and industries to better understand TSI supply chain stakeholders and inform strategic policymaking by addressing challenges and obstacles to profitable and sustainable growth. The completion of the generic model will be an asset in providing a clear understanding of the TSI value chain's status. The value chain model has several limitations: it does not account for the effects of changing production levels on prices or the impact of prices and cost changes on production (Islam, 2003).

Moreover, each sector in the shrimp supply chain must be classified as responsible and accountable for implementing best practices in gainsharing by sharing knowledge with all other sectors within the industry. Moreover, the government should provide sufficient funding for long-term investment plans, including those related to the supply chain and environmental responsibilities, such as social, political, and economic activities within the shrimp sector.

Conclusion

This study attempted to provide details on the value chain modeling and its importance in understanding the economic performance of TSI in the southeastern region of Thailand. The proposed method employs a value chain approach to address the price/cost gaps across different actors within the value chain. To this end, three value chain models were developed based on questionnaire data to understand and measure competitiveness and price/cost behavior. The application of the generic models on the three farms is believed to help identify and gather data to understand policy impacts through the model's application. Hence, the completion of the generic model offers valuable insights by providing a comprehensive understanding of the shrimp industry in the southeastern region of Thailand, including the structure of its value chain, the most value-adding sectors, and an overview of the supply chain. However, due to limited data availability from some actors, the researcher was only able to assess the implementation effectiveness, benefits, challenges, and outcomes across the three value chains. In evaluating best practices in gainsharing within the TSI, a value premium was observed at each stage of the value-adding chain, suggesting that gainsharing practices were present to some extent. Nonetheless, actors operated primarily based on individual interests, with little to no evidence of cross-sectoral cooperation within the supply chain.

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BEST PRACTICES IN PRODUCTIVITY GAINSHARING WITHIN THE AGRIFOOD SECTOR: THE AQUACULTURE INDUSTRY IN TURKIYE

Executıve Summary

Turkiye, with a surface area of 78.4 million hectares, population of 85.3 million, and GDP of USD905.8 billion as of 2022, is one of the world's significant contributors to agricultural production. In 2021, Turkiye ranked first in Europe and eighth globally in terms of agricultural GDP.

Over the last 20 years, Turkiye's agriculture and food sector has undergone significant changes and development in several areas. Concepts such as modernization, technological innovation, sustainability, and food safety have been at the heart of this process. However, challenges such as climate change, market competition, and food security persist. In the future, more innovative approaches and policies will be necessary to overcome these challenges. Turkiye's agricultural sector, with its dynamic structure, will continue to be a significant player in the domestic market and on a global scale. This study examines best practices in productivity gainsharing models in the agrifood sector in Turkiye, assesses the effectiveness of productivity gainsharing practices, and provides recommendations on relevant models based on the findings.

In recent years, there has been a growing emphasis on healthy dietary practices, particularly in developed countries, as individuals have become increasingly attentive to the nutritional quality of the foods they consume. Among these, fish occupies a prominent position due to its high-quality protein content and abundance of polyunsaturated fatty acids. These nutritional components play a crucial role in meeting the body's essential nutrient requirements and significantly contribute to human health by positively influencing physiological processes and metabolic functions.

Aquaculture is recognized as one of the world's major sources of animal protein and is a vital sector that consistently contributes to the economic development of nations worldwide. The seas surrounding Turkiye on three sides, each with distinct characteristics, constitute a significant portion of the fishery area. Turkiye's total coastline length spans 8,333 km. Similar to global trends, aquaculture production in this country relies on two primary forms of production: hunting and aquaculture. The variation in sea temperature and salinity across different regions enable hunting and aquaculture in these waters.

The results of the study analyzing the overall productivity of the trout and sea bream and sea bass value chains in Turkiye by market type are instrumental in identifying best practices for sharing productivity gains within the agrifood sector in Turkiye (Yıldırım, 2023).

This study employed Porter's value chain analysis framework to investigate the structural characteristics and revenue distribution of the sea bream, sea bass, and trout value chains. Two alternative value chain configurations were developed for these aquaculture products, and a multistage network data envelopment analysis (DEA) model was applied to assess their efficiency.

The efficiency analysis of domestic and international value chains for sea bream and sea bass indicated that overall efficiency scores were comparable between fresh and processed fish. In contrast, the processed trout value chain demonstrated higher efficiency compared with its fresh counterpart. Specifically, the efficiency score for fresh sea bream and sea bass in the domestic market was calculated at 0.852, whereas trout recorded a slightly higher score of 0.865. In overseas markets, processed trout outperformed sea bream and sea bass in terms of overall efficiency.

Furthermore, the wholesaler, processor, exporter, and retailer stages within the trout and sea bream and sea bass value chains demonstrated better input-to-output conversion efficiency compared with the producer stage. This performance advantage can be attributed to a collaborative operational culture, integration of advanced technologies, and improved access to financial capital. A cooperative approach promotes effective coordination, reduces resource waste, and enhances overall productivity. Additionally, the availability of financial resources enables investments in infrastructure, technological equipment, and research and development (R&D), thereby facilitating further efficiency gains.

Conversely, the efficiency of the domestic value chain may be enhanced by encouraging the consumption of processed trout and sea bass in the local market and increasing public awareness of their nutritional value and culinary flexibility. The development of an integrated value chain structure, along with advancements in logistics, cold chain infrastructure, and domestic market accessibility, would further enhance efficiency gains.

Fair trade mechanisms ensure equitable revenue allocation among participants in the fish value chain, particularly benefiting fish farmers. Key operational models applicable to product flow in the aquaculture sector include wholesale systems, cooperatives, blockchain-based traceability, direct e-commerce, and stock exchange or auction platforms. Among these, cooperatives and direct e-commerce are especially effective in enhancing producers' incomes, whereas blockchain technology offers long-term advantages. Achieving a balanced revenue distribution among value chain stakeholders can significantly improve overall system efficiency and the performance of individual actors. Prospective aquaculture studies should investigate the factors that contribute to efficiency disparities across actors or chains, including geographic location, farmed species, production techniques, and market conditions.

Introductıon

The role of agriculture in Turkiye's economic structure has gradually evolved over the past 20 years. While agriculture accounted for a significant share of GDP in the early 2000s, this share has declined over time; however, its strategic importance has been maintained. Agriculture remains a significant source of employment for millions of people. A significant portion of the population, particularly in rural areas, earns a living by engaging in agricultural activities (TSKB, 2023).

In the early 2000s, agricultural policies were largely state-supported and interventionist; however, over time, the influence of the free market economy has increased. Enacted in 2006, the Agricultural Reform Implementation Project aimed to increase agricultural productivity, with the provision of various types of support to farmers. During this period, strengthening agricultural cooperatives and prioritizing farmer training were among the key steps taken (İnan & Yomralıoğlu, 2006).

In the last 20 years, Turkiye has experienced significant increases in agricultural production. The adoption of modern agricultural techniques, the improvement of irrigation systems, and an increase in seed diversity have all contributed to increased productivity. In particular, significant progress has been made in the production of vegetables, fruits, and cereals. Turkiye has established itself as a global leader in the production of certain products, including olives, citrus fruits, grapes, and hazelnuts.

Food safety has emerged as a priority in Turkiye's agricultural and food policies. In 2010, with the establishment of the Ministry of Food, Agriculture and Livestock, food inspections were increased and food safety standards were raised. Additionally, initiatives promoting organic agriculture and local products have played a significant role in improving food quality. As of 2020, Turkiye has positioned itself as a key actor in the field of organic agriculture.

In recent years, the use of technology in agriculture has become increasingly widespread. Innovative solutions, including digital agriculture applications, sensor technologies, drone usage, and smart irrigation systems, have enhanced the efficiency of production processes. This transformation has reduced production costs and helped initiate sustainable agricultural practices.

Climate change has been one of the most significant threats directly impacting the agricultural sector. Drought, extreme temperatures, and climatic uncertainties have negatively affected agricultural production. Therefore, sustainable agricultural practices have emerged as a crucial strategy in combating the negative effects of climate change. The integration of renewable energy sources, effective water management practices, and a strong emphasis on soil health are essential components to achieving sustainability.

Turkiye has become a significant player in the export of agricultural products. Since the early 2000s, agricultural exports have continued to increase. In particular, the European Union, Middle East, and Far East markets have become important destinations for Turkiye's agricultural products. However, some technical barriers and competition conditions encountered in exports have been among the factors impacting the market share of Turkish agricultural products.

In recent years, local production and consumption trends have gained significant popularity. As consumer demand for organic and natural products has increased, farmers have increasingly turned toward producing local products to meet this demand. In this context, farmers' markets, cooperatives, and direct sales methods have benefited producers and consumers.

The agriculture and food sectors have significant influenced social structures, with growing public awareness of food safety and production issues. The younger generation has begun to express an increased interest in the agricultural sector, with concepts of entrepreneurship and innovation gaining prominence in the field of agriculture.

Over the last 20 years, Turkiye's agriculture and food sector has undergone significant changes and development across various areas. Concepts such as modernization, technological innovation, sustainability, and food safety have been at the heart of this process. However, challenges as associated with climate change, market competition, and food security persist. In the future, more innovative approaches and policies will be essential to overcome these challenges. Turkiye's agricultural sector, with its dynamic structure, will continue to be a significant player in the domestic market and on a global scale.

The equitable distribution of productivity gains along the supply chain is critical to ensure sustainability within Turkiye's agricultural sector and maintain food security. Prominent best practices include the integration of modern agricultural techniques, adoption of digital and smart farming systems, strategies to combat climate change, enforcement of food safety standards, promotion of organic agriculture, and efforts to boost export and overall competitiveness.

The selection of the sector was guided by the strategic significance of the food industry and the substantial economic contribution of the fisheries sector at the national level. In the applied study conducted by Yıldırım, the value chain was analyzed using Porter's model, and the overall efficiency was evaluated using a multistage network DEA model.

This chapter is structured as follows. Section 2 presents the conceptual background of the food value chain, while Section 3 provides a sector overview (production, consumption, and foreign trade). Section 4 presents a case study, while Section 5 concludes the study.

Conceptual Background of the Food Value Chain

Food Value Chain

The food value chain encompasses all stakeholders engaged in the coordinated production and value-enhancing processes necessary for generating food products. Applying sustainability principles

to food value chains enables small farmers and food businesses to manage inputs and resources more effectively, thereby enhancing their competitiveness and fostering innovation (Kelly & Ilie, n.d.).

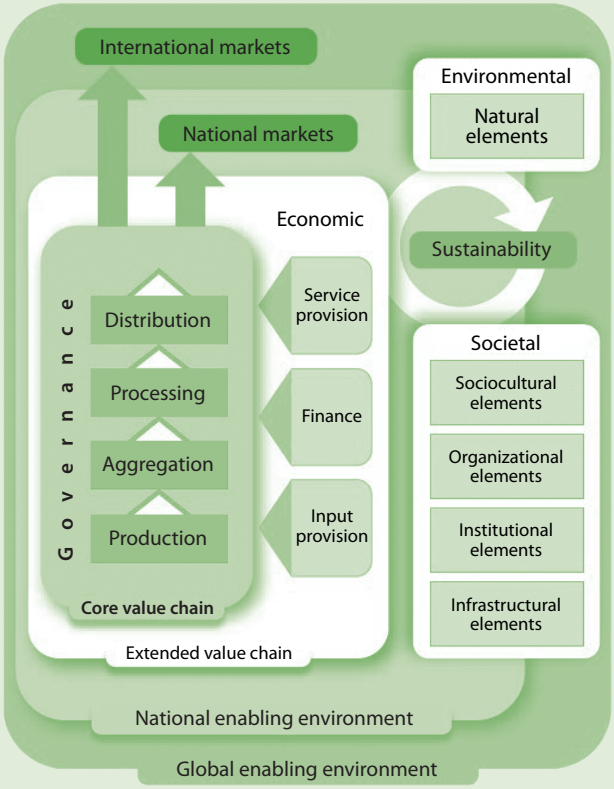
A sustainable food value chain refers to a chain that is profitable at all stages (economic sustainability), delivers broad-based benefits to society (social sustainability), and has a positive or neutral impact on the natural environment (environmental sustainability) (FAO, n.d.).

Sustainable Food Value Chain Framework

The sustainable food value chain framework draws upon multiple value chain models identified in the literature (Figure 1), depicting a system where a complex external environment shapes the behavior and performance of agribusinesses and other agrifood enterprises. The framework is structured around a core value chain in which actors contribute by producing or supplying products at the entry level, adding value to the product, and subsequently transferring it to the next stage.

FIGURE 1

SUSTAINABLE FOOD VALUE CHAIN SYSTEM



Source: Adopted from Neven (2014).

Value chain actors primarily involve private sector enterprises although public sector entities such as institutional buyers (e.g., food reserve agencies, emergency food purchasers such as the WFP, and the military) may also be involved. Actors operating at a given level of the chain are heterogeneous and vary in their connections to end markets, distribution channels, scale, technological capacity, and strategic objectives.

This chain is characterized by four primary functions: production (e.g., agriculture or fisheries), collection, processing, and distribution (wholesale and retail). The collection step is highly relevant to the food value chain, especially in developing countries. The efficient collection and storage of small

volumes of produce from small-scale producers, which is quite common in such countries, is a major challenge. It is recognized that the collection function may be performed by producer groups, specialized intermediaries, food processors, or, less frequently, food distributors such as wholesalers or retailers.

A value chain's governance structure is a pivotal component that encompasses interactions among actors at specific stages (horizontal linkages) and across the entire chain (vertical linkages). Governance encompasses various elements, including information flows, price formation, standards, payment systems, contractual arrangements (with or without embedded services), market power, leading firms, and wholesale market dynamics. Value chain actors are complemented by business development service providers who, while not owning the product, play a facilitative role in value creation. Together, these actors and support entities constitute the extended value chain.

Support providers can be categorized into three primary groups: physical inputs, nonfinancial services, and financial services. Physical input providers offer resources such as seeds at the production stage or packaging materials at the processing stage. Nonfinancial service providers deliver support in various areas, including spraying, storage, transportation, laboratory testing, management training, market intelligence, and processing. Financial service providers play a crucial role in providing working capital and investment funding.

These support services may be bundled and delivered by a single provider, offering integrated packages that may include seeds, fertilizers, insurance, credit, and extension services. Such providers may operate within the private sector, public institutions, NGOs, or through state-run entities.

Ultimately, value is defined by consumer preferences in domestic and international markets, with choices influencing upstream stages, including production, processing, and support services. Both value chain actors and support providers function within a specialized environment shaped by social and natural dimensions. Social components consist of human structures within a society. They are categorized as informal sociocultural norms (e.g., dietary preferences, religious requirements), formal institutions (e.g., laws, policies), organizational structures (e.g., professional associations, research and training institutions), and infrastructure (e.g., roads, ports, communications, energy). Natural elements include soil, air, water, biodiversity, and other environmental resources.

Economic, Social, and Environmental Dimensions of the Sustainable Food Value Chain

The sustainability of the value chain is concurrently reflected in three interrelated dimensions: economic, social, and environmental (Figure 2).

