Research Article

Assessing The Impact of Contract Farming on Coconut Farming in North Sulawesi, Indonesia, Using Cost and Revenue Analysis

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Abstract | The research aims to analyze the economic impact of the contract farming partnership between coconut farmers and companies in North Sulawesi. This research evaluates the effects of contract farming on the costs and income of coconut farmers. A comparison of income between partnered and non-partnered farmers was performed to clarify this impact. The study was conducted in the South Minahasa and North Minahasa Regencies, which were chosen because they are the largest coconut-producing areas in North Sulawesi. The sample consisted of 120 coconut farmers, including both those partnered with coconut processing companies specifically coconut flour producers and those who were not. Data collection employed two sampling techniques: purposive sampling was used to select partnered farmers, while random sampling was applied to select non-partnered farmers. The result shows that contract farming farmers (partnered) take higher coconut prices than non-partnered farmers. Partnered farmers receive 2,750.00 IDR per coconut unit, whereas non-partnered receive only 2,100.00 IDR. Partnered farmers spend less cost than non-partnered farmers. Some cost items are taken by the partners (factories), such as transportation costs. At 0.05% confidence, the study finds that the difference in implicit costs is insignificant between partnered and non-partnered farmers, with a p-value of 0.08 and a t-table value more significant than the t-count. Partnered coconut farmers earned more than non-partnered farmers. The partnered farmers gain around 13-15 million IDR per year per hectare. Non-partnered farmers take around 7 million IDR per year per hectare. The *p-value* of the income per hectare is below 0.05. This result indicates a significant difference between partnered and non-partnered farmers' income per hectare per year. These results indicate how contract farming relationships benefit farmers. By examining a variety of metrics, including production costs, revenues, income stability, and profitability, this research will provide valuable insights into the effectiveness of contract farming in improving the sustainability and profitability of coconut farming in the region.

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Introduction

Indonesia is one of the world's largest producers of coconuts, with millions of smallholder farmers relying on the crop for their livelihoods. According to the Food and Agriculture Organization (FAO) of the United Nations in 2023, the world's leading coconut producers are Indonesia, the Philippines, India, and Sri Lanka. Indonesia is the top producer, harvesting 18 million tons of coconuts annually. The Philippines follows with 14.7 million tons per year, while India ranks third with 11 million tons. Sri Lanka produces 2.5 million tons of coconuts each year However, fluctuating prices, market uncertainties, and supply chain inefficiencies often hinder productivity and income stability. In recent years, contract farming has emerged as a potential solution, offering farmers guaranteed prices, technical support, and access to formal markets. However, does this agricultural model benefit Indonesia's coconut farmers or introduce new challenges?

Contract farming in Indonesia typically involves agreements between smallholder coconut farmers and agribusiness firms, exporters, or processing companies (White and Wijaya 2022; Gato *et al*., 2017). Contract farming is a system of agricultural production in which buyers and producers enter into agreements to supply agricultural products. These agreements outline the quantity, quality, variety, grade, type of packaging, and delivery timeline for the products (Nawi, 2010; Barret *et al*., 2012; Nino and Oya, 2021). Under these contracts, farmers commit to supplying a predetermined quantity and quality of coconuts or coconut-derived products (Johnson *et al*., 2024; Narmada *et al*., 2022; Honlah *et al*., 2024). In contrast, buyers provide inputs such as seedlings, fertilizers, and technical assistance, often at pre-agreed prices (Otsuka *et al*., 2016; Ruml and Qaim, 2020; Chen and Chen, 2021; Liang and Zhang, 2023). This model has gained traction in key coconut-producing regions like North Sulawesi, Riau, and East Java, where companies seek a stable supply of products like virgin coconut oil (VCO), coconut sugar, and desiccated coconut (Hermiza, 2019; Sondak *et al*., 2023; Dumais *et al*., 2021; Ekawati *et al*., 2022). Proponents argue that contract farming reduces market risks for farmers, improves yields through better practices, and integrates smallholders into global value chains (Martiniello *et al*., 2019; Swinnen and Kujipers, 2019; Ncube, 2020; Vicol *et al*., 2022; Barik *et al*., 2024). However, critics point to unequal bargaining power, stringent quality demands, and dependency on a single buyer, which may leave farmers vulnerable to exploitation. The effectiveness of contract farming in Indonesia's coconut industry thus remains a contested yet critical topic for policymakers and agricultural stakeholders (Valvinov *et al*., 2024; Otsuka *et al*., 2016).

Contract farming represents a critical industrial farming model in China, as it effectively minimizes transaction costs and mitigates market imperfections by connecting smallholder farmers to markets (Mishra and Dey, 2020). Min *et al*. (2021) argue that contract farming is an effective mechanism for improving the efficiency of rice production. Contract farming has significantly enhanced the technical efficiency of food production among farmers, lowered transaction costs, and mitigated production risks (Bellemare and Bloem, 2018; Mishra *et al*., 2019). Contract farming is one way for smallholder and family farms to get the production inputs, credit, technology, information, and market access, leading to higher income and productivity (Dong and Liang, 2023; Bakhri *et al*., 2024).

