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Innovation and Quality Improvement in The Palm Oil Industry to Maintain Indonesia's Export Competitiveness

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Abstract

The palm oil industry is one of Indonesia's most strategic export sectors, yet its competitiveness in the global market is increasingly challenged by rising quality standards, sustainability requirements, and international competition. This study aims to analyze the effect of innovation and quality improvement on maintaining Indonesia's palm oil export competitiveness. A quantitative research approach was applied using primary data collected from 85 palm oil farmers through a structured questionnaire measured on a Likert scale. The data were analyzed using SPSS version 25, employing descriptive statistics, validity and reliability tests, and multiple linear regression analysis. The results indicate that innovation has a positive and significant effect on export competitiveness, while quality improvement shows a stronger positive and significant influence. These findings suggest that farmers who adopt new technologies, improve cultivation practices, and maintain consistent product quality are more capable of meeting global market demands. Simultaneously, innovation and quality improvement significantly explain variations in export competitiveness, with the model accounting for 50.8 percent of the variance. This study highlights the importance of strengthening innovation capacity and implementing continuous quality enhancement at the farmer level to sustain Indonesia's competitive position in the global palm oil market. The findings provide practical implications for policymakers and industry stakeholders in designing programs that support technological adoption and quality-based development strategies.

Keywords: Innovation; Quality Improvement; Export Competitiveness

1. Introduction

The palm oil industry is one of Indonesia's most important strategic sectors, contributing significantly to national income, employment creation, and foreign exchange earnings. As the world's largest producer and exporter of crude palm oil (CPO), Indonesia plays a central role in supplying global demand for vegetable oils used in food, cosmetics, bioenergy, and industrial products [1], [2]. Despite this strong position, Indonesia's palm oil export competitiveness faces increasing pressure from international market dynamics, including stricter quality standards, sustainability requirements, price volatility, and competition from other producing countries [3], [4]. These challenges require continuous improvements in production systems, product quality, and innovation across the palm oil value chain, particularly at the farmer level.

In addition to external market pressures, internal structural challenges also influence the long-term competitiveness of Indonesia's palm oil industry. Many smallholder farmers still rely on traditional cultivation practices, limited access to modern technology, and inconsistent quality control systems, which can reduce productivity and hinder compliance with international standards. Strengthening institutional support, improving farmer training programs, and encouraging collaboration between government agencies, industry actors, and research institutions are therefore essential to accelerate innovation adoption and enhance overall product quality. By addressing both internal capacity gaps and external market demands, Indonesia can reinforce its strategic position and ensure the sustainability of its palm oil export performance in an increasingly competitive global environment.

In recent years, global palm oil markets have undergone significant transformation. Importing countries increasingly emphasize product quality, traceability, and compliance with environmental and social standards. Issues such as deforestation, greenhouse gas emissions, and labor practices have intensified scrutiny of palm oil production, especially from European and North American markets [2], [5]. As a result, competitiveness in the

palm oil industry is no longer determined solely by production volume and cost efficiency, but also by the ability to innovate and consistently deliver high-quality products that meet international standards [6], [7]. For Indonesia, strengthening innovation and quality improvement has therefore become a critical strategy to maintain and enhance its export performance.

Moreover, the growing emphasis on sustainability certification and responsible sourcing has encouraged producers to adopt more transparent and accountable production practices. International initiatives such as traceability systems, sustainable palm oil standards, and environmentally friendly processing methods are increasingly shaping market access and pricing structures. For Indonesian producers and smallholder farmers, adapting to these evolving expectations requires not only technological innovation but also institutional support, knowledge transfer, and continuous capacity building. By aligning production practices with global sustainability trends, Indonesia can strengthen market trust, improve its international reputation, and secure long-term competitiveness in the global palm oil industry.

Innovation in the palm oil sector can take various forms, including the adoption of improved farming techniques, use of superior seedlings, better harvesting and post-harvest handling practices, and the application of new technologies to enhance productivity and efficiency [8], [9]. At the same time, quality improvement efforts—such as ensuring optimal fruit maturity, reducing contamination, improving processing methods, and complying with certification schemes—are essential to increase the acceptance of Indonesian palm oil in international markets [1], [10]. Farmers play a crucial role in this process, as the quality of palm oil products is strongly influenced by practices at the plantation level. However, many smallholder farmers still face constraints related to limited access to technology, capital, training, and market information, which can hinder innovation adoption and quality enhancement.

To address these challenges, collaborative efforts among government institutions, industry stakeholders, and research organizations are increasingly necessary to support farmer capacity building. Training programs, access to affordable financing, technology dissemination, and extension services can help smallholders adopt innovative practices and maintain consistent product quality. Furthermore, strengthening farmer cooperatives and partnerships with processing companies may improve knowledge sharing, reduce production risks, and facilitate compliance with certification standards. By enhancing institutional support and encouraging innovation-driven practices, smallholder farmers can play a more active role in improving Indonesia's palm oil competitiveness in global markets.

Previous studies emphasize that innovation and quality management play key roles in enhancing agricultural competitiveness and export performance. Innovation-oriented farmers are better able to adapt to market changes, improve productivity, and access broader markets, while quality improvement contributes to customer trust, price premiums, and long-term sustainability. However, studies examining the combined effects of innovation and quality improvement on export competitiveness in the Indonesian palm oil industry, particularly from a farmer-based perspective, remain limited.