Within the economic dimension, a value chain is deemed sustainable if the required activities at each level, whether by actors or support providers, are commercially viable for private services or financially viable for public services. In this context, it is emphasized that each stakeholder within the value chain should be able to achieve equal or higher profits or revenues than the status quo and that these profits should be sustained over time.

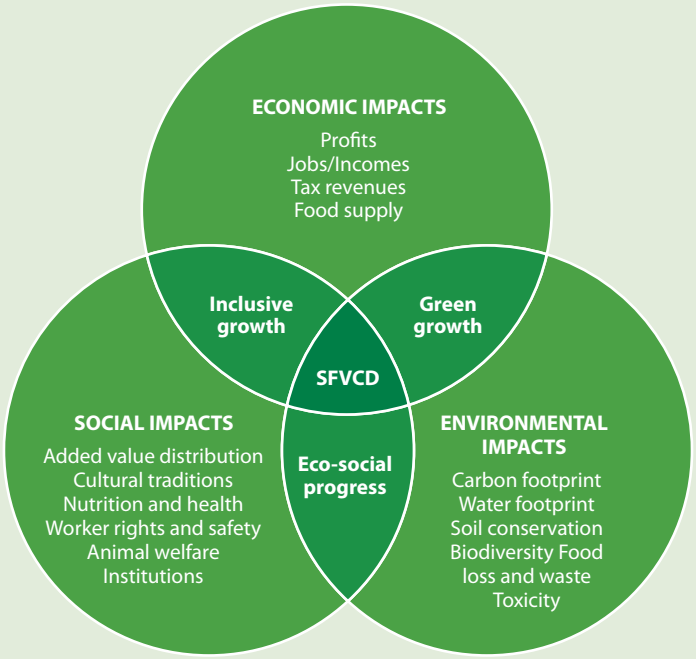
Social sustainability refers to socially and culturally acceptable outcomes, particularly regarding the equitable distribution of benefits and costs linked to value creation. In this context, an improved value chain model must generate additional value (notably profit and wage income) that is equitably distributed along the chain, in proportion to value added, and sufficiently benefits a broad base of low-income households to avoid socially adverse effects. All stakeholders (e.g., farmers, processors, youth, older adults, men, and women) should perceive their share as fair (a win–win scenario), and the model must avoid socially objectionable practices such as unsafe labor conditions, child labor, animal mistreatment, or violations of strong cultural norms. Failure to meet these conditions compromises the model's medium-term sustainability.

Environmental sustainability is primarily defined by the capacity of value chain actors to conduct value-adding activities with minimal or no adverse impact on the natural environment. Ideally, these activities should yield positive or beneficial environmental outcomes. An improved value chain model must generate

additional value without causing irreversible depletion of natural resources such as water, soil, air, flora, and fauna. If this condition is not met, the model cannot be considered sustainable in the long term.

FIGURE 2

SUSTAINABILITY IN FOOD VALUE CHAIN DEVELOPMENT



Source: Adopted from Neven (2014).

Value Chain Analysis of the Agriculture and Food Sector in Turkiye

The existing value chain analyses of Turkiye's agricultural and food sectors are presented below.

Özdoğan (2009) conducted a value chain analysis of the fresh olive sector. In this analysis, a value chain was created, starting from the production stage of olives to the final retail stage. The study began with the production stage of Gemlik-type black fresh olives. Subsequently, each successive link leading to the retailer was evaluated separately and positioned within its corresponding step in the value chain. Furthermore, the second stage discussed the process by which olives are harvested from producers and transferred to enterprises, where they undergo fermentation and are processed into edible products. In the third stage, the process of delivering black fresh olives to wholesalers through the Marmara Union and to retailers through wholesalers was discussed. As a result, this study analyzed the costs and profits associated with production, operations, wholesale, and retail stages from production to final consumption (Özdoğan, 2009)

In the thesis "Value Chain Analysis: Investigation of Sustainable Competitiveness of Finike Orange" by Bülbül (2011), a survey-based study was conducted focusing on Finike oranges. In the first stage of the Finike orange analysis, orange inputs were evaluated. In the second stage of the study, production was discussed. In the third stage of the value chain, the issue of packaging was addressed. In this process, following the harvesting of oranges, the loading and packaging onto trucks was observed. In the last stage of the value chain, location was discussed, including export activities to other countries and sales strategies for the domestic market (Bülbül, 2011).

The value chain analysis conducted by Azak (2011) examined the value added for olive oil. In this study, the production and consumption links were identified in the value chain analysis. All links in the chain were then analyzed individually.

In the value chain analysis of the food sector by TEPAV (2013), the topics titled "red meat and meat products," "milk and dairy products," and "sugar" were compiled into a single report. This study examined red meat and meat products. The value chain analysis of meat and meat products began by evaluating the production process. The producers involved in this process were identified as large enterprises, small- and medium-sized enterprises, and butchers. The production process was evaluated beginning with the purchase of live animals. In the second stage of the study, the distribution stage of the red meat and meat products sector was analyzed. Here, the process of purchasing live animals as part of the distribution process and the subsequent supply of inputs necessary for producing finished products were analyzed.

In the report by FKA (2012), a value chain analysis of vegetable production was conducted. In general, the analysis primarily focused on herbaceous plants, with some other plant species also examined. It has been established that these vegetables are of great nutritional importance. For this reason, vegetable agriculture has been deemed important in terms of generating profit due to its high yield in the TRB1 region.

A report titled Konya Milk and Dairy Products Sector Value Chain Analysis and Clustering Studies was prepared by MKA. This report examined the sector's activities by analyzing each component individually. In the first stage of the value chain study, research findings related to inputs, outputs, and the supply structure were presented. In the second stage, the production process was analyzed, focusing on the distribution of products obtained through milk processing. In the third stage of the value chain analysis, the sales and marketing infrastructure was analyzed. At this stage, it was observed that approximately 800 milk collectors in the region supplied milk to processing enterprises, where they obtained products for their production (MKA, 2011).

Turkiye's Overall Agriculture and Food Sector Outlook

Turkiye has a surface area of 78.4 million hectares, a population of 85.3 million, and a GDP of USD905.8 billion as of 2022; it is among the significant countries that still contribute substantially to agricultural production. In 2021, Turkiye ranked first in Europe and eighth in the world in terms of agricultural GDP.

While agriculture accounted for 6.4% of Turkiye's GDP in 2017, its share decreased to 5.8% in 2022.

Turkiye's export value increased from USD6.58 billion in 2017 to USD8.26 billion in 2022, whereas its import value increased from USD5.70 billion to USD10.57 billion over the same period.

Between 2017 and 2022, agricultural employment in Turkiye continued its downward trend, and the share of agricultural employment decreased from 19.2% in 2017 to 15.8% in 2022. During the same period, the number of individuals involved in agricultural production decreased from 5.4 million to 4.9 million people.

As of 2022, the share allocated to agricultural areas in Turkiye was 30%, aligning closely with the global average.

Although Turkiye has primarily directed its economic activities toward the industry and service sectors, it aims to produce high-value added food products by increasing agricultural productivity, leveraging its current geographical location and infrastructure conducive to agricultural production.

Turkiye's Political Approach and Practices

Turkiye's policies to support productivity-based gainsharing in the agricultural sector generally focus on increasing agricultural production, promoting equitable income distribution, and adopting sustainable production practices. These policies are implemented in collaboration with various public institutions, particularly the Ministry of Agriculture and Forestry, cooperatives, and the private sector. The following are some basic policies implemented in this context (MAF, 2023):

1. Support Policies- Agriculture Support Payments: Direct support payments are made to farmers based on the products they produce. These supports aim to increase production productivity and protect farmers' income, and include:- Diesel, fertilizer, and feed subsidies;- Differential payment (premium) support;- Area-based support (such as organic agriculture, good agricultural practices).

2. Cooperatives and Organizations

   - ✓ Supporting Agricultural Cooperatives: This initiative aims to organize producers to utilize resources more efficiently, reduce costs, and increase earnings.

   - ✓ Producer Unions and Cooperative Credits: Efficiency in marketing and sales processes is increased by providing financial support to producer organizations.

3. Agricultural R&D and Technology Use

   - ✓ Research and Development Investments: R&D activities are supported to encourage the use of modern technologies in agriculture, which increases productivity and allows for greater output with fewer inputs.

   - ✓ Smart Agriculture Applications: Practices such as digitalization of agriculture, use of drones, and modernization of irrigation systems are expanding.

4. Rural Development Programs

   - ✓ Support Program for Rural Development Investments (KKYDP): Economic development is encouraged through the provision of grants and support for small enterprises engaged in agriculture and animal husbandry.- Young Farmer Projects: Young farmers are provided with financing for projects that aim to increase agricultural productivity.

5. Contract Agriculture

   - ✓ Gainsharing and Risk Management: With the contract farming model, profit-sharing is established between farmers and companies, reducing the risk for producers and ensuring income sustainability.

6. Marketing and Export Support

   - ✓ Supporting the Export of Agricultural Products: Marketing of products produced using efficient agricultural methods abroad, along with income-increasing incentives, is provided.

   - ✓ Development of Agricultural Product Markets: Market infrastructures (market reforms, e-commerce platforms) have been developed to enable producers to deliver their products directly to consumers.

7. Training and Consultancy Services

   - ✓ Farmer Training Programs: Training sessions are organized to provide farmers with the knowledge and skills necessary to increase agricultural productivity.

   - ✓ Agricultural Consultancy Services: Producers are guided on agricultural techniques, marketing, and productivity-enhancing strategies.

The effective implementation of these policies aims to enable Turkiye to meet domestic consumption and increase its international competitiveness in agricultural production. However, problems encountered during implementation (e.g., rising agricultural input costs and climate change) can limit the effectiveness of such policies. Therefore, policies must be continuously updated and adapted to local needs.

Sectoral Overview

In recent years, there has been a growing emphasis on healthy dietary practices, particularly in developed countries, as individuals have become increasingly attentive to the nutritional quality of the foods they consume. Among these, fish occupies a prominent position due to its high-quality protein content and

abundance of polyunsaturated fatty acids. These nutritional components play a crucial role in meeting the body's essential nutrient requirements and significantly contribute to human health by positively influencing physiological processes and metabolic functions.

Aquaculture, recognized as one of the world's major sources of animal protein, is a vital sector that consistently contributes to the economic development of nations worldwide.

The seas surrounding Turkiye on three sides, each with distinct characteristics, constitute a significant portion of the fishery area. Turkiye's total coastline length spans 8,333 km. As in the rest of the world, aquaculture production in the country relies on two primary forms of production: hunting and aquaculture. The variation in sea temperature and salinity across different regions enable hunting and aquaculture in these waters.

Among the inland waters important for aquaculture are approximately 200 natural lakes, over 300 dam lakes, around 750 ponds, and 33 large rivers. These inland waters serve as vital resources for hunting as well as aquaculture. The number of economically significant species in Turkiye is estimated to be around 100.

This chapter analyzes the production and foreign trade of fishery and aquaculture products in Turkiye as well as the status of the aquaculture sector.

Situation ın the World

World Aquaculture Production

Aquaculture is a rapidly growing sector in terms of its contribution to global food security and nutrition. This sector, which has experienced rapid growth in production over the past few years, has increasingly established its presence in international trade. Exports of fish and fish products play a significant role in the economies of many countries (FAO, n.d.).

TABLE 1

WORLD AQUACULTURE PRODUCTION (TONNES)

Years	Capture Amount	Aquaculture Amount	Total Amount
2017	94,547,558	79,632,242	174,179,800
2018	97,649,995	82,491,232	180,141,227
2019	93,580,698	85,221,567	178,802,264
2020	90,538,340	87,632,276	178,170,616
2021	91,913,341	90,863,706	182,777,048

According to a report published by FAO (n.d.), global aquaculture production reached 182.8 million tonnes. When analyzed by country, it is evident that countries in Asia are the predominant leaders in this sector. China leads global aquaculture production, accounting for 64.2 million tonnes, which represents approximately 35% of the total output. Following China, the highest production levels are observed in India, Indonesia, Vietnam, and Peru. According to FAO data, world aquaculture production is expected to reach 202 million tonnes by 2030 (FAO, n.d.).

TABLE 2

WORLD AQUACULTURE PRODUCTION BY COUNTRY (TONNES)

Countries	2017	2018	2019	2020	2021
China	62,198,086	62,207,398	62,242,310	62,846,808	64,159,579
India	11,739,313	12,562,853	13,386,400	13,265,638	14,394,560
Indonesia	12,469,899	12,563,277	12,774,873	12,103,606	12,665,749
Vietnam	7,135,253	7,489,679	7,926,658	8,173,609	8,276,370

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Countries	2017	2018	2019	2020	2021
Peru	4,257,871	7,311,264	4,976,241	5,770,371	6,677,498
Russia	5,049,585	5,310,940	5,212,169	5,342,456	5,455,718
USA	5,466,911	5,253,977	5,314,752	4,708,885	4,723,804
Bangladesh	4,134,436	4,276,641	4,384,219	4,503,371	4,621,228
Norway	3,702,692	3,849,317	3,767,966	3,962,634	4,060,575
Japan	3,819,029	3,939,849	3,786,422	3,779,468	3,710,570
Others	119,973,074	124,765,195	123,772,011	124,456,846	128,745,650
World	174,179,800	180,141,227	178,802,264	178,170,616	182,777,048

World Aquaculture Consumption

Driven by shifting consumer preferences, technological advancements, and rising income levels, aquaculture consumption has grown substantially over the past six decades. In 2019, out of the 157 million tonnes of seafood consumed globally, approximately 72% was consumed in Asia. China, Indonesia, India, the USA, and Japan are the leading countries in global aquaculture consumption. Globally, fish accounted for approximately 17% of animal protein intake and 7% of total protein consumption in 2019 (FAO, n.d.).

While global fish consumption was 9 kg per capita in 1961, it increased to 20.2 kg in 2020. In 2019, 75% of the per capita aquaculture consumption was from fish, 12% from mollusks, and 13% from shellfish. It has been determined that the difference in fish consumption among countries is due to differences in income levels and nutritional culture among consumers. While per capita fish consumption in 2019 was 5.4 kg in low-income countries with a food deficit, it was 15.2 kg in middle-income countries and 26.5 kg in high-income countries (FAO, n.d.).

Although 157 million tonnes of the total aquaculture production worldwide, which reached approximately 178 million tonnes in 2020, were used directly for food supply, the remaining 20 million tonnes were used in the production of nonfood products, mainly fish meal and fish oil (FAO, n.d.).

World Aquaculture Foreign Trade

Aquaculture represents one of the most widely traded food sectors in the world. Over the years, global economic growth and technological advancements have contributed significantly to the expansion of international seafood trade. The trade value of aquaculture products has increased at a faster rate than trade volume. This trend is largely attributed to the fact that species with higher economic value are more frequently traded, often after undergoing value added processing. The fact that seafood trade is highly sensitive to economic conditions can be attributed to trade contractions during periods of economic recession. Additionally, geopolitical changes, fluctuations in exchange rates, changes in logistics costs, and epidemics can impact aquaculture trade in the short term (FAO, n.d.).