North Sulawesi is a region in Indonesia known as the Nyiur Melambai Region, encapsulates scenic coastal landscapes, a firm economic reliance on coconuts, and a rich cultural identity. The region also has significant agricultural potential, particularly in coconut production. Coconuts are cultivated in all regencies and cities in North Sulawesi, making it one of the major plantation crops in the region. Coconuts, consisting of around 266,968 hectares (BPS, 2024), are a significant commodity that enhances the local economy and provides various high-value derivative products for export. The most important coconut goods manufactured in North Sulawesi include coconut oil, coconut flour, and shell charcoal (Dumais *et al*., 2021; Waney *et al*., 2021). Coconut farming involves around 200,763 households, with smallholder farmers owning most of the land (96.96%). Coconut growing in North Sulawesi faces significant challenges that affect the sector's growth and productivity. According to survey and research by Hutapea *et al*. (2022); Kairupan *et al*. (2023), Sondak *et al*. (2023), the primary obstacles that smallholder farmers confront are: (1) Coconut cultivation has high production costs, including plant maintenance and processing. It reduces many farmers' ability to maintain profitability on their farms. (2)

Low coconut production: In North Sulawesi, the average coconut yield is about 1.1 tons per hectare for copra. It is much lower than the world average of 4.94 tons per hectare.

The challenges encompass outdated facilities, insufficient financial resources, and a deficiency in modern agricultural technology. (3) Many small farmers do not have direct access to larger markets. They typically rely on intermediaries, unconcerned about the quality of the things they sell, resulting in price decreases and fluctuations. (4) Strict quality criteria: Global retailers and markets frequently have stringent quality requirements that smallholder farmers cannot meet without central technical and financial assistance. For farmers to gain access to markets, they face an important challenge in the form of logistical obstacles: (5) insufficient infrastructure for transportation hurts the efficient distribution of coconut products, reducing their market competitiveness. (6) Restricted Access to Information and Networks: Farmers occasionally face challenges in identifying international consumers and acquiring knowledge regarding market opportunities, impeding their capacity to compete globally.

In North Sulawesi, contract farming significantly enhances coconut farmers' productivity and income; however, many farmers do not fully utilize the contract farming system. Although government officials and policymakers often promote contract farming to increase coconut productivity, many farmers lack an understanding of its benefits and procedures (Sondak *et al*., 2023; Chen and Chen, 2021). This lack of awareness limits their participation in a system that could increase their income (Liang *et al*., 2023; Pramana and Rondhi, 2020).

Therefore, it is important to understand the impact of contract farming on the income of coconut farmers in North Sulawesi. The research aims to analyze the economic impact of the contract farming partnership between coconut farmers and companies in North Sulawesi, Indonesia This research evaluates the effects of contract farming on the costs and income of coconut farmers. A comparison of income between partnered and non-partnered farmers was performed to clarify this impact. The results of this study will provide valuable policy recommendations aimed at promoting sustainable and profitable farming systems for coconut farmers. It will also help farmers understand how contract farming affects their income and production costs. By analyzing costs and income, farmers can determine whether contracts with agro-industry companies offer more stable economic benefits compared to traditional marketing systems, which often leave them vulnerable to price fluctuations and market risks. This study open opportunities the way for further research aimed at developing a fairer and more profitable contract farming model for coconut farmers. This can include the integration of modern agricultural technology to enhance productivity and cost efficiency. Additionally, the findings from this study can serve as a foundation for evaluating government policies and support programs that aim to strengthen the position of coconut farmers in the global market, particularly in facing of the challenges by international market dynamics.

Materials and Methods

Study area, sample, and data collection

This study was carried out in North Sulawesi, specifically in the South Minahasa and North Minahasa Regencies, which are recognized as centers for coconut plantations. Contract farming takes place between companies that process desiccated coconut and coconut farmers. The study focused on two primary samples: coconut farmers and desiccated coconut processing companies. Desiccated coconut processing companies turn coconuts into high-quality flour for domestic and international markets.The companies were selected because desiccated coconut processing is a significant industry in the research area. As a result, these businesses are the primary buyers of local farmers' coconuts. Furthermore, these businesses offer farmers opportunities to engage in mutually beneficial partnerships between coconut farmers and companies.

This research purposively sampled 120 farmers. Sixty partner farmers were selected using purposive sampling, while 60 non-partner farmers were chosen through random sampling. Purposive sampling is a technique where individuals are intentionally selected based on specific criteria relevant to the research objectives. The chosen sample possesses particular characteristics that align with these aims. This study included samples of non-contract farmers. Data from non-contract farmers was used to compare costs, income, and profits with those of contract farmers, thus demonstrating the impact of contract farming.

Purposive sampling was also applied to select the industrial sample to ensure the inclusion of relevant desiccated coconut companies. The partnership form is a contract farming between farmers and desiccated coconut companies. The coconut price, supply, and demand are guaranteed under the agreement. Beyond contract farming, non-partnered farmers sell their harvests straight to the market or through intermediaries without a corporate agreement. Data collection involved multiple methods Primary data were gathered through direct observation, allowing the researchers to examine phenomena related to the study in the field closely. Data collection in this study was conducted through interviews using a structured questionnaire. Additionally, structured interviews using questionnaires to collect specific information about the research objectives. These interviews followed an interview guide, and respondents' views and other relevant issues not listed in the questionnaire were recorded when possible. This comprehensive approach aimed to obtain accurate and relevant information regarding coconut farming and the partnership conditions between coconut farmers and desiccated coconut companies.