Exports: According to data from the World Fisheries and Aquaculture Status Report, the monetary value of aquaculture exports, which was expected to reach 40.8 million tonnes worldwide in 2021, is USD176 billion. In addition to being the largest producer in the aquaculture sector, China has also been the leading exporter since 2002, accounting for 9% of international aquaculture exports (FAO, n.d.).

TABLE 3

WORLD AQUACULTURE EXPORTS (TONNES)

Countries	2017	2018	2019	2020	2021
China	4,255,401	4,229,964	4,174,873	3,725,798	3,707,268
Norway	2,627,962	2,722,349	2,652,554	2,705,848	3,096,447

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Countries	2017	2018	2019	2020	2021
Peru	1,543,427	1,568,892	1,764,072	1,451,062	1,969,105
Russia	2,221,214	2,329,799	2,190,324	2,355,623	1,792,073
Vietnam	1,822,326	1,716,536	1,810,890	1,545,160	1,714,831
Chile	1,150,460	1,326,476	1,298,818	1,494,351	1,430,713
Netherlands	1,416,432	1,415,534	1,418,302	1,373,894	1,420,209
Equator	902,980	1,097,529	1,100,135	1,152,700	1,395,148
India	1,409,055	1,435,721	1,366,815	1,140,808	1,363,598
Thailand	1,353,674	1,393,516	1,391,349	1,481,362	1,354,430
Others	21,044,192	21,746,152	21,842,996	21,070,300	21,609,585
World	39,747,123	40,982,468	41,011,128	39,496,906	40,853,407

Imports: The value of global aquaculture imports, totaling 40.4 million tonnes, is USD173.4 billion. USA is the leading importer by value, accounting for USD30 billion or 17.3% of the total import value. According to 2021 data, China ranks first in live weight imports of aquaculture products at 5.4 million tonnes. However, the majority of these imports are not intended for domestic consumption; instead they are processed and reexported (FAO, n.d.).

TABLE 4

WORLD AQUACULTURE IMPORTS (TONNES)

Countries	2017	2018	2019	2020	2021
China	4,625,127	4,964,629	5,984,437	5,390,844	5,423,001
USA	2,795,725	2,884,129	2,810,701	2,893,124	3,256,355
Japan	2,418,544	2,324,887	2,405,004	2,197,932	2,152,012
Thailand	1,919,111	2,123,347	1,983,139	2,149,345	2,097,008
Spain	1,757,899	1,752,114	1,809,784	1,698,162	1,799,974
South Korea	1,466,421	1,538,561	1,507,651	1,509,752	1,633,330
Denmark	1,370,326	1,423,982	1,358,001	1,296,794	1,328,163
France	1,168,286	1,173,033	1,166,508	1,138,662	1,272,161
Netherlands	1,103,228	1,098,558	1,069,314	1,109,298	1,171,071
Italy	1,115,800	1,131,763	1,106,242	1,028,030	1,133,876
Others	19,740,467	20,415,002	21,200,782	20,411,943	21,266,952
World	38,216,786	39,267,654	40,251,513	39,200,303	40,417,752

Situation in Turkiye

Aquaculture Production of Turkiye

Although capture fisheries historically dominated Turkiye's aquaculture production, the share of aquaculture within total production has steadily increased over the years. In recent years, significant advancements have been made in aquaculture systems across the nation. The transfer of fish farms to open and deep waters has necessitated the use of new techniques suitable for these conditions. Accordingly, cage sizes and structures, net systems, and feeding systems have been enhanced by applying technology that exceeds world standards (Bilgüven & Can, 2018).

TABLE 5

AQUACULTURE PRODUCTION IN TURKIYE (TONNES)

Years	Capture Amount	Aquaculture Amount	Total Amount
2012	432,442	212,410	644,852
2013	374,121	233,394	607,515
2014	302,212	235,133	537,345
2015	431,907	240,334	672,241
2016	335,320	253,395	588,715
2017	354,318	276,502	630,820
2018	314,094	314,537	628,631
2019	463,168	373,356	836,524
2020	364,400	421,411	785,811
2021	328,165	471,686	799,851
2022	335,003	514,805	849,808

Aquaculture production in Turkiye increased by 6% in 2022 compared with the previous year, reaching 849,808 tonnes. The declining trend in the volume of products obtained through fishing and the increase in the volume of products obtained through aquaculture indicates that global production is moving in a more sustainable and strategic direction (TUİK, 2023a).

Aquaculture of Turkiye

As of 2022, aquaculture accounted for 60.5% of Turkiye's total fishery production. In Turkiye, aquaculture production is distributed across 72% of marine environments and 28% of inland waters. The leading cultivated species include trout (145,649 tonnes) in inland waters as well as sea bass (156,602 tonnes) and sea bream (152,469 tonnes) in marine environments. As of 2022, sea bass accounted for 30% of total aquaculture production, followed by sea bream at 28% and trout at 38%. Aquaculture activities are conducted in various aquatic environments, including inland waters, dam reservoirs, natural lakes, rivers, and marine areas. Although aquaculture production in inland waters was higher than that in seas previously, the amount of production in seas has been higher than that in inland waters for the last 10 years (TUİK, 2023a).

Aquaculture Capture in Turkiye

In 2022, 90% of Turkiye's total capture production originated from marine environments. Of this total, 71% comprised sea fish, while the remaining 29% comprised other seafood species. Compared with the previous year, total capture production increased by 2% in 2022, reaching 335,003 tonnes. Anchovy remains the most significant species harvested from Turkish seas. Moreover, the Black Sea region holds the largest share of marine fisheries, accounting for approximately 73% of total marine capture (TUİK, 2023a).

Aquaculture Consumption in Turkiye

In 2020, the per capita consumption of aquaculture products in Turkiye was 6.7 kg per year, whereas the global average was 22 kg. Consumption levels are influenced by factors such as dietary habits, production volume, product pricing, and consumer purchasing power. Although the consumption of aquaculture products in Turkiye varies by region, the annual per capita consumption of aquaculture products was recorded at 7.3 kg in 2022, representing a 12% increase compared with the previous year (TUİK, 2023a).

TABLE 6

AQUACULTURE CONSUMPTION IN TURKIYE (TONNES)

Years	2018	2019	2020	2021	2022
Consumption (tonnes)	546,737	514,640	559,932	554,291	622,229
Per Capita Consumption (kg)	6.1	6.3	6.7	6.5	7.3

Aquaculture Foreign Trade in Turkiye

Turkiye is a net exporter of aquaculture products in foreign trade. Analysis of export–import data reveals that in 2022, exports surpassed imports by 136,000 tonnes in volume and USD1.338 billion in value. According to TUIK data, Turkiye's aquaculture trade witnessed its most significant increase in 2022 compared with the previous year, with exports increasing by 5% and imports by 10%. In the same year, aquaculture exports totaled USD1.651 billion and were distributed across 103 countries, with 67% of these exports directed to European Union countries (TUİK, 2023b).

TABLE 7

AQUACULTURE FOREIGN TRADE IN TURKIYE

Years	Export		Import	
	Amount (tonnes)	Value (USD)	Amount (tonnes)	Value (USD)
2012	74,006	413,917,190	65,384	176,402,894
2013	101,063	568,207,316	67,530	188,068,388
2014	115,381	675,844,523	77,551	198,273,838
2015	121,053	692,220,595	110,761	250,969,660
2016	145,469	790,303,664	82,074	180,753,629
2017	156,681	854,731,829	100,444	230,111,248
2018	177,500	951,793,070	98,315	188,965,220
2019	200,226	1,025,617,723	90,684	189,438,745
2020	192,462	1,020,673,539	80,525	127,415,564
2021	238,732	1,376,291,922	104,708	217,179,174
2022	251,416	1,651,496,218	115,189	312,980,444

Aquaculture and Fishing Products Prices

Feed prices tend to have a significant impact on the pricing of aquaculture products, with changes in feed prices directly affecting product sales prices. Furthermore, exchange rates play a crucial role, given that the majority of feed raw materials are imported and a substantial proportion of farmed fish is destined for export markets. In aquaculture, sea bass, sea bream, and trout in inland waters are of great economic importance. The prices of these three products continue to increase over the years.

The prices of fishing products can fluctuate more rapidly than those of aquaculture products. In general, prices tend to decrease when catch volumes increase, whereas they increase when catch volume decreases or during the off-season. Logistics costs represent one of the most important cost components for fishery products. The prices of selected fishery products between 2018 and 2022 are presented in Table 8 (TUİK, 2023a).

TABLE 8

TABLE 8. PRICES OF SELECTED AQUACULTURE AND FISHING PRODUCTS

Species	2018	2019	2019	2020	2021	2022
Sea bream	4.1	3.9	3.9	4.0	4.8	5.4
Sea bass	4.4	4.1	4.1	4.2	5.5	6.0
Trout (inland)	2.4	2.7	2.7	2.5	2.7	3.3
Trout (sea)	3.3	3.5	3.5	3.6	3.7	4.6
Anchovy	1.2	1.3	1.3	1.5	1.4	1.2
Bonito	1.7	3.4	3.4	1.8	2.8	1.8

Case Study

This section provides a detailed analysis of a study examining the overall efficiency of the trout and sea bream/sea bass value chains in Turkiye by market type, within the scope of identifying best practices in gainsharing in the agrifood sector. This study is significant for informing best practices aimed at enhancing productivity and value sharing within Turkiye's agricultural and food sectors (Yıldırım, 2023).

It compares the profit margins and efficiency levels of producers, wholesalers, and retailers within each chain. Data were obtained from 30 aquaculture farms in Muğla Province using simple random sampling, while data for other value chain actors were gathered using the snowball sampling technique. The Porter value chain model was employed for structural analysis, and a multistage network DEA model was applied to estimate overall efficiency. Farm selection was based on stock size using a 10% precision level and a 95% confidence interval (Table 9).

TABLE 9

CHARACTERISTICS OF SAMPLED FISH FARMS

Characteristics	Sea bream and sea bass	Trout
Total production capacity (tonnes)	24,099.0	1,450.0
Capacity-use ratio (%)	82.1	81.5
Average cage size (m^3)	100,412.5	20,422.4
Fish stock (kg/m^3)	9.6	14.2
Feed price (EUR/kg)	1.2	1.2
Fingerling price (EUR/unit)	0.2	0.1
Feed conversion ratio	1.7	1.5
Price (domestic market)		
Producer (EUR/kg)	4.8	3.1
Wholesaler (EUR/kg)	6.9	4.3
Retailer (EUR/kg)	9.5	6.2
Price (overseas market)		
Producer (EUR/kg)	4.8	3.0
Processor (EUR/kg)	5.8	3.9
Exporter (EUR/kg)	6.4	4.5
Retailer (EUR/kg)	10.4	7.9

The study revealed that sea bream/sea bass farms exhibited greater total production capacity, capacity utilization rates, fingerling costs, feed consumption per kilogram of fish produced, and market prices compared with trout farms. In contrast, trout farms exhibited larger average cage sizes and higher stocking densities per cubic meter. For trout and sea bream/sea bass, the average selling price per kilogram was higher in international markets. Using the snowball sampling method, data were collected from 30 participants in each of the following categories: wholesalers, retailers, processors, exporters, and overseas retailers. Russia, Italy, and the United Kingdom were selected as target countries, representing approximately half of Turkiye's processed seafood exports. Structured questionnaires were employed to gather data across the producer, wholesaler, processor, exporter, and retailer levels for the 2021 production year.

Value Chain Analysis

This study employed Porter's value chain analysis framework to investigate the structure and revenue distribution of the sea bream/sea bass and trout value chains. The analysis included fresh and processed fish, with fresh fish marketed domestically and processed fish exported internationally. The domestic market followed a producer–wholesaler–retailer–consumer structure, whereas the overseas market

followed a producer–processor–exporter–retailer–consumer path. Key variables included production costs, revenue, net profit per kilogram of fish produced and sold, and absolute and relative value added. Net profit margins were calculated as the ratio of profit to revenue at each stage of the chain.

Net profit margins were calculated by dividing the net profit at each stage by its corresponding revenue on a per-kilogram basis, with fish prices serving as the intermediary's revenue at each stage. Variable and fixed costs were calculated separately for producers, wholesalers, processors, exporters, and retailers. Variable costs included items such as fingerlings, feed, labor, vitamins, medicine, energy, transport, packaging, and freezing, whereas fixed costs included depreciation, repair and maintenance, rent, insurance, interest, and taxes. The revenue and total net profit distribution across intermediaries was also assessed to evaluate equity along the chain. The value added at each stage was expressed as a proportion of the total value added, whereas net profit at each stage was calculated as a share of the total net profit generated across the value chain.

Estimating Overall Efficiency

This study developed two alternative value chain networks for trout and sea bream/sea bass, employing a multistage network DEA model to assess efficiency. These networks are defined by structural linkages among producers, processors, wholesalers, exporters, and retailers, with the technology at each stage described using input–output data from the preceding and succeeding stages. The networks were constructed using aggregated input and output variables, with intermediate input–output factors serving as linkages across different stages of the value chain.

DEA is one of the most widely used methods in efficiency measurement. It is a nonparametric method that utilizes linear programming to determine the points on the curve obtained using the inputs and outputs of the most efficient firm rather than relying on a specific production function Fanchon (2003). It evaluates the performance of similar units, known as decision-making units, which transform a large number of inputs into a corresponding number of outputs. The fundamental principle underlying DEA is to provide a methodology for identifying the most efficient CVBs among comparable CVBs and establish an efficient frontier. Furthermore, DEA facilitates the assessment of relative efficiency by comparing each CVB to this frontier, thereby highlighting areas for potential improvement in underperforming units (Cook & Seiford, 2009).

The use of DEA in the agricultural and food sector is becoming increasingly widespread to increase the efficiency of production processes, optimize resource utilization, and improve overall performance (Aydın & Borat, 2021).

Agricultural Production Efficiency

Agricultural Production Efficiency: Agricultural enterprises can utilize DEA to evaluate productivity through their inputs (such as seed, fertilizer, and water) and outputs (quantity and quality). This analysis identifies which farms leverage resources more efficiently and which have potential for increased production. For example, when the same type of crop is cultivated across different farms, efficiency can be determined by analyzing input–output ratios.

Irrigation Management: The efficiency of irrigation systems is crucial for conserving water and enhancing productivity. DEA determines which methods are more effective by analyzing irrigation practices. For example, it can prove beneficial to select the most suitable method by comparing the efficiency of a drip irrigation system with that of traditional irrigation methods. Such an analysis contributes to the efficient use of water resources and supports the sustainability of agricultural production during periods of drought.

Agribusiness Management: In farm management, DEA facilitates the evaluation of efficiency across different operational units within an enterprise. Through these analyses, business owners can identify areas requiring improvement. For example, analyzing factors such as labor, machinery utilization, and land management supports more informed and effective decision-making in farm management.

Food Processing and Distribution: Production efficiency represents a critical factor in the food processing industry. By analyzing various production networks of food processing plants, DEA can identify which networks operate more efficiently. Additionally, DEA can enhance logistics efficiency in distribution processes by providing insights into which routes and methods transport larger quantities of products at lower costs.

Sustainable Agricultural Practices: The adoption of sustainable agricultural practices is crucial for reducing input use and minimizing environmental impacts. By analyzing the efficiency of such practices, DEA can identify sustainable methods that are more effective. For example, comparing organic farming practices with conventional farming methods can reveal which approach yields higher productivity.

Performance of Agricultural Cooperatives: Agricultural cooperatives aim to achieve better prices by combining the production of their members. By assessing the overall performance of cooperatives, DEA can identify which ones are operating more efficiently. Furthermore, these analyses provide clues to where cooperatives should receive more support.

Product Quality Analysis: Product quality is a crucial factor in the agricultural and food sectors. DEA can also be used in evaluating product quality. For example, by analyzing the effects of different cultivation methods on product quality, it is possible to determine which methods yield higher quality products.

Research Findings and Discussion

Cultured fish farms are the principal link in the value chain for domestic and international markets. Domestically, producers contribute the highest value addition in the trout and sea bream/sea bass chains but receive the lowest share of total net profit. Internationally, while sea bream/sea bass producers generate the most value added, retailers capture a larger share of the profit. Trout producers contribute the second-highest value added, although their net profits are lower than those of retailers and processors. The production costs per kilogram are EUR3.90 for sea bream and sea bass, and EUR2.70 for trout. Feed represents the largest share of production costs, accounting for 50.6% and 38.5% of the revenue. Other miscellaneous expenses (including vitamins and medicine) account for 24.3% at sea bream/sea bass farms and 27.8% at trout farms. Fingerlings represent the third-largest cost component (Figures 3 and 4).

The domestic value chains for sea bream/sea bass and trout include wholesalers and retailers. Wholesalers contribute 36.6% and 30.6% of total net profit in sea bream/sea bass and trout chains, respectively. The average costs for wholesalers are EUR5.20/kg for sea bream/sea bass and EUR3.50/kg for trout. Fish purchases account for the majority of wholesale costs, at 92.5% for sea bream/sea bass and 89.4% for trout (Figure 3).

Retailers account for 28.1% and 31.4% of the total value added in the sea bream/sea bass and trout chains, respectively, capturing the largest share of net profits within these chains. Fish procurement constitutes the majority of retailers' costs, representing 89.3% of total costs in the sea bream/sea bass chain and 83.8% in the trout chain. Labor costs are also included, comprising 7% of total costs for trout and 4.5% for sea bream/sea bass retailing. Transportation represents another major expenditure across both chains. Retailers also incur marketing expenses, accounting for 1.6% of the total costs in the sea bream/sea bass chain and 2.4% in the trout chain (Figure 3).

The study demonstrates that the overseas processed fish market follows a structured value chain, yielding total net profits of EUR5.30/kg for sea bream/sea bass and EUR4.20/kg for trout. The corresponding net profit margins are 50.7% and 53.2%, respectively. Producers generate the highest value added in the overseas chain, although they receive the second-highest share of net profits. In the processed trout value chain, retailers contribute the greatest value and capture the largest share of net profits, whereas producers rank second in terms of value addition but receive the second-lowest share of net profits (Figure 4).

Processors represent the second stage in the overseas value chain, contributing 9.4% and 11.5% of the total value added in the sea bream/sea bass and trout supply chains, respectively. They capture 14.6%

FIGURE 3

MAP OF THE FRESH SEA BREAM/SEA BASS AND TROUT VALUE CHAINS IN THE DOMESTIC MARKET

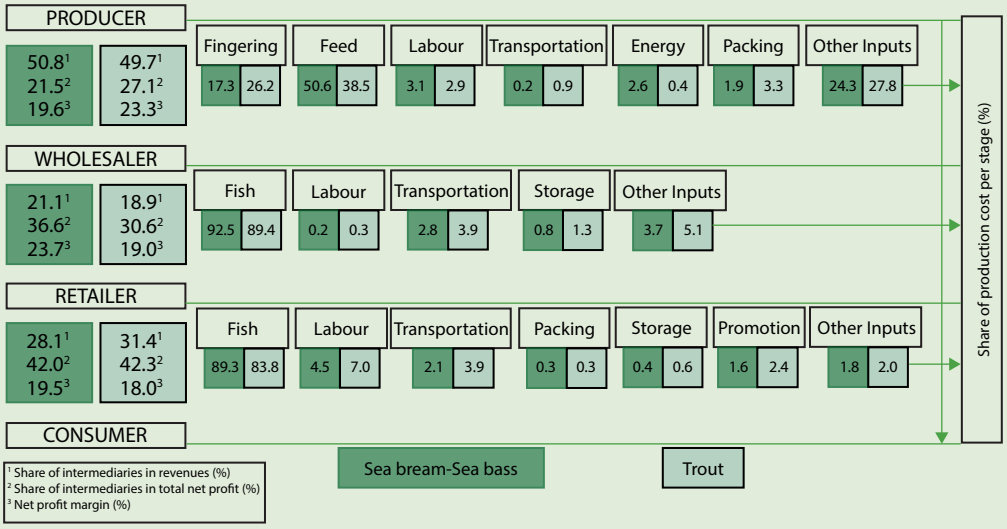
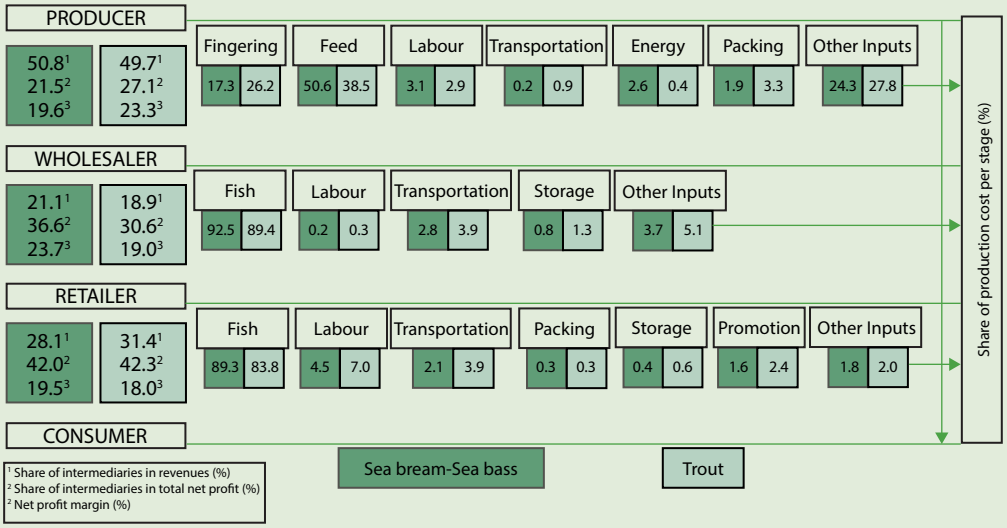


FIGURE 4

MAP OF PROCESSED SEA BREAM/SEA BASS AND TROUT VALUE CHAINS IN THE OVERSEAS MARKET



of the total net profit in sea bream/sea bass and 16.2% in trout. Processing costs are EUR5.10/kg for sea bream/sea bass and EUR3.20/kg for trout, with fish purchases accounting for the majority of the total costs. Packaging accounts for 2.7% and 3.1% of the total processing costs for sea bream/sea bass and trout, respectively (Figure 3). Net profit margins at the processing stage account for 13.2% of revenue for sea bream/sea bass and 17.4% for trout (Figure 3).

Exporters follow processors in the chain, contributing 6% and 7.6% of value added in the sea bream/sea bass and trout chains, respectively. Turkiye holds a comparative advantage in international processed fish markets, with fish purchases accounting for 95.4% of exporters' total costs. Additional inputs, such

as product loss, communication, and interest, account for 1.9% and 2.1% of the costs in the sea bream/sea bass and trout chains, respectively. Labor and storage contribute 1.0% and 0.8% of the total value added in the sea bream/sea bass chain, and 1.3% and 1.4% in the trout chain, respectively. Transportation and customs tariffs comprise less than 1% of total costs. Exporters' net profit margins are 8.4% for sea bream/sea bass and 12% for trout (Figure 4).

Retailers in the overseas processed fish chain contribute 38.2% of the value added for sea bream/sea bass and 42.7% for trout, capturing 57.3% and 56.4% of total net profits, respectively. Fish purchases account for the majority of total retail costs, comprising 87.1% for sea bream/sea bass and 82.8% for trout. Labor accounts for the second-largest cost component, accounting for 5.8% of the total cost in the sea bream/sea bass chain and 8.3% in the trout chain. Other inputs (such as energy, taxes, and interest) constitute 4.1% and 7.1% of total costs in the sea bream and trout supply chains, respectively, whereas marketing expenses account for 0.6% and 1.0%, respectively. Storage and transportation each account for less than 1% of total costs. Retailers' net profit margins are 29.1% for sea bream/sea bass and 30% for trout in the overseas market (Figure 4).

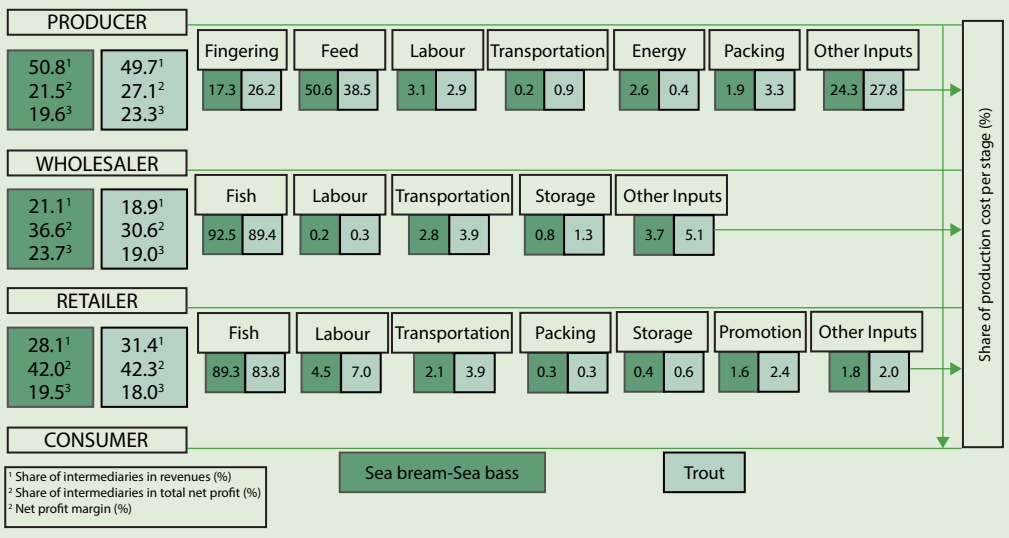
Overall Efficiency

An efficiency analysis of value chain networks for sea bream/sea bass in domestic and overseas markets indicated that overall efficiency scores were comparable between fresh and processed products. However, processed trout exhibited a higher efficiency score compared with its fresh counterpart. Specifically, the efficiency score for fresh sea bream/sea bass in the domestic market was 0.852, whereas trout scored slightly higher at 0.865. In the overseas market, processed trout demonstrated greater overall efficiency compared with sea bream/sea bass. Within the domestic fresh fish market, intermediary efficiency increased progressively along the value chain, from producers to downstream actors (Figure 5).

Among all value chain participants, producers recorded the lowest efficiency scores, whereas wholesalers achieved the highest. Retailers were the most efficient actors in the domestic fresh fish market, with scores of 0.989 for sea bream/sea bass and 0.987 for trout. In the overseas processed fish market, producers again demonstrated the lowest efficiency scores, consistent with their performance in the domestic market. Processors followed with the second-lowest efficiency scores, whereas exporters achieved the highest scores. Exporters in the sea bream/sea bass value chain recorded the top efficiency score (0.978), followed by retailers in the trout value chain with a score of 0.989 (Figure 5).

FIGURE 5

OVERALL EFFICIENCY OF SEA BREAM/SEA BASS AND TROUT VALUE CHAIN NETWORKS



Conclusıon

This study examined the efficiency of fresh and processed value chains for trout and sea bream/sea bass, with a particular focus on the revenue distribution within each chain. The findings indicate that the total net profit was higher for processed fish in the overseas market compared with fresh fish in the domestic market. Furthermore, the efficiency of the processed trout value chain exceeded that of its fresh counterpart. Across fresh and processed chains, wholesalers, processors, and retailers demonstrated higher efficiency scores compared with producers.

The sea bream/sea bass value chain exhibited efficiency advantages in areas such as labor utilization, storage, transportation, and packaging; however, it lagged behind the trout chain at the producer level. The trout chain demonstrated a more efficient use of labor and energy, achieving a superior feed conversion ratio. To improve efficiency, interventions should focus on optimizing inputs at the producer level, particularly by reducing energy, labor, transportation, and storage costs. Specialized training programs and targeted extension services focusing on workforce management, energy efficiency, and feed optimization can empower producers to increase their operational efficiency.

The intermediary stages (wholesalers, processors, exporters, and retailers) within the trout and sea bream/sea bass chains outperformed producers in converting inputs into outputs. This performance can be attributed to collaborative practices, technological advancements, and greater access to financial capital. A culture of collaboration promotes coordinated production, reduces resource wastage, and enhances operational efficiency. Access to financing facilitates investments in infrastructure, equipment, and R&D, which in turn drive productivity gains.

The overseas value chain demonstrated superior efficiency compared with the domestic chain, primarily due to its ability to generate higher value added and command premium prices in foreign markets, driven by higher quality standards and a greater willingness among international consumers to pay higher prices. Furthermore, the overseas chain benefits from economies of scale, which increase production volumes and profitability. Exposure to global market competition compels continuous innovation and process improvement.

Conversely, the domestic value chain can improve efficiency by promoting local consumption of processed trout and sea bream/sea bass and increasing public awareness of their nutritional value and culinary adaptability. Establishing a well-coordinated value chain and enhancing logistics, cold chain systems, and market access for domestic consumers further strengthens performance.

Fair trade principles are crucial for ensuring that all value chain participants, particularly fish farmers, receive a fair and equitable share of revenues. Several models, including wholesale systems, cooperatives, blockchain-based traceability, direct e-commerce, stock exchanges, and auction platforms, can support value chain operations in the aquaculture sector. Among these, cooperatives and direct e-commerce exhibit strong potential for increasing producer income, whereas blockchain applications are expected to yield long-term benefits. Equitable revenue distribution among stakeholders can positively affect overall and individual efficiency across the chain. Future aquaculture research should investigate the drivers of efficiency differences among actors or chains, including geographic location, cultivated species, production methods, and market characteristics.