Data analysis

Descriptive statistics were used to analyse farmers' demographics to determine the demographic attributes of partnered and non-partnered farmers. The examined variables consist of (1) Age: Demographic distribution of farmers' ages; (2) Education: Degree in formal and informal education; (3) Farming Experience: Duration of expertise in coconut farming; and (4) Land Ownership Status: Indication of whether the land is owned or leased; (5) Production : Amount of harvest; (6) Farm area: Area of land owned by farmers . Furthermore, *the cost and revenue analysis* used cost and revenue analysis (CRA). It considers all costs experienced by farmers, both implicit and explicit (Hubbard *et al*., 2015). Implicit costs refer to opportunity costs that arise when a farm uses its internal resources without incurring cash expenses. Because these costs do not involve actual cash transactions, they are not reflected in financial statements. Instead, they represent the potential revenue lost by allocating these resources to specific activities.: rent land and labour cost in family ; Explicit cost are tangible expenses that are directly recorded in a farm's financial statements. These costs include direct cash payments for a variety of operational needs on the farm : tax, depreciation cost, land rent, fertilizer and pesticide cost, labour cost out of family and transportation. Both implicit and explicit costs are presented in Indonesian Rupiah (IDR). The currency code IDR represents the Indonesian Rupiah and is used to identify the Indonesian currency in global transactions and financial reports. It refers to earlier research that has demonstrated the value of cost analysis in assessing the revenue, income and profitability of farming operations (Hutapea *et al*., 2024; Saidah *et al*., 2019; Ciaian *et al*., 2013). To identify the impact, this study analyzes the independent samples t-test. An independent sample t-test study was undertaken to determine differences among explicit costs, implicit costs, income, and profits between partnered and non-partnered farmers. This test will determine whether they are significantly different or vice versa.

Results

Socio-demographic and farming characteristics

The demographic profile of partnered and non-partnered farmers shown in Table 1 reveals distinct characteristics across multiple variables. Among partnered farmers, 73.33% are male, whereas females constitute 26.67%. A similar pattern is observed among non-partnered farmers, where 81.67% are male, and 18.33% are female. It suggests a male-dominated engagement in coconut farming, particularly among non-partnered farmers. Most partnered farmers (51.67%) fall within the 51–66 age group, followed by 26.67% in the 35–50 years category and 21.67% in the 67–82 years range. Conversely, non-partnered farmers exhibit a slightly different age distribution, with 46.67% aged 51–66 years, 20.00% aged 35–50, and 33.33% aged 67–82. It indicates that non-partnered farmers tend to have an older age distribution than partnered farmers.

Regarding education, Table 1 describes that the partnered farmers primarily hold high school diplomas (53.33%) and bachelor's degrees (23.33%), with smaller proportions having completed junior high school (18.33%) and primary school (5.00%). On the other hand, non-partnered farmers have a relatively lower education level, with 40.00% completing high school, 23.33% obtaining a bachelor's degree, 20.00% finishing junior high school, and 16.67% having only primary school education. These findings suggest that partnered farmers tend to have a higher level of formal education than their non-partnered counterparts.

Among partnered farmers, 66.67% utilize 5–10 family members as labor, 25.00% engage 1–5 family members, and 8.33% employ more than ten. In contrast, most non-partnered farmers (83.33%) rely on 5–10 family members, while 16.67% utilize only 1–5 family members.

Table 1: *Demographic profile of coconut farmers.*

Characteristics	Partnered farmers		Non-partnered farmers	
	Fre-quency	Percent-age	Fre-quency	Percent-age
Gender				
Male	44	73.33%	49	81.67%
Female	16	26.67%	11	18.33%
Age (years)				
35-50	16	26.67%	12	20.00%
51-66	31	51.67%	34	56.67%
67-82	13	21.67%	14	23.3%
Education level				
Primary school	3	5.00%	10	16.67%
Junior high school	12	20.00%	10	16.67%
High school	31	51.67%	26	43.33%
Bachelor degree	14	23.33%	14	23.33%
Family labour (people)				
1-5	15	25.00%	10	16.67%
5-10	40	66.67%	50	83.33%
>10	5	8.33%	-	-
Experience in coconut farming (years)				
6-24	23	38.33%	34	56.6%
25-44	35	58.33%	20	23.33%
45-62	2	3.33%	6	10.0 %
Farm area (hectare)				
4-50	4	6.67%	60	100.00%
51- 100	54	90.00%	-	-
>100	2	3.33%	-	-
Production (unit)				
<34,000	-	-	56	93.33%
35,000-66,000	-	-	1	1.67%
67,000-87,000	-	-	3	5.00%
88,000-440,000	42	70.00%	-	-
450,000-810,000	6	26.67%	-	-
820,000-1,180,000	2	3.33%	-	-

Partnered farmers generally have extensive experience in coconut farming, with 58.33% having farmed for over 25 years, 38.33% farming for 6–24 years, and only 3.33% having 25–42 years of experience. Conversely, among non-partnered farmers, the majority (56.67%) have 6–24 years of experience, 23.33% have more than 25 years, and 20.00% have 25–42 years of experience. It suggests that partnered farmers are more likely to have longer farming experience than non-partnered farmers. Most partner farmers have relatively large farm area, ranging from 10–150 ha. Specifically, 6.67% of partnered farmers own between 4-50 ha, 90.00% have 51–100 ha, and only 3.33% own more than 100 hectares. In contrast, all non-partner farmers in the data set own land within ranging 10–50 ha, which indicates that partner farmers tend to have larger average farm area than non-partnered farmers.

Production data show a significant difference between partnered and non-partnered farmers. Among partnered farmers, 70% produce between 880,000 and 440,000 units, 26.67% yield between 87,000 and 450,000 units, and 3.33% achieve production levels between 320,000 and 1,180,000 units. In contrast, 93.33% of non-partnered farmers produce less than 34,000 units, only 5.00% achieve 67,000–87,000 units, and 1.67% produce 35,000–66,000 units. These findings suggest partnered farmers exhibit significantly higher production levels than non-partnered farmers.

Explicit and implicit costs: The cost structure of coconut farming varies significantly between partnered and non-partnered farmers and between cultivator farmers and sharecroppers. The analysis is categorized into explicit and implicit costs, which provide insights into the financial burden and economic efficiency of different farming arrangements. Explicit costs represent the direct monetary expenditures incurred by farmers. These include taxes, depreciation, rent, fertilizer, pesticide, labor, and transportation costs.

Table 2 illustrates that partnered cultivator farmers incur a tax cost of 4,645,000 IDR, whereas partnered sharecroppers pay 1,500,000 IDR. Non-partnered cultivator farmers, however, bear a significantly higher tax burden at 129,333,33 IDR, while non-partnered sharecroppers pay only 110,000 IDR. The stark difference in tax costs suggests that partnered farmers may benefit from specific tax incentives or subsidies. In contrast, non-partnered farmers face higher tax obligations, possibly due to independent land ownership.

The depreciation cost for partnered cultivator farmers is 1,572,583.33 IDR, while partnered sharecroppers

Table 2: *Explicit and implicit costs.*

Cost items	Partnered		Non-partnered	
	Cultivator farmers	Sharecroppers	Cultivator farmers	Sharecroppers
Explicit cost				
Tax	4,645,000.00	1,500,000.00	129,333.33	110,000.00
Depreciation	1,572,583.33	1,080,000.00	36,305,000.00	1,560,000.00
Land Rent	-	18,750,000.00	-	2,750,000.00
Fertilizer cost	2,100,000.00	-	126,666.70	200,000.00
Pesticide cost	1,250,000.00	-	53,500.00	-
Labor costs are out of the family	151,938,983.05	54,300,000.00	8,006,545.50	6,904,000.00
Transportation cost	426,101.69	200,000.00	547,200.00	332,000.00
Total explicit cost				
IDR/years	158,757,881.36	9,368,472.73	9,368,472.73	3,560,263.32
IDR/years/ha	354,162.70	10,298,000.00	10,298,000.00	4,712,000.00
Implicit cost				
Rent land	58,728,813.60	18,750,000.00	3,055,084.71	2,750,000.00
Labor cost in the family	14,561,440.70	3,000,000.00	947,836.36	462,000.00
Total implicit cost				
IDR/years	73,290,254.24	3,000,000.00	76,932,870.37	1,564,857.00
IDR/years/ha	1,528,961.10	200,000.00	1,531,599.83	4,500,000.00

incur 1,080,000 IDR. In contrast, non-partnered cultivator farmers experience a significantly higher depreciation cost of 36,305,000.00 IDR much larger than the 1,560,000 IDR incurred by non-partnered sharecroppers. The high depreciation cost for non-partnered cultivators indicates greater investment in fixed assets such as machinery and infrastructure, while partnered farmers likely receive external assistance, reducing their capital burden. Partnered cultivator farmers do not report land rent costs, likely due to ownership or subsidized leasing through partnerships. However, partnered sharecroppers incur a land rent expense of 3,000,000 IDR. In contrast, non-partnered cultivators bear a significantly higher land rent cost of 126,666.70 IDR, while non-partnered sharecroppers pay 2,750,000 IDR. The relatively lower rent costs for partnered farmers suggest that partnership agreements include land-use benefits that reduce financial burdens.

Partnered cultivator farmers spend 2,100,000 IDR on fertilizers and 1,250,000 IDR on pesticides. In contrast, non-partnered cultivator farmers spend 126,666.70 IDR on fertilizers and 53,500 IDR on pesticides. Sharecroppers in both categories do not report explicit fertilizer costs, which suggests that either the landowners or external sources provide fertilizers to them. The lower costs for non-partnered farmers indicate limited fertilizer and pesticide usage, potentially affecting productivity. Labor costs are significant, particularly for partnered cultivator farmers who pay 151,938,983.05 IDR. Partnered sharecroppers pay 54,300,000 IDR, while non-partnered cultivators spend 8,006,545.50 IDR, and non-partnered sharecroppers 6,904,000 IDR. The significantly higher labor cost among partnered cultivators indicates that they employ more hired labor, which could reflect larger farm sizes and greater production intensity.

Partnered cultivator farmers spend 426,101.69 IDR on transportation, compared to 200,000 IDR for partnered sharecroppers. Non-partnered cultivators incur 547,200 IDR in transportation costs, whereas non-partnered sharecroppers spend 332,000 IDR. The variation in transportation costs may reflect differences in market access, with non-partnered cultivators potentially facing higher logistical expenses due to the absence of collective distribution channels in partnerships.

Partnered cultivator farmers incur a total explicit cost of 158,757,831.36 IDR per year, whereas partnered sharecroppers have a significantly lower explicit cost of 9,368,472.73 IDR. Non-partnered cultivator farmers also report 9,368,472.73IDR, while non-partnered sharecroppers incur only 3,560,263.32 IDR. On a per-hectare basis, partnered cultivator farmers incur the highest explicit cost (354,162.70 IDR/ha), whereas non-partnered sharecroppers have the lowest explicit cost (4,712,000 IDR/ha).