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BEST PRACTICES IN PRODUCTIVITY GAINSHARING WITHIN RICE FARMING COOPERATIVES IN VIETNAM'S MEKONG RIVER DELTA

Executive Summary

Rice production is a key agricultural product ensuring food security and providing raw materials for export in Vietnam. The Mekong River Delta accounts for 55% of the rice area, contributing 56% of total rice production and 90% of rice exports.

This research identifies and evaluates best practices in productivity gainsharing within the agrifood sectors of APO member countries. The findings can help enhance productivity across the supply chain for small-scale farmers and agricultural service cooperatives in the Mekong River Delta, balancing low-carbon emissions with traditional farming practices.

The survey results of agricultural cooperatives showed weak potential resources for cooperatives. Only a few survey cooperatives have invested in warehouses, rice dryers, tractors, drones, and irrigation water supply services, whereas other agricultural cooperatives lack infrastructure such as warehouses, machinery and equipment, irrigation pumping stations, and rice processing and packaging capabilities.

Some agricultural cooperatives exhibit good production and business performance, providing agricultural services such as water pumping, clean water provision, input supply, and purchasing output products.

The program[1] for cultivating one million hectares of low-carbon emission rice was approved by the Prime Minister under Decision No. 1490/ QĐ-TTg dated November 27 2023. Based on this decision, the Provincial People's Committees develop pilot programs for each province. In the case of Soc Trang, An Giang, and Tra Vinh, each province selected some agricultural cooperatives with an area of 100 ha/ province to implement the pilot program.

This study's results demonstrated the positive performance of the low-carbon rice farming model in households linked with agricultural cooperatives compared with those engaged in conventional rice farming systems. This model positively contributes to environmental sustainability by reducing the use of seeds, chemical fertilizers, pesticides, and irrigation water through the implementation of the alternate wetting and drying irrigation method. Additionally, it lowers fuel consumption associated with water pumping in rice cultivation. Furthermore, the program supports soil protection by increasing the use of organic and biofertilizers. Moreover, low-carbon rice farming practices contribute to healthier rice plants, reduced pest infestations, and improved rice yields.

Compared to conventional rice farming, the total production costs in low-carbon rice farming have been reduced by 16%. Notably, seed investment costs decreased by 32%, fertilizer input costs by 18%, and pesticide costs by 12%.

1 *Sustainable development of one million hectares of high-quality and low-carbon emission specialized rice linked to green growth in the Mekong River Delta by 2030.*

The economic performance of the rice seed supply chain, encompassing cooperative-linked farming households and distributors, demonstrates significant effectiveness. The rice seed supply chain has achieved a total profit of VND7,406,000 per ton produced. Regarding profit distribution per ton of rice seed, households linked with agricultural cooperatives account for 75.7% of the total profit, agricultural cooperatives 12.6%, and fertilizer and seed input dealers 11.7%.

Based on these analytical results, we recommend implementing programs and policies to expand the area under the low-carbon rice farming model in the Mekong Delta region.

Furthermore, training programs should be developed to enhance the capacity of farmers and agricultural cooperatives, enabling them to use seeds, fertilizers, pesticides, and irrigation water more efficiently compared with traditional rice farming methods.

Moreover, agricultural agencies should consider evaluating the level of carbon emission reduction achieved and establishing programs to link enterprises and markets to facilitate the consumption of certified low-carbon rice products.

Keywords: rice supply chain, small-scale farmers, agricultural cooperatives, Mekong River Delta of Vietnam

Introduction

Background of Rice Production in Vietnam

Rice production is a key agricultural product that ensures food security and the provision of raw materials for export in Vietnam. Vietnam's annual rice output is estimated at 43.4 million tons/year, with an annual planting area of 7.3 million hectares in 2023 (GSO, 2024). Thus, from a country that had to import rice before the 1990s, Vietnam has become the world's second-largest rice producer and exporter. Vietnam's rice export turnover reached USD4.78 million in 2023, an increase of 36% in export volume compared with 2022 (GSO, 2024).

The two primary rice-producing regions in Vietnam include the Red River Delta and the Mekong River Delta. The Mekong River Delta accounts for 55% of the total cultivated area, contributing 56% of total rice output and supplying 90% of the country's rice exports.

Vietnam is a leading global producer and exporter of rice; however, its production predominantly relies on small-scale farming systems. Therefore, several limitations arise in organizing production and linking rice-growing households with enterprises. The supply chain involves multiple actors, including rice brokers at the village level, purchasing agents/facilities, rice drying facilities, and milling enterprises. As a result, the operating costs of the rice supply chain are high for enterprises and farm households.

Small-scale rice production must be restructured to promote production linkages, strengthen cooperatives, and share productivity gains of the rice chain, ultimately enhancing the economic performance of all participating actors, particularly small-scale farmers.

Some rice production cooperatives have established links between farming households, forming a rice supply chain for processing and exporting. Production linkage activities have improved production performance, with cooperative members achieving better economic outcomes compared with those engaged in individual production.

However, certain limitations persist regarding linkage outcomes and productivity gains. This study examines best practices in productivity gainsharing within the rice supply chain of agricultural cooperatives in the Mekong River Delta of Vietnam and is funded by the Asian Productivity Organization (APO).

Research Objectives

This study examines the rice supply chain to identify and compare best practices in productivity gainsharing between low-carbon emission rice and conventional rice farming within rice farming cooperatives in Vietnam's Mekong River Delta.

Specific Study Objectives

This study reviews the organizational structures, operations, and actors participating in rice production cooperatives in the Mekong Delta. It examines the rice supply chain from the perspective of farmers participating in cooperative supply services and related actors to assess rice production performance and productivity gainsharing among actors. Finally, we recommend interventions to strengthen production linkages and productivity gainsharing among actors.

Study Structure

This study is structured in seven sections. The first section presents an overview of the rice sector and policies related to developing agricultural cooperatives. The second section presents the methodology for examining the rice supply chain and introduces the related actors. The third and fourth sections present the actors within rice supply chains and assess the economic performance of rice production at household farms. The fifth and sixth sections identify climate risks in rice production and present a strengths, weaknesses, opportunities, and threats (SWOT) analysis of rice production at household farms and agricultural cooperatives. The seventh section analyzes the economic performance of rice production at agricultural cooperatives and examines productivity gainsharing.

Overview of the Mekong River Delta and the Rice Sector

Mekong River Delta

The Mekong Delta is connected to the Mekong subregion and comprises 12 provinces (Long An, Tien Giang, Can Tho, Hau Giang, An Giang, Dong Thap, Vinh Long, Tra Vinh, Ben Tre, Soc Trang, Bac Lieu, and Ca Mau).

Vietnam's Mekong Delta is strategically located along the southern economic corridor of the Greater Mekong Subregion, connecting Vietnam with Cambodia and Thailand. Specifically, the Mekong Delta borders the Kingdom of Cambodia and Tay Ninh Province (Vietnam) to the north, Ho Chi Minh City to the northeast, and the East Sea to the south and southwest.

The region has a dense network of canals, which determines the soil characteristics and agricultural potential of its floodplains; however, the delta faces significant challenges from rising tides and saltwater intrusion, which have affected rice cultivation lands.

It has a population of approximately 18 million people and covers 4.1 million hectares of land (93.9%) and 245,000 hectares of maritime area (6.1%) (GSO, 2024). It is Vietnam's largest rice-producing region, contributing approximately 90% of the country's rice exports.

Rice Sector in the Mekong River Delta

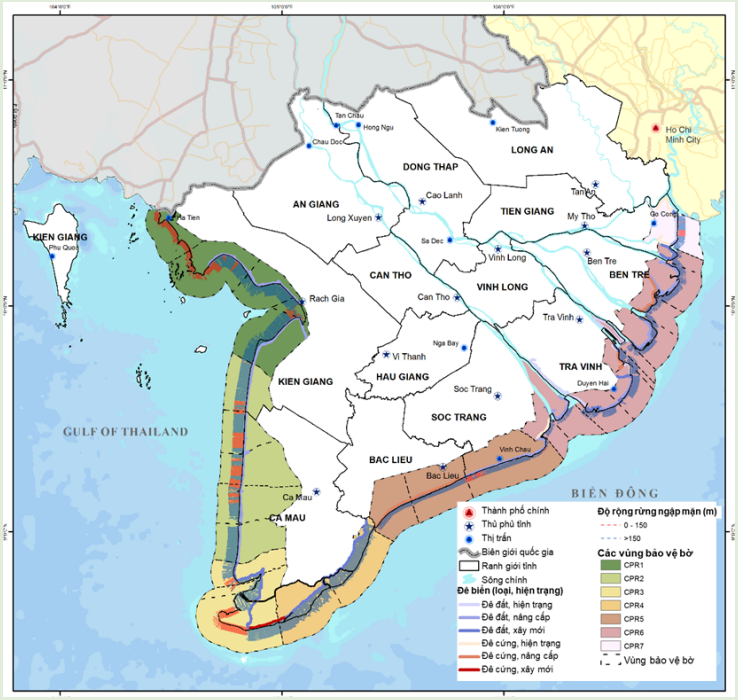
Small-scale rice farming is a characteristic of Vietnam's rice sector. According to the General Statistics Office (2016), Vietnam has approximately 8 million rice farming households, with over 85% cultivating less than 0.5 ha per household. Vietnam's total rice cultivation area spans approximately 7.3 million ha, with an annual production of 43.4 million tons, meeting domestic consumption and export requirements (GSO, 2024). In 2023, Vietnam exported 8.2 million tons of rice, generating a revenue of USD4.78 billion. This represents a 36% increase in rice export revenue compared with 2022 (GSO, 2024).

The Mekong River Delta accounts for 55% of the country's total rice cultivation area and produces 56% of the nation's total rice. Each farming household cultivates 1.3 ha, higher than the national average of 0.4 ha/household (GSO, 2024).

Prior to 2020, high-yield hybrid rice varieties were primarily cultivated to meet domestic food security needs and to be exported to markets with lower quality requirements. However, in recent years, high-quality and fragrant rice varieties have gradually gained prominence, resulting in significant improvements in rice quality.

FIGURE 1

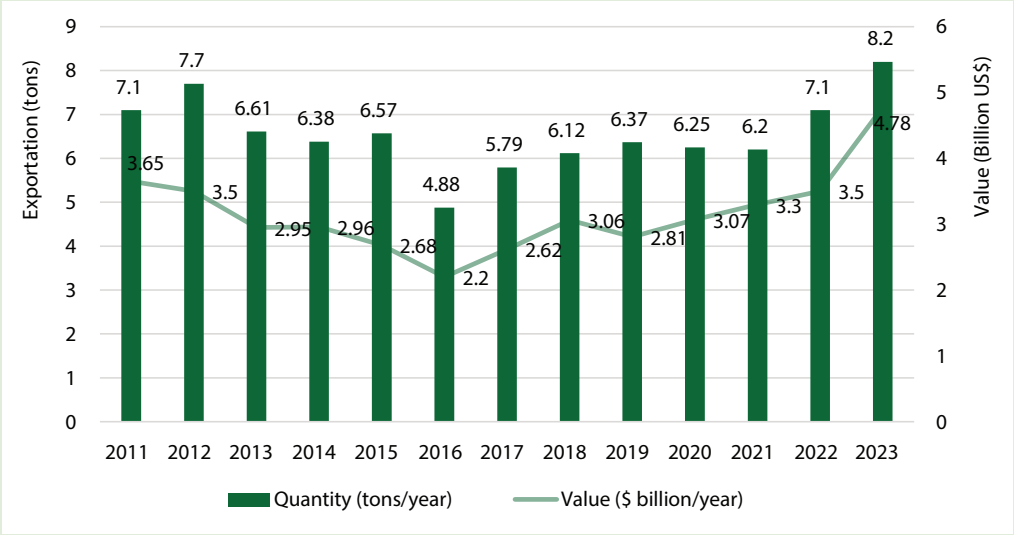
MAP OF VIETNAM'S MEKONG DELTA



Source: Mekong Delta Regional Planning Report, 2020

FIGURE 2

EVOLUTION OF RICE PRODUCTIVITY AND EXPORTATION IN VIETNAM OVER THE PAST DECADE



Source: Statistical data are from the Statistical Yearbook 2013, 2016, 2023, and 2024.

Policies for Agricultural Cooperative Development

Agricultural cooperatives in Vietnam aim to unite and support small-scale farming households in meeting quality standards and establishing market-oriented production linkages. Cooperatives are key intermediaries, connecting farmers with processing enterprises and product markets.

The 2012 Cooperative Law serves as the legal foundation for cooperative development policies in Vietnam, including various decrees and circulars. Certain key policies establish the legal basis for agricultural cooperatives to play a crucial role in agricultural and rural development strategies, facilitate agricultural value chain linkages, and mobilize financial resources for investment.

The Vietnamese government recognizes that cooperatives are essential for organizing and supporting small-scale and disadvantaged farmers to improve production efficiency, increase income, and create better employment opportunities. Cooperatives enable small farmers to access better input services and secure fairer product prices via joint purchasing, joint selling, and production linkages with processing enterprises.

These policies have enabled Vietnam's agricultural sector (particularly rice production) to form stronger production linkages. These linkages include agricultural extension programs that provide farmers with sustainable farming knowledge, using high-quality rice varieties, improved product packaging and labeling to attract consumers, and the application of technical standards in cultivation, production, and product distribution.

According to 2023 statistics data, Vietnam has 19,431 agricultural cooperatives, accounting for 66% of all cooperatives nationwide, with 3.8 million members belonging to small-scale farming households. Each agricultural cooperative has an average of 195 members and employs about 1.57 million workers; however, the average annual revenue of cooperatives remains low, at VND1.3 billion per cooperative (Department of Cooperative Economics and Rural Development, 2023).

Small-scale agricultural cooperatives with 50 to 100 members account for 30% of agricultural cooperatives. Large cooperatives with 300 members or more account for 10% of agricultural cooperatives nationwide (Department of Cooperative Economics and Rural Development, 2023).

Agricultural cooperatives are designed to benefit their members and provide essential community services, such as irrigation water management, clean water supply, and environmental sanitation.

In practice, however, many cooperatives are established to capitalize on state policies, incentives, and financial support from development programs and projects. Additionally, some cooperatives are formed to meet local political objectives, such as fulfilling criteria for new-style rural development programs.