Implicit costs reflect opportunity costs such as the rent value for owned land and labor contributed by family members. Partnered cultivator farmers have an implicit land rent cost of 58,728,813.60 IDR, whereas partnered sharecroppers account for 18,750,000 IDR. Non-partnered cultivator farmers report 3,055,084.71 IDR, while non-partnered sharecroppers incur 2,750,000 IDR. The significantly higher implicit land rent for partnered cultivators suggests they manage larger land areas, reinforcing the earlier observation that partnerships provide access to more extensive agricultural land. The opportunity cost of family labor is also substantial, with partnered cultivator farmers attributing 14,561,440.70 IDR to family labor contributions. Partnered sharecroppers account for 3,000,000 IDR, while non-partnered cultivators report 947,836.36 IDR and non-partnered share croppers 462,000 IDR.

Partnered cultivator farmers incur the highest total implicit cost (73,290,254.24 IDR), while partnered sharecroppers have 3,000,000 IDR. Non-partnered cultivators report 76,932,870.37 IDR, and non-partnered sharecroppers have the lowest implicit cost at 1,564,857.00 IDR. Per hectare, non-partnered sharecroppers exhibit the highest implicit cost at 4,500,000 IDR/ha, while partnered sharecroppers have the lowest at 200,000 IDR/ha.

Price, revenue, income, and profit of coconut farmers

The financial performance of coconut farming varies significantly between partnered and non-partnered farmers and between cultivator farmers and sharecroppers. This analysis examines these farming groups' price, revenue, income, and profit, highlighting key differences in economic efficiency and financial outcomes. The price per unit of coconut product differs across farming categories. Partnered cultivator farmers receive the highest price at 2,750.00 IDR per unit, followed by partnered sharecroppers at 2,412.04 IDR. In contrast, non-partnered farmers receive significantly lower prices, with cultivators earning 2,173.64 IDR and sharecroppers earning the lowest at 2,150.00 IDR (Table 3).

Table 3 shows that revenue per year per hectare also varies significantly across groups. Partnered sharecroppers generate the highest revenue, reaching 20,533,333.33 IDR per hectare, followed by partnered cultivator farmers at 18,119,094.26 IDR per hectare. Non-partnered farmers report lower revenues, with cultivators earning 12,661,098.58 IDR per hectare and sharecroppers earning 11,861,111.11 IDR per hectare.

Income, defined as revenue minus total costs, follows a similar trend. Partnered sharecroppers again report the highest income at 15,578,000.00 IDR per hectare, followed by partnered cultivators at 14,729,394.53 IDR per hectare. In contrast, non-partnered farmers have significantly lower income levels, with cultivators earning 9,034,904.46 IDR per hectare and sharecroppers earning 7,934,444.44 IDR per hectare.

Profit, representing net earnings after accounting for all explicit and implicit costs, provides insight into the overall financial sustainability of coconut farming across different groups. Partnered sharecroppers achieve the highest profit at 15,278,000.00 IDR per hectare, followed by partnered cultivators at 13,164,537.53 IDR per hectare. Non-partnered cultivators earn significantly lower profits at 7,503,304.63 IDR per hectare, while non-partnered sharecroppers report the lowest profit at 7,717,361.11 IDR per hectare.

Table 3: *Price, revenue, income, and profit of coconut farmers.*

Price/revenue/ income/ profit	Partnered		Non-partnered	
	Cultivator farmers	**Sharecroppers**	**Cultivator farmers**	**Sharecroppers**
Price	2,750.00	2,412.04	2,173.64	2,150.00
Revenue				
IDR/years/ha	18,119,094.26	20,533,333.33	12,661,098.58	11,861,111.11
Income				
IDR/years/ha	14,729,394.53	15,578,000.00	9,034,904.46	7,934,444.44
Profit				
IDR/year/ha	13,164,537.53	15,278,000.00	7,503,304.63	7,717,361.11

The t-test results presented in the table provide statistical insights into the differences between partnered and non-partnered farmers in terms of explicit costs, implicit costs, income, and profit. The significance of these differences is determined by comparing the t-test values with the critical t-table values, along with their corresponding p-values (Table 4).

The t-test value for the explicit cost is 2.2500, which exceeds the t-table value of 1.980, with a p-value of 0.026. Since the p-value is less than the commonly used significance level of 0.05, this indicates a statistically significant difference in explicit costs between the two groups. It suggests that partnered and non-partnered farmers incur different explicit costs, likely due to variations in input usage, hired labor, and production expenses. For implicit costs, the t-test value is 1.770, which is lower than the t-table value of 1.980, with a p-value of 0.08. Since the p-value exceeds 0.05, the difference in implicit costs is not statistically significant.

Table 4: *Independent sample test of explicit cost, implicit cost, income, and profit.*

Variables	t-table	t-test
Explicit cost	1.980	2.2500
p-value	0.026	
Implicit cost	1.980	1.770
p-value	0.08	
Income	1.9803	10.065
p-value	1.40206E-17	
Profit	1.9802	9.737
p-value	8.42737E-17	

Table 4 shows that the t-test result for income is 10.065, far greater than the critical t-table value of 1.9803, with an extremely low p-value of 1.40206E-17 (essentially 0). This strong statistical significance confirms a highly significant difference in income levels between partnered and non-partnered farmers. The large t-value suggests that partnered farmers generate substantially higher income, likely due to better market access, higher productivity, and improved efficiency in cost management. Similarly, the t-test value for profit is 9.737, well above the t-table value of 1.9802, with an almost negligible p-value of 8.4273E-17.

Discussion

The findings of this study highlight several key differences between partnered and non-partnered farmers in terms of demographics, education, experience, land cultivation, and production output. These differences provide insights into the potential benefits of partnerships in the agricultural sector, particularly coconut farming. Research findings indicate several reasons why farmers who do not have contracts choose not to enter contract farming. One reason is that these farmers often do not meet the criteria set for partner farmers, which may include factors such as having smaller land areas, limited labor, or insufficient resources. Additionally, some farmers are hesitant to sell their crops exclusively to one company. They also perceive that contract farming does not provide higher profits compared to other marketing systems.

The dominance of male farmers in both groups suggests that coconut farming remains a male-driven occupation. Male workers are more prevalent in this coconut-growing profession since it requires more physical power. These findings correlate with Khairizal *et al.* (2019); Pramana *et al.* (2020); Johnson *et al.* (2024) who studied deep coconut farming in the Riau peatlands. Coconut farming involves complex tasks like trimming, harvesting, and transporting coconuts. The research focused on deep coconut cultivation. Men are more likely to work in this job due to its physical demands. However, the lower percentage of female farmers in the non-partnered group may indicate that women have fewer opportunities or resources when not engaged in partnerships.

Regarding age, the fact that a higher proportion of non-partnered farmers belong to the older age group (67–82 years) suggests that most coconut farmers are no longer productive. This group includes farmers who work on their farms because they have fewer generations. Coconut farmers' children are increasingly choosing office work over agriculture. This result is in line with research from Bentayao *et al.* (2025) where in the Philippines, the average age of coconut farmers is 55 years, which causes a laborshortage in agricultural communities due to the lack of the next generation where children of farmers prefer jobs outside the agricultural sector. Similarly, in Kerala, India, the coconut farming sector is characterized by an aging farmer population (Thamban *et al.*, 2019).

Links Researchers

Education plays a crucial role in agricultural productivity, as farmers with higher education levels are more likely to adopt modern techniques, implement better farm management strategies, and access financial support. The results show that partnered farmers have a higher proportion of individuals with high school and bachelor's degrees than non-partnered farmers. Those with better education may be more likely to engage in partnerships, which could provide training opportunities, financial incentives, and access to technology that contribute to higher productivity. The study found that more educated farmers earn more because they can better manage their farms. Low education correlates with low agricultural productivity. Studies by Luh (2017); Causey and Nink (2019); Kabiru and Arshad (2019); Kabiru (2024), show that education has a positive effect on farming.

Both groups reliance on family labor indicates the continued importance of family-based agricultural work. However, non-partnered farmers show a higher dependence on mid-sized family labor (5–10 members), which may suggest that they have limited access to hired labor or mechanization. Partnered farmers, on the other hand, show slightly more variation in labor distribution, which could indicate better access to external labor sources and mechanized farming techniques through their partnerships. Partnered farms, particularly those involved in machinery-sharing arrangements, tend to exhibit higher efficiency compared to non-partnered farms (Papp *et al*., 2019; Yagi and Hayashi, 2021).

Farmers with more experience generally have better knowledge of soil conditions, pest control, and crop management techniques techniques (Tesfahunegn *et al*., 2016; Tafesse *et al*., 2020; Yo and Luo, 2022). The fact that most partnered farmers have over 25 years of experience suggests they have accumulated significant expertise, allowing them to make informed decisions about farm expansion and resource allocation. The data also reveal that partnered farmers tend to cultivate larger land areas than non-partnered farmers. The partnered farmers in this study were mostly landowners in their areas and large coconut farmers in North Sulawesi with their own land ownership status. They inherited agricultural land from generation to generation (Hutapea *et al*., 2022; Lolowang and Rawung, 2021; Kairupan *et al*., 2023). Their land is spread not only in one place but also in the surrounding areas. Because they have the availability of capital to buy land, it makes it easier for them to expand their land. Beside that, it could be due to partnerships financial and logistical support, enabling them to expand their farms and increase production capacity Meanwhile, non-partner farmers have limited land because of their ownership status: self-owned and rented. In addition, they cultivate coconut plants and other commodities, so the land used for coconut plants is limited (Sondak *et al*., 2023).

It could be due to partnerships financial and logistical support, enabling them to expand their farms and increase production capacity.

The most striking difference between the two groups lies in their production levels. Partnered farmers exhibit significantly higher yields, with the majority producing between 440,000 kg/year and 880,000 kg/year , while non-partnered farmers primarily produce less than 34,000 kg/year. This stark contrast suggests that partnerships provide essential advantages, such as better access to quality seeds, fertilizers, advanced farming techniques, and market linkages. Furthermore, the variation in production levels among partnered farmers implies that some farmers may be utilizing these resources more effectively than others, indicating the need for targeted support programs to enhance productivity across all partnered members.

The substantial differences in land use and production output between the two groups underscore the effectiveness of partnerships in improving agricultural performance. Partnerships likely provide better access to financial resources, technical assistance, and structured market opportunities, all of which contribute to higher productivity and economic stability. Moreover, partnered farmers may benefit from collective bargaining power, which allows them to negotiate better prices for their produce and reduce costs through shared resources. The yield and profitability of coconut farmers depend on the extent of their property. Research by Thomas *et al*. (2018), Khaswarina *et al*. (2024), and Mawari *et al*. (2023) demonstrates that larger land areas correlate with increased productivity and profitability for coconut production.

Explicit costs represent direct expenditures that influence the financial sustainability of farming operations. Partnered cultivator farmers exhibit the highest explicit costs, particularly in labor wages, fertilizers, and pesticides. These higher costs likely reflect greater investments in agricultural inputs, which can contribute to improved productivity and efficiency (Narmadha *et al*., 2022; Ekawati *et al*., 2022; Liang and Zhang, 2023). In contrast, non-partnered cultivator farmers report significantly lower expenses, suggesting lower input usage or financial constraints limiting their ability to invest in farm improvements.