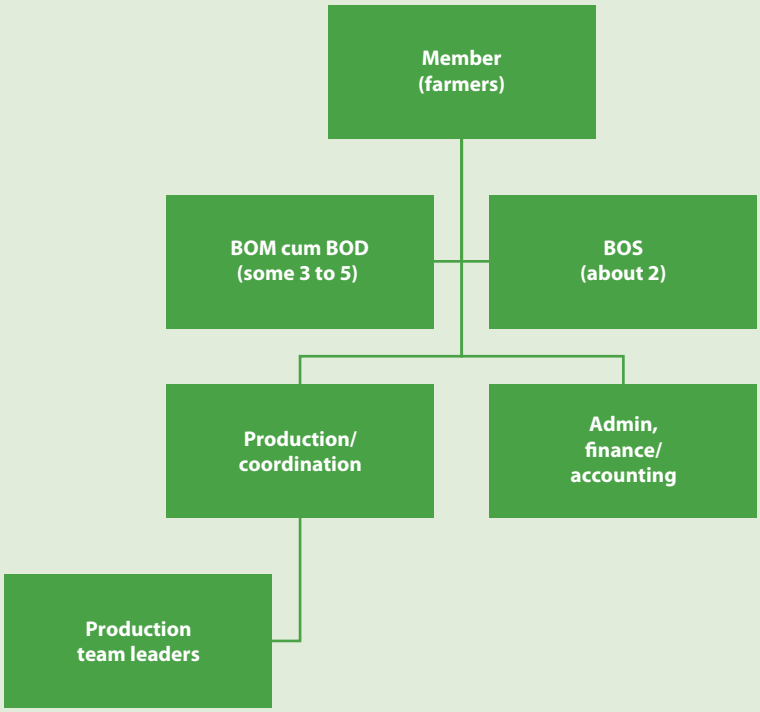
Research on cooperatives in the Mekong Delta reveals several challenges, including weak preprocessing, processing, packaging, and product distribution capacity. The proportion of cooperatives engaging in income-generating activities remains low. In 2015, only 6% of cooperatives purchased products from their members, however, this figure increased to 22.5% in 2023 (Department of Cooperative Economy and Rural Development, 2023).

Vietnam's agricultural cooperatives remain small-scale, characterized by limited capital, weak production capacity, and low member engagement. They also face challenges related to poor infrastructure, inadequate financial resources, and the ability to establish production linkages with enterprises, limiting their sustainability within the agricultural value chain.

An agricultural cooperative's organizational structure includes farmer members of the cooperative. Through the general annual meeting, farmer members elect the board of managers (BOM), board of directors (BOD), and board of supervisors (BOS). To streamline the management structure, members of the BOM concurrently serve as the BOD. Depending on the cooperative's scale, the BOD establishes production units and groups, administrative units, and finance and accounting divisions (Figure 3).

FIGURE 3

ORGANIZATIONAL STRUCTURE OF AN AGRICULTURAL COOPERATIVE



Source: Synthesized from surveys of cooperatives in the Mekong River Delta, 11/ 2024
BOM/BOD = Board of Managers/Board of Directors
BOS = Board of Supervisors

Research Methods

Research Timeline and Location Introduction

The study was conducted from August to December 2024. The study synthesizes secondary data on the rice sector, including supply chains, production actors, farming cooperatives, purchasing agents, processing entities, and export enterprises.

Based on the assessment of the rice value chain, a rapid survey was conducted with key actors involved in the Mekong Delta rice supply chain, including cooperatives, processing enterprises, and rice farming households. To clarify the extent of productivity gainsharing among actors within the rice supply chain, the study focused on specific cooperatives to identify the most suitable cases for analyzing stakeholder benefit-sharing mechanisms.

Research Approach

To provide an overview of the Mekong Delta rice production region, this study analyzed the total area, cultivated area, yield, and the development of agricultural cooperatives contributing to the rice sector. It also reviewed policies on cooperative development and support for rice production in Vietnam and the Mekong Delta.

Furthermore, discussions were conducted with cooperatives, enterprises, wholesalers, retailers, and provincial authorities in Tra Vinh, Soc Trang, and An Giang provinces to explore cooperative development, production linkages, and profit-sharing among rice supply actors. Rice markets and export volumes in recent years were examined and rice farming households were surveyed to assess economic performance and profit-sharing among value chain participants.

This study also examined typical cases of benefit sharing at the rice production level, focusing on cooperatives and smallholder farmers involved in production linkages.

Research Methods

Secondary Data

This study utilized secondary data from reports and documents, with statistical data being collected from the following sources:

- General Statistics Office (GSO), Department of Cooperative Economics and Rural Development, and Provincial Departments of Agriculture and Rural Development (DARD) in Soc Trang, An Giang, and Tra Vinh.
- National statistics on rice production and exports from the GSO.
- Surveys and reports on agricultural cooperatives, particularly rice cooperatives, from the Vietnam Cooperative Alliance (2024).
- Data and reports from relevant rice sector projects shared for research purposes.

The study also incorporated insights from industry experts, local specialists, cooperatives, enterprises, and DARD officials to identify key actors in the Mekong Delta's rice supply chain through focus group discussions and structured interviews.

Primary Data

In-depth surveys of cooperatives and cooperative members were conducted using semi-structured questionnaires. This approach allowed us to assess profit-sharing mechanisms between cooperatives and their members. Key data collected include:

- Historical trends in rice farming within the community and ongoing transitions in cultivation practices;
- Farm size, yield, and production output per household, drawing comparisons between traditional and technologically improved rice farming methods;
- Intensity of rice farming, cultivation practices, and compliance with quality standards;
- Sources of rice seeds and agricultural inputs, market linkages, and economic performance of rice farming at the household and cooperative levels;
- Access to credit for rice production;
- Surveys of agricultural cooperative models, focusing on input supply services (rice seeds, fertilizers, irrigation) and paddy procurement;
- Surveys of rice processing and exporting enterprises (though it was challenging to collect information on production volumes and financial performance from these entities), including their production capacities and development of raw material areas with cooperatives and farming groups.

Local and rice sector policies support the development of actors within the rice supply chain (cooperative development policies, the 1-million-ha high-quality rice program, and carbon emission reduction initiatives). Table 1 presents the scale and number of actors surveyed in the rice supply chain across Soc Trang, An Giang, and Tra Vinh provinces.

TABLE 1

SCALE AND ACTORS PARTICIPATING IN THE RICE SUPPLY CHAIN

Actors	Surveyed units	Data collected
Government agencies (n = 12)	Focus group discussions with representatives from: Sub-departments of Crop Production and Plant Protection in Tra Vinh, Soc Trang, and An Giang provinces; Sub-Department of Agro-Forestry-Fisheries Quality Management; Agricultural Extension Center	Cultivated area, productivity, and rice output Stakeholder involvement in the provincial rice value chain Quality of rice varieties and fertilizers Policies on production linkages in rice cultivation
Producers: Rice farmers and agricultural cooperatives (n = 60)	Rice farming households in 10 agricultural cooperatives across Tra Vinh, An Giang, and Soc Trang provinces	Cooperative management capacity and resources Number of members and production linkages Cultivated area, productivity, and rice production output Input supply chains and output sales channels Preliminary processing, production processes, and rice product quality Access to credit and markets
Processing/ exporting enterprises (n = 3)	Large-scale rice trading, processing, and exporting enterprises, including Loc Troi Group and A An Company	Value chains for rice products and output markets Sustainable certification standards and chain of custody (CoC) systems Management of by-products in rice farming and production of organic fertilizers Access to credit and capital for purchasing raw rice materials

Source: Compiled from surveys conducted in Tra Vinh, Soc Trang, and An Giang provinces, November 2024

Supply Chain Analysis

This study analyzes the supply chain and the key actors involved in developing the linkage chain between small-scale rice farmers and cooperatives. It examines cooperative management practices and the organization of rice production, particularly in relation to service provision and the adoption of sustainable rice production standards by small-scale farmers

Based on the assessment of the participation of actors in the chain, the study evaluates overall performance outcomes and the extent of productivity and profit-sharing among the participating stakeholders.

Economic Performance Analysis at the Household Level

The economic performance analysis method was applied to evaluate rice production at the household level and compare the results between conventional rice farming and cooperative-linked rice farming practices under low-carbon emission reduction programs. We propose recommendations for rice production and linkages between farming households, cooperatives, and enterprises based on the economic performance analysis results.

Data Analysis

The data collected from secondary and primary sources on planted areas, productivity, production output, selling prices, and economic performance were analyzed using Microsoft Excel and Minitab software.

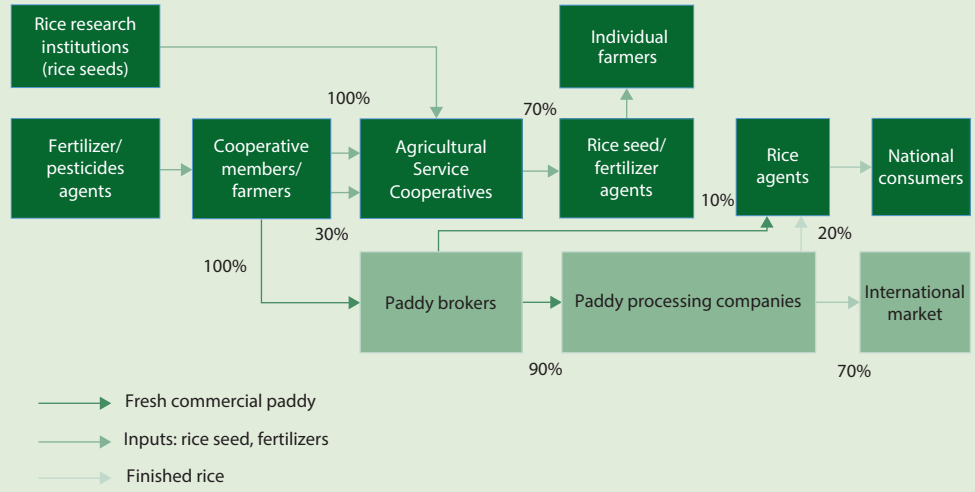
Current State of Productivity Gainsharing in the Rice Supply Chain

Actors Participating in the Rice Supply Chain

Diverse actors are involved in the rice supply chain, with small-scale rice farming households forming its central component. Input suppliers provide essential items such as rice seeds, fertilizers, and other materials. Purchasing agents include rice brokers, branch companies of rice processing enterprises, and agricultural cooperatives. Rice processing enterprises consist of milling, packaging, and exporting companies, whereas the rice retail actors include retail stores, supermarkets, and rice traders (Figure 4).

FIGURE 4

RICE SUPPLY CHAIN IN THE RESEARCH REGION



Source: Synthesized from surveys of cooperatives in the Mekong River Delta, 11/ 2024

We were unable to collect sufficient information on rice processing plant agents and exporting enterprises; therefore, the study focused on the agents involved in the production and distribution of the rice seeds within the supply chain. Furthermore, we evaluated the efficiency of rice production under the low-carbon rice program compared with conventional rice cultivation.

Analysis of Actors in the Rice Supply Chain

Development of Agricultural Cooperatives and the Linkage between Small-Scale Farmers and Agricultural Cooperatives

Vietnam has 19,431 agricultural cooperatives, accounting for 66% of the total number of cooperatives nationwide, with a membership comprising approximately 3.8 million small-scale farming households. Each agricultural cooperative includes 195 small-scale farming households, collectively providing regular employment to about 1.6 million workers. These cooperatives leverage technology to implement modern farming techniques, including crop breeding and postharvest preservation. As part of their development strategies, cooperatives increasingly adopt technology, automation, and information technology in agricultural production. In particular, they establish linkages with households that produce in accordance with sustainable production certification standards, committing to purchase products directly from small-scale farmers.

Since 2012, new-style cooperatives have emerged in Vietnam and are recognized as an important economic component of the national economy. These cooperatives bring together small-scale farming households and share input costs for various services such as irrigation, seed supply, fertilizer and pesticide application, harvesting, product purchasing, preliminary processing, and the provision of supply services to processing enterprises.

In the context of the low-carbon agricultural development strategy, cooperatives also play a crucial role in coordinating production processes among numerous small-scale farming households. This collective

approach helps ensure adherence to production protocols, reduce production costs, enhance production performance, and mitigate environmental impacts.

For example, Phu Thanh Agricultural Cooperative, established in 2005 in An Giang province with 1,700 members, represents a new type of cooperative that actively engages with farmers as part of a strategy to develop the local rice value chain. The cooperative supports farmers by providing them with sustainable rice production processes, purchasing their products, and managing preprocessing, processing, and the supply of rice to processing enterprises.

The cooperative's activities have had several positive impacts, such as introducing high-quality rice varieties into production and treating postharvest straw with biofertilizers. These measures help reduce production costs and enhance the economic performance of small-scale rice farming.

Within the production linkage, the cooperative guides farming households to produce rice in accordance with the Sustainable Rice Platform (SRP) and VietGAP standards, aiming for low-carbon rice production. As a result, the cooperative's rice products meet the standards of high-quality rice, including 4-star and 5-star OCOP rice.

Initially, small-scale rice farmers benefited from their association with cooperatives, including reduced production costs and higher rice prices compared with market rates, provided they met the required production standards. However, as cooperatives work to form a cohesive supply chain for rice products, they face challenges such as obtaining member consensus, accessing sufficient capital for rice production, improving production and business economic performance, and meeting the purchasing demands of processing enterprises.

Actors Involved in the Rice Supply Chain at the Agricultural Cooperative

Stakeholders' Support for Agricultural Cooperative Development

Many actors build and develop linkages between small-scale rice farming households and cooperatives, including the following.

Cooperative members are farmers who produce rice within the cooperative's operating area, adhering to its quality and sustainability standards as required by processing enterprises.

Several actors support the linkage of rice production at the cooperative level, each contributing to different stages of the value chain:

- Input suppliers include enterprises supplying fertilizers and materials to cooperatives.
- Enterprises sign contracts to purchase rice products that meet the cooperative's sustainability standards, often offering prices above market rates.
- Facilities offer land preparation, plant protection spraying, and fresh rice drying facilities.
- Agents supply machinery, equipment, packaging, and product labels.
- Quality testing centers assess product quality indicators.
- The sustainable certification standards assessment unit (SRP, VietGAP) is also involved.
- Commercial banks provide capital.
- Enterprises provide transportation services for rice and materials.
- Event organizers and product exhibitions play a role.
- The Commune People's Committee and the District People's Committee (Department of Agriculture and Rural Development; Agricultural Service Center) are involved.

FIGURE 5

ANALYSIS OF STAKEHOLDERS IN THE COOPERATIVE'S RICE PRODUCTION CHAIN

Source: Synthesized from surveys of cooperatives in the Mekong River Delta, 11/ 2024

- The Department of Agriculture and Rural Development (Department of Rural Development, Department of Crop Production and Plant Protection, Agricultural Extension Center) plays a role.
- The An Giang Province Cooperative Union is involved in the process.
- The Provincial Agricultural Enterprise Association plays a role.
- Finally, sustainable agricultural development programs and projects are included (GAC, GIZ, AgriTerra, GDRV, etc.).

Stages of Agricultural Cooperative Development

2000–2005: Small-scale cooperatives or farmer groups were established at the hamlet level with a few members, providing rice seeds and basic services such as irrigation. Additionally, these cooperatives also offered cropping schedules. Their activities were primarily intended to serve the community rather than generate economic returns.

2005–2015: Small cooperatives in the commune were merged into a single, larger cooperative and provided services such as irrigation services and fertilizer and seed supply. Subsequently, this unified cooperative expanded its range of services to include land preparation and domestic water provision. Consequently, the cooperative's activities were larger in scale and exhibited better economic performance.