The cost of hired labor is another critical factor. Partnered cultivator farmers allocate a substantial portion of their explicit costs to hired labor, reflecting the potential for larger-scale operations and greater labor demand. Non-partnered farmers, in contrast, exhibit lower hired labor costs, which could indicate a higher reliance on family labor or limited financial resources to employ external workers. Sharecroppers in both partnered and non-partnered groups incur significantly lower labor costs, suggesting a lower degree of mechanization and labor intensity, which may affect productivity. Farmers spend the most on non-family labor because they hire non-family workers to operate their farms. Tree climbing and fruit plucking are essential to coconut cultivation. Skilled labor enhances both yield efficiency and quality. Coconut farming requires expert climbing and scraping labor during harvest, increasing labor expenses. Scrapping labor refers to the work of scraping or peeling coconut flesh from the shell after the fruit has been opened or split. The harvesting of coconuts is a specialized task typically executed by expert climbers (Pandiselvam *et al*., 2024; Manikantan *et al*., 2018).

Most fertilization is biannual. Most coconut growers fertilized once, but not at the Plantation Service's recommended rate. Farmers believed their fertilizing methods were transmitted and passed down; thus, they were more knowledgeable, and farmers believed their soil was fertile enough without fertilizer. It is the same as the research results on coconut cultivation in Central Sulawesi, where coconut farmers frequently neglect proper agricultural practices, making coconut farming inefficient (Rauf *et al*., 2024).

In North Sulawesi, rhinoceros beetles, pests, and illnesses can destroy coconuts prematurely. Partnered and non-partnered farmers use synthetic and natural pesticides and insecticides to address this issue. Thus, many farms are using natural insecticides. Coconut farmers in North Sulawesi use Ginger plants under coconut plants to help farmers control pests naturally. Ginger smells destructive to coconut pests, so it can repel them. Therefore, fresh ginger extracts and their residues could be harnessed in pre- and postharvest pest control options (Amuji *et al*., 2012). They say natural insecticides are cheaper than synthetic pesticides and help maintain ecosystem balance and decrease environmental damage. These results align with research by Sajangati *et al*. (2025) and Atapattu *et al*. (2024) regarding coconuts, which found that farmers switched to natural pesticides because they were considered cheaper and helped maintain the ecosystem balance and reduce environmental damage. In Pekanbaru, farmers use wood vinegar from coconut shells as an environmentally friendly pesticide against armyworms (Purnama *et al*., 2024). Besides that, natural predators like the cocopet *Chelisoches morio* and weaver ants also help control coconut pests.

Coconut harvest transport prices depend on harvest volume and customer distance. Partnered farmers usually use personal transportation or work with a firm to avoid direct transportation expenditures. When harvests are large, the business collects directly from farmers. Non-partner farmers usually deliver their harvests directly to companies or collectors. As a result, their transportation costs are higher since they often rely on private vehicles or rent transportation. Typically, farmers rent vehicles twice a week and those who own their own transportation commonly use pick-up trucks, which have a carrying less capacity .

Four partnered farmers have 10-50 hectares, 54 farmers have 51-100 ha, and two farmer has 101–150 ha. Given that family labor costs are the same as external labor, coconut farming's implicit costs include family labor (TKDK). TKDK in farming stands for Family Labor. It refers to the work done by members of the farmer's own family who help with various agricultural activities. This family labor represents their contribution to overall agricultural production and is typically not accounted for in direct monetary terms, meaning no cash wages are paid for this work. In coconut farming, TKDK cleans, fertilizes, and sprays. Partnered and non-partnered farmers spend the most on cleaning. This study shows that farmers and workers negotiate cleaning costs without a pricing baseline. Farmers usually pay a lump price for land clearance, regardless of the number of workers. The agreed-upon work is paid

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for, not individual salaries or daily rates. Partnered farmers fertilize and spray annually, with two farms participating. Seven non-partnered farmers fertilize, and two spray. Farmers spend less on external labor when more family members work. Saving money in coconut farming is a priority due to several challenges, including *economic vulnerabilities*: Coconut farmers face significant economic risks from volatile market prices, leading to unpredictable incomes. Saving money is essential to buffer against periods of low prices (Sairam and Jayasekhar, 2019; Jayasekhar and Thomas, 2024; Veerakhumar, 2019). Additionally, coconut cultivation requires substantial investment in inputs such as fertilizers, fungicides, and pest control. Efficient resource use and cost-saving strategies are critical to maintaining profitability (Omar and Fatah, 2021; Thomas *et al*., 2019); pest and disease threats: Coconut trees are vulnerable to pests and diseases like the Rhinoceros beetle and red palm weevil, which can cause significant yield losses (Vasumathy *et al*., 2024; Bhat *et al*., 2024); climate change impacts: Climate change threatens coconut farming through increased temperatures, altered rainfall patterns, and extreme weather events, all of which reduce productivity. Farmers must invest in adaptive measures such as irrigation systems and resilient crop varieties. Maintaining soil fertility and health is also vital for sustainable production (Bentayao *et al*., 2025; Hebbar *et al*., 2022; Thomas *et al*., 2019; Subramanian *et al*., 2024); technological and management improvements: adopting modern technologies like drone imagery for crop monitoring and machine learning for disease diagnosis can boost efficiency and productivity. However, these innovations require initial investment (Thomas *et al*., 2019); market and policy challenges: global market liberalization has intensified competition, making cost optimization crucial for farmers to remain competitive (Vasumathy *et al*., 2025; Thomas *et al*., 2019). While government support and subsidies can alleviate some financial pressures, farmers must manage resources efficiently to fully benefit from these programs (Jayasekhar *et al*., 2019; Vijaykumar, 2020).

A key observation is the stark difference in depreciation costs. Non-partnered cultivators report disproportionately high depreciation expenses compared to partnered farmers. It suggests that non-partnered farmers must invest more in equipment and infrastructure, likely due to insufficient financial or technical support from agricultural partnerships. The reduced depreciation costs among partnered farmers imply that partnerships may facilitate shared resources, equipment leasing, or subsidized farm infrastructure, reducing the financial burden on individual farmers.

Implicit costs, including the opportunity cost of land and family labor, are essential in understanding the full economic impact of different farming models. Partnered cultivators report the highest implicit costs, particularly regarding land rent, suggesting they manage larger agricultural areas. Implicit costs, including land rent, significantly influence agricultural decisions and productivity (Zhang *et al*., 2022). It reinforces the notion that partnerships facilitate access to larger plots of land, either through land consolidation or leasing arrangements. In contrast, non-partnered farmers report lower implicit land rent, likely due to land fragmentation or limited expansion opportunities.

Family labor contributions also vary significantly across groups. Partnered cultivators report the highest opportunity costs for family labor, indicating that family members remain actively involved in farming activities even with increased hired labor. It suggests that partnerships encourage a balance between mechanization and traditional labor inputs, optimizing labor efficiency. Conversely, non-partnered farmers allocate fewer implicit costs to family labor, which may reflect a lower availability of household labor or a more substantial reliance on external employment for income diversification.

These price variations suggest that partnered farmers benefit from better market access, premium pricing opportunities, or collective bargaining advantages that allow them to secure higher prices for their produce. Conversely, non-partnered farmers may face weaker negotiation power, higher market competition, or reliance on intermediaries, lowering selling prices. Similar findings were reported by Kumar *et al.* (2025), indicating that contract farmers in India who produced onions, okra, and pomegranates achieved higher returns, better prices, and improved access to premium markets. Similarly, contract farmers growing cucumbers in Vietnam received higher prices and net returns compared to non-contract farmers (Au and Culas, 2021). Contract farming offers stable market access and reduces marketing risks, which is particularly beneficial for smallholder farmers who are vulnerable to price fluctuations. For example, in

Rwanda, contract farming in maize seed production helped lower transaction costs and marketing risks, thereby supporting a sustainable supply chain (Nduwimana, 2022).

The higher revenue among partnered farmers, particularly sharecroppers, suggests that partnerships provide advantages such as increased productivity, better access to high-yield inputs, or superior postharvest management strategies that enhance revenue generation. Non-partnered farmers lower revenue figures indicate possible limitations in farm management, market access, or yield performance, restricting their income potential. Li and Wang (2024) explained that contract farming increase efficiency. It means that contract farmers will earn more profit than non-partnered farmers.

The substantial income gap between partnered and non-partnered farmers highlights the financial benefits of agricultural partnerships. These partnerships may reduce production costs through input subsidies, technical assistance, or improved market linkages, leading to higher net earnings for partnered farmers. Non-partnered farmers, especially sharecroppers, face lower income levels, which may result from higher cost burdens and lower market prices, affecting their overall profitability.

The profit disparity reinforces the economic advantages of agricultural partnerships. Partnered farmers, particularly sharecroppers, generate higher revenue and income and achieve superior profitability, indicating more efficient cost management and market access. Despite maintaining operational independence, non-partnered farmers struggle with lower profit margins, which may hinder their long-term financial viability.

Conclusion

The study's findings indicate that contract farming has a beneficial economic influence on the return of coconut farmers. It demonstrates that coconut farmers who have a partnership agreement with the corporation earn more than non-partnered. This research also demonstrates the significance of pricing as an indicator and consideration in the profitability of both farming systems. To further enhance the benefits of such partnerships, policymakers and agricultural organizations should consider implementing the following measures: (1) Encouraging Young Farmers to Join Partnerships Given that non-partnered farmers tend to be older, initiatives should be developed to attract younger farmers into partnerships by providing financial incentives, training, and mentorship programs; (2) Improving Educational Access Since partnered farmers have higher education levels, efforts should be made to provide educational resources and training programs for non-partnered farmers to enhance their knowledge and skills; (3) Enhancing Market Linkages Partnerships should focus on strengthening supply chain networks and market access to ensure that farmers receive fair prices and stable demand for their produce; (4) Providing Financial and Technical Support Governments and agricultural agencies should facilitate access to credit, modern farming equipment, and quality inputs to help non-partnered farmers increase their productivity; and (5) Promoting gender inclusion with female participation lower in both groups, targeted programs should be designed to encourage women's involvement in coconut farming by addressing barriers such as land ownership, training opportunities, and financial support. By implementing these recommendations, agricultural partnerships can maximize their impact, ensuring that partnered and non-partnered farmers achieve sustainable growth and improved livelihoods.

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Novelty Statement

This study is the first study to discuss the impact of contract farming between coconut farmers and desiccated coconut companies in North Sulawesi, Indonesia

Author's Contribution

Lorraine Sondak: Conceptualized the research work, conducted data, analysis data, prepared the initial draft of the paper
Dwidjono Hadi Darwanto and Lestari Rahayu Waluyati: Conceptualized the research work , reviewed analysis data, reviewed and edited the final draft

Generative AI and AI-assisted technology statement

The authors declare that no Genrative AI was used in the creation of this manuscript.

Conflict of interest

The authors have declared no conflict of interest.

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