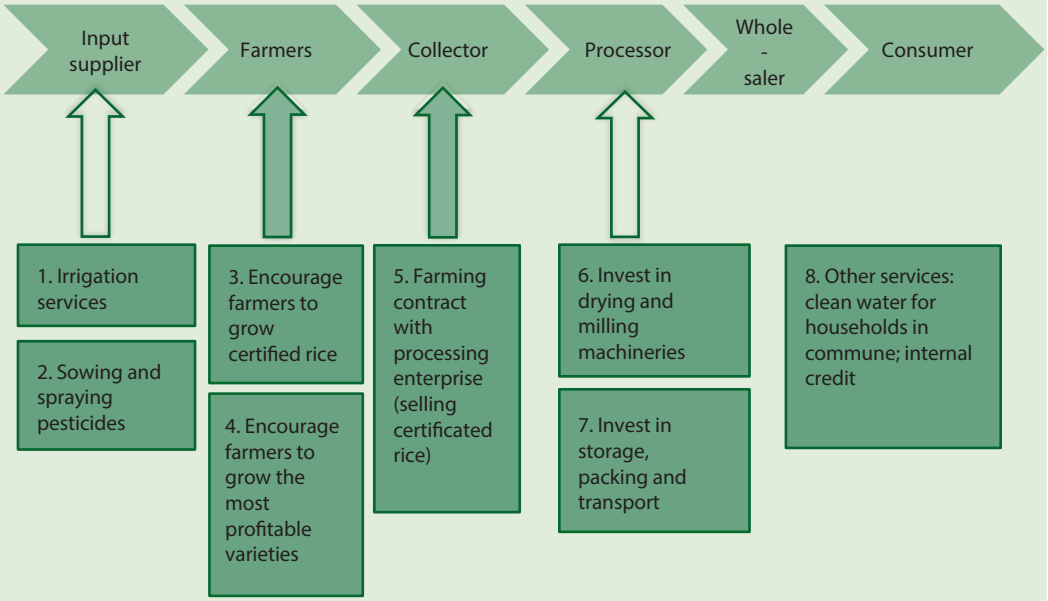
2015–present: The cooperatives were restructured according to the Cooperative Law in 2012. In addition to establishing a Board of Directors and providing agricultural services, they also began focusing on market development and linking the production of high-quality rice varieties to evolving market consumption trends.

Rice Supply Chain of Agricultural Cooperatives

Currently, the primary business activities of the cooperative include providing irrigation services, seeds, fertilizers, and plant protection. The cooperative also facilitates compliance with SRP and other certification standards for its rice products. In partnership with several enterprises, particularly those focused on local specialty rice, the cooperative supports the production of glutinous rice production (short-term glutinous rice) and other varieties aligned with these sustainability criteria. Such activities generate income for the cooperative and its members.

FIGURE 6

THE CURRENT RICE SUPPLY CHAIN OF AGRICULTURAL COOPERATIVES



Source: Synthesized from surveys of cooperatives in the Mekong River Delta, 11/ 2024

Input Supply Services

Agricultural cooperatives provide input services to their members, including irrigation, field protection, rice seed supply (as most farmers previously used preharvested seeds), fertilizers, and plant protection. Currently, 100% of the members' rice-growing areas are fully irrigated and supported by field protection services.

The cooperatives adopt production practices in accordance with SRP standards and sell rice to processing and exporting enterprises. They also implement emission-reducing rice cultivation methods such as the system of rice intensification (SRI), thereby lowering production costs and reducing the use of chemical fertilizers, irrigation water, and the incidence of pests and diseases.

Furthermore, cooperatives often maintain revolving capital generated from fertilizer and plant protection trading activities, which is used to provide loans to their members.

Supplying rice seeds, fertilizers, and pesticides forms an important part of the cooperative's activities. The quantity of fertilizers and pesticides supplied by the cooperative accounts for 80% of farmers' needs at some agricultural cooperatives such as Phu Thanh; however, other cooperatives supply a small proportion of these products.

Rice Farming Households

Rice farmers are members of the cooperative and primarily cultivate key rice varieties, including glutinous rice and fragrant rice, to meet the requirements of enterprises. Furthermore, some households grow other local rice varieties or high-yield hybrid rice. In particular, rice seeds and glutinous rice offer particularly high economic returns. Glutinous rice is specifically grown to meet the needs of the domestic market and export enterprises.

Small-scale rice farming systems primarily rely on household labor, while services such as land preparation, rice harvesting, and drying are typically provided by cooperatives or private entities.

The area for growing sticky rice accounts for 70%, equivalent to 420 hectares at the Phu Thanh cooperative and the rice seed farming area at the Phat Tai cooperative. High-yield hybrid rice is grown on the remaining 30% of the rice-growing area Today, rice cultivation uses chemical fertilizers, pesticides, and small-capacity machines instead of manual labor such as sowing, weeding, harvesting, and drying rice. Therefore, the cooperative applies SRI farming methods and SRP standards to help farmers reduce the use of chemical fertilizers and minimize soil and straw pollution following the rice harvest.

Calculating Inputs to the Project Interventions

There is a high demand for sticky rice, especially in the food processing and confectionery industries. The demand for sticky rice is also increasing in the Chinese market, resulting in higher prices for sticky paddy compared with regular paddy. Consequently, sticky paddy is purchased in large quantities.

Sticky rice is cultivated during the winter–spring and summer–autumn cropping seasons at the Phu Thach cooperative in An Giang province, with the majority of cultivation occurring during the summer–autumn season.

The total area under sticky rice cultivation is approximately 376 hectares a year, yielding an estimated 2,000 tons of paddy. Of this, around 20% is consumed by the respective households, whereas 80% is sold to the market outside the commune.

Fresh sticky paddy is directly purchased at harvest by small collectors or traders. Subsequently, this fresh paddy is transported to dried enterprises. Large traders and enterprises then buy or sell the sticky rice through established distributed systems. Consumers in Hanoi account for approximately 30% of the production, with the remainder distributed across provinces in the southern region.

Agricultural cooperatives have cooperated with rice processing companies through contract farming. The rice processing companies provide seeds, technical procedures, fertilizers, and monitoring services.

Rice seeds are cultivated during the winter–spring and summer–autumn cropping seasons at the Phat Tai cooperative in Tra Vinh province. Approximately 94 small-scale rice farmers cultivate rice seeds on the cooperative's land, providing about 700 tons for the market.

Paddy Collecting Activity

Since 2018, cooperatives have begun engaging in paddy-buying activities. By the end of 2023, they were committed to purchasing from farmers who produced rice in accordance with SRP procedures and sticky rice in accordance with SRP and VietGAP certification standards.

Private enterprises play an important role in fresh paddy collection, an activity marked by intense competition among paddy drying and milling agents in the region. Fresh paddy is typically harvested and sold directly to traders at the rice fields, who then transport it to drying and milling facilities. Once dried, the paddy is stored in warehouses and later processed into rice, which is subsequently sold to wholesale traders or processing enterprises.

Processing Activity at Cooperatives

Agricultural cooperatives do not engage in paddy drying and milling activities. Instead, these activities are undertaken by private processing enterprises. As a result, cooperatives contribute minimally to value addition, primarily serving as intermediaries that transfer paddy to processing enterprises

Agricultural cooperatives purchase dried paddy from their members to enhance value addition and subsequently hire milling services for rice processing. The rice is then packed into 1 kg and 2 kg bags for retail and 50 kg bags for wholesale; however, the quantity of processing rice accounts for a small part of the paddy at these cooperatives. Currently, agricultural cooperatives are considering investing in modern drying and milling machines to build their rice brands.

The investment level of paddy drying and milling facilities depends on each private household's market requirements, capital sources, and market experience.

The profit margin from drying and milling activities is quite low due to the high competition among rice drying and milling agents. The profitability of millers depends on the volume of massive paddy purchased and the ability to forecast the market.

Climate Change Risks in Rice Farming

In rice farming, climate risks are primarily associated with heavy rains that cause rice plants to fall, affecting the yield or the ability to harvest. Heavy rains occur during the autumn–winter cropping season from August to November. Continuous rains can persist for up to two weeks. During this period, rice plants bloom or those nearing harvest fall over, resulting in reduced grain quality and yield losses of up to 50%.

Group discussions with rice-growing households at the cooperative revealed that 70% of the surveyed households regularly encounter risks associated with heavy rains. Heavy rains are frequent, accompanied by storms, causing rice to fall almost yearly. In recent years, rice crops have faced significant risks due to extreme weather events, particularly in 2017, 2022, and 2023. Under normal conditions, water pumping systems can drain rainwater within 3 days; however, rainfall lasting longer than 3 days overwhelms the system, leading to flooding and damage to rice crops. The survey results of rice farming households reveal that the percentage of rice farming households facing the risk of heavy rain accounts for 58.9% of cooperatives.

Climate risks related to drought account for a low percentage and have little impact on rice productivity. Water sources for rice crops in the surveyed areas are relatively adequate. In years of severe drought, rice productivity can decrease by 10%–20%. Moreover, drought conditions accompanied by pest outbreaks can affect up to 50% of productivity. Other climate risks, such as storms and floods, have been assessed to have relatively low impacts in the past 10 years.

In addition to risks caused by natural disasters in rice cultivation, disease outbreaks are also considered a major threat by rice-growing households across the surveyed province. Risks caused by pests and diseases often occur in specific fields. During the 2023 cropping season, certain rice-growing households within the cooperative faced a high risk of onion mosquito infestation, which caused substantial damage to rice productivity.

Climate-related risks in particular, and agricultural production risks in general, occur frequently and have been increasing in severity. However, the level of risk varies depending on the crop season, time of year, and locality. To reduce the incidence of disease and promote more sustainable rice production, cooperative households are encouraged to shift from cultivating eight rice crops over three years to five crops over two years.

SWOT Analysis of Production and Business Activities of Agricultural Cooperatives

Survey results indicate that the resource capacity of agricultural cooperatives remains extremely limited. Only a few survey cooperatives have invested in warehouses, rice dryers, tractors, drones, and irrigation water supply services. Conversely, many others lack infrastructure such as warehouses, machinery and equipment, irrigation pumping stations, and rice processing and packaging capabilities.

Moreover, they exhibit limited management capacity and face a shortage of investment capital for production and business activities. Additionally, the surveyed agricultural cooperatives lack sufficient assets to qualify for loans from commercial banks.

Most agricultural cooperatives only supply certain collective services for farmer members (irrigation, provision of clean water, and a few fertilizer inputs). Based on the survey results of agricultural cooperatives, we analyze the SWOT of these cooperatives, as shown in Table 2.

TABLE 2

SWOT ANALYSIS OF AGRICULTURAL COOPERATIVES IN THE MEKONG RIVER DELTA

SWOT Analysis	Potential Strategies
Strengths:	
- The cooperative has been granted a sustainable certification for rice production. - Appropriate soil and soil conditions lead to high productivity. - The chairperson is reputable and experienced. - The cooperative has a strong connection with buyers and external stakeholders. - Members have faith in the cooperative.	- Promote certified rice production - Access to cooperative development support programs/policies
Weaknesses:	
- Owner equity is relatively subsidized, making access to bank financing difficult. - No marketing staff nor plan is available - The cultivated land area is too fragmented, complicating efforts for centralized cultivation. - Member commitment is primarily driven by price - Weak linkage with processing companies	- Improve member commitment - Appoint/recruit marketing staff - Improve financial reporting and analysis - Increase member loans or member capital contributions
Opportunities:	
- Support from government agencies, such as extension services, branding and promotion, and sustainable rice production, is available. - Growing market demand for certified rice driven by increased consumer health awareness. - Availability of diverse high-quality rice varieties - Opportunities exist to access new markets and establish linkages with companies for product sales.	- Ensure quality and certification of rice - Seek opportunities to expand the rice and paddy products market under sustainable certification standards - Develop low-carbon production areas
Threats:	
- Small-scale production and low earnings result in marginal rice income, discouraging farmers from making further investments. - Unpredictable climate patterns driven by climate change increase disease outbreaks, leading to greater pesticide use that negatively impacts the environment. - Input use strongly depends on climatic conditions (The climate in 2022 was unfavorable compared with the more favorable conditions observed in 2023). - The reliability and integrity of certified production monitoring remain questionable.	- Divide tasks for the management team

Assessment of Best Practices

The Phu Thanh Agricultural Cooperative in An Giang province and the Tai Phat Agricultural Cooperative in Tra Vinh province exhibit good production and business results in the Mekong River Delta. These agricultural cooperatives play a key role in supplying materials and purchasing products from farmers, maintaining strong linkage with entities such as the Loc Troi Group in An Giang province and other retailers of rice seeds in Tra Vinh province. Furthermore, these cooperatives provide other production and business activities such as water pumping and clean water services, supplying input materials, and purchasing output products. These cooperatives possess relatively substantial resources and enjoy a good reputation among local members.

Moreover, they establish production linkages and facilitate product consumption through partnerships with enterprises by linking production material areas.

The cooperatives' revenue fluctuates greatly depending on the field of operation (providing water services, clean water, and purchasing rice). In particular, the cooperatives' annual revenue averages VND5 billion to 10 billion annually.

Farmer households participating in the cooperative commit to producing rice in accordance with SRP standards and through programs linked with organizations and enterprises involved in the product consumption chain. These households practice sustainable rice cultivation, aimed at reducing greenhouse gas emissions.

The cooperative's profit is about USD24,000 per year, a significant improvement compared with its near-unprofitable operations prior to 2015. Farmer households applying SRP standards and linking production with the cooperative yield higher profits and rice prices of VND200 to 500 per kg at Phu Thach agricultural cooperative, depending on the specific certification standard and the enterprise involved in the consumption chain

Productivity of Rice Seed Farming at the Household Level

The One Million-Hectare Program for Low-Carbon Rice Emissions

The Prime Minister approved the *"Sustainable development of one million hectares of high-quality and low-carbon emission specialized rice linked to green growth in the Mekong River Delta by 2030"* under Decision No. 1490/QĐ-TTg dated 27 November 2023. Based on this decision, the Provincial People's Committees will develop pilot programs for each province. In Soc Trang, An Giang, and Tra Vinh, each province will select some agricultural cooperatives with an area of 100 ha/province to implement the pilot program.

Agricultural cooperatives are essential in organizing member households, ensuring that they apply trained production techniques and closely monitor implementation results at the field level.

Specialized agricultural agencies and scientific institutions apply technical methods to monitor and calculate emissions, comparing low-carbon rice production models with conventional rice farming practices.

The low-carbon rice farming program applies techniques to reduce input use and production costs. In particular, farmers are guided to reduce the quantity of rice seeds used for sowing, increase the use of organic fertilizers, reduce the application of chemical fertilizers and pesticides, and reduce water consumption in rice cultivation through the application of the alternate wetting and drying irrigation method. Table 3 presents a comparison of the practices applied in low-carbon and conventional rice farming models.

TABLE 3

COMPARISON OF THE LOW-CARBON AND CONVENTIONAL RICE FARMING MODELS

Techniques applied	Low-carbon rice farming	Conventional rice farming
Quantity of rice seeds used (kg/ha)	Row sowing or drone sowing techniques are used (80–130 kg/ha) to reduce seed quantity.	Manual broadcasting or drone sowing techniques are used (150–220 kg/ha).

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Techniques applied	Low-carbon rice farming	Conventional rice farming
Fertilizers	Organic fertilizers and bio-phosphate fertilizers are used (500 kg of bio-phosphate/ha). Single nitrogen, phosphorus, and potassium (NPK) fertilizers are used, with an average application of 390 kg/ha.	Organic fertilizers or bio-phosphate fertilizers are not used. Compound NPK fertilizers are used, with an average application of 519 kg/ha.
Pesticides	An average of 5.6 applications are used for weed control, apple snail control, and disease prevention, with an average cost of VND6,050,000 per ha per season.	An average of 5.6 applications are used for weed control, apple snail control, and disease prevention, costing VND6,850,000 per ha.
Irrigation techniques	Alternate wetting and drying irrigation to reduce fuel use and production costs	Continuous water retention in fields
Rice yield	6,682 kg/ha/season	5,824 kg/ha/season

Source: Survey results from cooperatives participating in the low-carbon rice farming program, surveyed in December 2024.

Survey results from farming households applying the low-carbon rice farming model and conventional rice farming indicate a significant reduction in seed quantity, chemical fertilizers, and fuel consumption in rice cultivation when adopting low-carbon techniques compared with conventional methods during the same period.

Additionally, rice cultivation using the alternate wetting and drying irrigation method resulted in healthier rice plants and higher yields compared with continuous flooding irrigation.

Economic Performance of Rice Seed Farming in Low-Carbon vs. Conventional Rice Farming

The analysis indicates that the low-carbon rice farming model reduces production costs and improves performance. Total production costs in low-carbon rice farming decreased by 16% compared with conventional rice farming. Economic performance analysis demonstrates that the low-carbon rice farming model outperforms usual rice farming in profitability.

Survey results show that households applying low-carbon rice farming techniques achieved 1.2 times higher production performance compared with conventional rice farming. Moreover, profitability in low-carbon rice farming increased by 1.5 times compared with conventional rice farming under the same conditions. The profit from low-carbon rice farming reached VND46,032,000 per household, equivalent to VND38,360,000 per ha or VND5,604,000 per ton of fresh paddy. In contrast, the profit from conventional rice farming averaged VND31,629,000 per household, equivalent to VND26,358,000 per ha or VND4,478,000 per ton of fresh paddy (Table 4).

TABLE 4

ECONOMIC PERFORMANCE OF THE RICE SEED SUPPLY CHAIN AT COOPERATIVES (VND1,000)

Cost items (1USD = VND25,300)	Farmers (n = 21)		Agricultural Cooperative (n = 10)	Retail agents (n = 3)	Total
	Low-carbon rice farming	Conventional rice farming			
Scale	1.2 ha/farm	1.2 ha/farm	94–300 farmer members	Retailers sell rice seeds in villages	With the rice supply chain of the low-carbon rice program
Rice seeds or fresh paddy	2,115	3,112	69,523	110,889	182,527
Sowing rice	600	600	0	0	600

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Cost items (1USD = VND25,300)	Farmers (n = 21)		Agricultural Cooperative (n = 10)	Retail agents (n = 3)	Total
	Low-carbon rice farming	Conventional rice farming			
Pest control	6,050	6,850	0	0	6,050
Fertilizer	10,106	12,323	0	0	10,106
Irrigation	1,200	1,800	0	0	1,200
Harvest	3,420	3,420	0	0	3,420
Management	0	0	410	0	410
Packaging	0	0	2,900	0	2,900
Storage	0	0	820	820	1,640
Transport	0	0	821	821	1,642
Dried costs	0	0	986	0	986
Admin costs	0	0	328	0	328
Other costs	0	0	1,520	1,000	2,520
Wages	0	0	15,000	5,000	15,000
Interest	0	0	6,000	0	6,000
Rents	0	0	4,928	0	4,928
Total costs	**23,491**	**28,105**	**103,236**	**118,530**	**245,257**
Gross value of total outputs	**69,523**	**59,734**	**110,889**	**125,674**	**306,086**
Value added	46,032	31,629	33,581	12,144	91,757
Profit/actor	46,032	31,629	7,653	7,144	60,829
Profit/ha	38,360	26,358	6,378	5,954	50,691
Profit/ton	5,604	4,478	932	870	7,406

Source: Survey results of actors in the rice seed supply chain in Tra Vinh, 12/2024.

Productivity of Rice Seed Farming in Cooperatives

Cooperatives provide key input services for rice production, such as irrigation services, pest and disease monitoring, and input supply, including rice seed, fertilizers, and sowing services. However, the operations of most cooperatives remain limited, with the majority only able to provide irrigation services and seasonal farming schedules. The supply of inputs such as rice seeds, fertilizers, and paddy procurement is only conducted by some cooperatives with effective production and business operations in each province.

This study selected five cooperatives in An Giang, Soc Trang, and Tra Vinh provinces to evaluate the capacity of cooperatives in the rice supply chain. Subsequently, we selected a typical cooperative, which was assessed as demonstrating good performance, to analyze the rice seed supply chain.

The case study of Phat Tai Agricultural Cooperative in Tra Vinh Province indicated that the cooperative signed rice seed production contracts with 150 member households, purchased fresh paddy from its member households, dried the paddy, packaged the rice, and sold rice seeds to other rice production areas in Tra Vinh and some neighboring provinces in the Mekong Delta.

Annually, the cooperative can supply 700 tons of rice seed to its affiliated members and other rice farming households in Tra Vinh and neighboring provinces. The cooperative's revenue reaches approximately VND10.5 billion, with a profit of VND652,400,000 per year.

The cooperative's primary costs related to rice seed production include the procurement of fresh paddy from member households. Moreover, it carries out paddy drying, bagging, storage, and transportation to retail distributors of fertilizers and rice seed within the province.

In this study, the cooperative requires an investment of VND103,236,000 per affiliated member household for rice seed procurement, drying, bagging, and distribution. The profit generated from the cooperative's rice seed business is VND7,653,000 per member household, equivalent to VND6,378,000 per ha of rice seed production or VND932,000 per ton of rice seed.

The cooperative's rice seed production and business activities have been assessed as highly effective compared with other production and business operations; however, it also faces many challenges related to market development. Costs related to rice seed licensing, packaging, and labeling tend to increase the cooperative's production costs, thereby reducing its competitiveness compared with other enterprises.

Productivity of Rice Seed Farming Among Fertilizer and Seed Input Distributors

Fertilizer and seed input distributors play an important role in supplying rice seeds to farming households. In this survey, we found that distributors often provide fertilizers and rice seeds to farming households on credit for one rice crop cycle, approximately four months. The interest rate applied ranges from 1.5% to 2.2% monthly for credit-based fertilizer and rice seed supply to farming households.

Distributors also play a role in providing drone-based rice-sowing services. In some cases, distributors act as brokers or traders, purchasing fresh paddy and transporting commercial fresh paddy to preprocessing facilities and rice milling plants.

Survey results from fertilizer and seed input distributors indicate that, on average, each distributor can supply between 1 and 3 tons of rice seed. Revenue from rice seed supply accounts for only a minimal portion of the distributors' total revenue from fertilizer and pesticide supply activities.

Economic performance analysis shows that profits from rice seed supply amount to VND7,144,000 per farm linked to rice seed production, VND5,954,000 per ha of rice seed linked with agricultural cooperatives, and VND 870,000 per ton of rice seed.

Economic Performance of the Rice Seed Supply Chain

The results presented in Table 4 show that the rice seed supply chain's economic performance under the low-carbon emission model is positive. The profit per cooperative member household reaches VND60,829,000, equivalent to VND50,691,000 per ha of linked rice farming or VND7,406,000 per ton of rice produced.

Regarding profit distribution per ton of rice seed, smallholder farmers linked with agricultural cooperatives account for 75.7% of the total profit in the supply chain. Agricultural cooperatives that provide services and trade rice seed account for 12.6%, while fertilizer and seed input distributors account for 11.7%.

The analysis of profit results shows that the production and supply linkages in the rice seed supply chain generate high economic performance for the participating actors.

Conclusions and Recommendations

This study demonstrated the positive outcomes of the low-carbon rice farming model in households linked with agricultural cooperatives compared with the conventional rice farming system. The low-carbon rice farming model creates more positive environmental impacts in agriculture by reducing

the use of seeds, chemical fertilizers, pesticides, and irrigation water through the alternate wetting and drying irrigation method, as well as lowering fuel consumption for water pumping. Furthermore, applying low-carbon rice farming methods helps protect rice-growing soil by increasing the use of organic and biofertilizers. Furthermore, low-carbon rice farming practices contribute to healthier rice plants, lower pest infestation, and higher rice yields.

The total production costs in low-carbon rice farming have been reduced by 16% compared with conventional rice farming techniques. Notably, seed investment costs decreased by 32%, fertilizer input costs by 18%, and pesticide costs by 12%.

The economic performance of the rice seed supply chain involving cooperative-linked farming households and distributors has also been highly effective. The total profit of the rice seed supply chain has reached VND7,406,000 per ton of rice seed produced. Regarding profit distribution per ton of rice seed, households linked with agricultural cooperatives account for 75.7% of the total profit, agricultural cooperatives account for 12.6%, and fertilizer and seed input dealers account for 11.7%.

Agricultural cooperatives require substantial capital for activities such as fresh paddy procurement, drying, warehouse construction, seed storage, and seed distribution logistics. The surveyed cooperatives indicated a need to access credit ranging from VND1 to 5 billion. Nevertheless, agricultural cooperatives' financial resources and collateral assets remain limited, making it difficult to access credit sources from financial institutions.

Some surveyed cooperatives partially self-financed investments related to warehouse construction, equipment purchases, and maintaining cooperative assets; however, domestic and international development programs and projects funded most of the valuable assets of cooperatives, such as warehouses, pumping stations, and irrigation systems.

In the current business environment, cooperatives face significant challenges related to limited capacity, financial resources, and intense market competition from private enterprises. As a result, fertilizer supply, fresh paddy procurement, and rice milling operations continue to account for an insignificant share of cooperative services.

In the case of the Phat Tai Agricultural Cooperative examined in this study, the cooperative faces difficulties in governance, improving packaging and labeling, and reducing production costs to increase economic performance in rice seed production and business operations.

Based on these analytical results, we recommend implementing programs and policies to expand the area under the low-carbon rice farming model in the Mekong Delta region.

Furthermore, training programs should be developed to enhance the capacity of farmers and agricultural cooperatives, enabling them to use seeds, fertilizers, pesticides, and irrigation water more efficiently compared with conventional rice farming methods.

Moreover, agricultural agencies should consider evaluating the level of carbon emission reduction achieved and establishing programs to link enterprises and markets to facilitate the consumption of certified low-carbon rice products.

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LIST OF ABBREVIATIONS

AEZs	Agroecological Zones
AKF	Aga Khan Foundation
AKRSP	Aga Khan Rural Support Program
ANR	Agriculture and Natural Resources
APO	Asian Productivity Organization
ASSR	Agriculture Statistics Survey Report
BAI	Bureau of Animal Industry,
BOD	Board of Directors
BOM	Board of Managers
BOS	Board of Supervisors
CBO	Community Based Organizations
CEA	Community Enterprise Approach
CLSU-SERDAC	Central Luzon State University Socioeconomic Research and Data Analytics Center
CoC	Chain of Custody
CPEC	China–Pakistan Economic Corridor
CPR	Common Pool Resources
CSA	Climate Smart Agriculture
DA PRDP	Department of Agriculture, Philippine Rural Development Project
DARD	Department of Agriculture and Rural Development
DoA	Department of Agriculture
DOCs	Day-old Chicks
DTI	Department of Trade and Industry
EEZ	Exclusive Economic Zone
ETI	Economic Transformation Initiative
EU	European Union
FCR	Feed Conversion Ratio
FKA	Fırat Development Agency
FPA	Floodplain Aquaculture
FY	Fiscal Year
GAP	Good Agricultural Practices
GB	Gilgit-Baltistan
GBRSP	Gilgit-Baltistan Rural Support program
GDP	Gross Domestic Products
GHG	Greenhouse Gas
GoP	Government of Pakistan
Govt	Government
GP	Grandparent Stock
GSO	General Statistics Office of Vietnam
HH	Household
IGP	Income Generating Project
ITA	Italian Aid Agency
IUCN	International for Conservation of Nature

LIST OF ABBREVIATIONS

JICA	Japan International Cooperation Agency
KGF	Krishi Gobeshona Foundation
KIU	Karakoram International University
KKH	Karakoram Highway
KP	Khyber Pakhtunkhwa (province)
KPI	Key Performance Indicators
LFS	Labour Force Survey
LGED	The Local Government Engineering Department
MAF	Ministry of Agriculture and Forestry
MARD	Ministry of Agriculture and Rural Development
MDM/MSC	Mechanically deboned meat/Mechanically Separated Chicken
MFC	Mountain Fruit Company
MKA	Mevlana Development Agency
MMT	Million Metric Tons
MNFS&R	Ministry of National Food Security & Research
MoI&C	Ministry of Industries & Commerce
MRD	Mekong River Delta
MT	Metric Tons
NEDA	National Economic and Development Authority
NGO	Nongovernment Organization
NMIS	National Meat Inspection Service
OCOP	One Commune One Product
OIE	Office of International des Epizooties/World Organization for Animal Health
PABI	Philippine Association of Broiler Practitioners
PCAARRD	Philippine Council for Agriculture, Aquatic, and Natural Resources Research and Development
PCPP	Philippine College of Poultry Practitioners,
PPP	Public–Private Partnership
PPPP	Public–Private Producer Partnership
PS	Parent Stock
QĐ-TTg	A common abbreviation in Vietnamese to indicate that a decision was approved by the Prime Minister
S&T	Science and Technology
SAARC	The South Asian Association for Regional Cooperation
SETUP	Small Enterprise Technology Upgrading Program
SHISUK	Shikkha Shastha Unnayan Karzakram
SME	Small- and Medium-sized Enterprises
SRI	System of Rice Intensification
SRP	Suggested Retail Price
SRP	The Sustainable Rice Platform
SVCA	Supply and Value Chain Analysis
TEPAV	The Economic Policy Research Foundation of Turkiye
TSKB	Industrial Development Bank of Turkiye
TUIK	Turkish Statistical Institute
UA&P	University of Asia and the Pacific
UBRA	United Broilers Raisers Association
USA	United State of America
USAID	United States Agency for International Development

USD	United States Dollar (USD1 is equivalent to VND25,300)
USD	US Dollars *conversions are based on the average exchange rate for 2019
USDA FAS	United States Department of Agriculture Foreign Agricultural Service
VACs	Village Agricultural Cooperatives
VietGAP	Vietnamese Good Agricultural Practices
VND	Vietnam Dong
WFC	Wells Fargo & Company
ZTBL	Zari Taraqiati Bank Limited

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