This research gap highlights the need for empirical investigation that integrates both innovation and quality improvement as complementary factors influencing export competitiveness. Understanding how these two dimensions interact at the farmer level is essential to identify practical strategies that can strengthen production performance while meeting international market standards. By examining the simultaneous impact of innovation and quality enhancement, this study seeks to provide a more comprehensive perspective on the drivers of competitiveness in Indonesia's palm oil sector and contribute to the development of evidence-based policies that support sustainable agricultural growth.

Therefore, this study analyzes the role of innovation and quality improvement in sustaining Indonesia's palm oil export competitiveness. Using a quantitative approach, data were collected from 85 palm oil farmers through a structured Likert-scale questionnaire and analyzed using SPSS version 25. By focusing on the farmer level, this study provides empirical insights into how micro-level practices support macro-level export performance, offering practical implications for policymakers and industry stakeholders in strengthening innovation and quality standards in the palm oil sector.

In addition, this study is expected to contribute to the academic literature by providing empirical evidence on the relationship between innovation, quality improvement, and export competitiveness within the context of

Indonesia's palm oil industry. The findings may serve as a reference for future research that explores sustainable agricultural competitiveness from a farmer-centered perspective. Furthermore, the results can support the formulation of development programs that encourage technology adoption, improve production standards, and strengthen collaboration among stakeholders to enhance the long-term resilience and global positioning of Indonesia's palm oil exports.

2. Literature Review

2.1 Palm Oil Industry and Export Competitiveness

The palm oil industry is a vital component of global agricultural trade, with Indonesia positioned as the world's largest producer and exporter. Export competitiveness in this sector reflects a country's ability to supply palm oil products that meet international market requirements in terms of price, quality, consistency, sustainability, and market share [8], [9]. While traditional determinants of competitiveness have focused on cost efficiency, scale of production, and resource availability, recent developments indicate that non-price factors—such as product quality, innovation capacity, compliance with standards, and responsiveness to evolving consumer preferences—have become increasingly influential [1], [4]. In the palm oil context, stringent import requirements related to quality specifications, traceability, and sustainability certifications mean that failure to comply can limit market access and weaken export performance. Therefore, sustaining export competitiveness in the palm oil industry requires not only maintaining production volumes but also strengthening innovation and quality improvement across the supply chain [11], [12].

2.2 Innovation in the Agricultural and Palm Oil Sector

Innovation is widely recognized as a key driver of agricultural competitiveness, including in the palm oil industry, where it refers to the adoption of new technologies, practices, and processes that enhance productivity, efficiency, and product quality [13], [14]. Such innovation encompasses improved planting materials, mechanization, precision agriculture, effective fertilization and pest management, the use of information and communication technologies, as well as better harvesting, transportation, and post-harvest handling practices. From a theoretical standpoint, innovation enables farmers to optimize resource use and achieve higher productivity, thereby strengthening their competitive position, while empirical evidence shows that innovative farmers tend to attain higher yields, lower production costs, and more consistent product quality [15], [16]. In the palm oil sector, farm-level innovations directly influence oil extraction rates and compliance with quality standards, yet their adoption—particularly among smallholders—is often constrained by limited access to capital, technology, extension services, and market information [16], [17]. These constraints highlight the importance of understanding the role of innovation in enhancing export competitiveness to inform effective policy and support mechanisms.

2.3 Quality Improvement in the Palm Oil Industry

Quality improvement is a crucial determinant of export competitiveness in the palm oil industry, as product quality is commonly assessed through physical and chemical attributes such as purity, free fatty acid content, moisture level, color, and contamination. High-quality palm oil is more likely to comply with international standards, secure premium prices, and gain acceptance in competitive export markets [2], [9]. Quality improvement involves systematic efforts to ensure consistent production and processing standards, including optimal harvesting maturity, timely handling and processing, contamination control, and adherence to recommended agronomic practices at the farmer level. These practices contribute to higher-quality fresh fruit bunches, which directly affect crude palm oil quality and export performance. Empirical studies show that effective quality management enhances buyer confidence, reduces rejection rates, and strengthens long-term trade relationships, while in the palm oil sector, quality improvement is increasingly intertwined with sustainability certification requirements [2], [5]. As global markets become more quality- and sustainability-oriented, continuous quality improvement has become a strategic necessity for maintaining export competitiveness.

2.4 Relationship Between Innovation, Quality Improvement, and Export Competitiveness

The relationship between innovation, quality improvement, and export competitiveness is well established in agribusiness and international trade literature, where innovation functions as an enabling mechanism for quality enhancement through improved technologies, processes, and management practices. Enhanced quality, in turn,

strengthens product acceptance in international markets and supports export competitiveness. Empirical studies show that innovation and quality improvement jointly improve export performance by increasing productivity, reducing inefficiencies, and aligning products with evolving market and regulatory requirements, making producers more resilient to market fluctuations. This synergy is particularly relevant in the palm oil industry, where quality and sustainability standards continue to tighten. However, existing research largely emphasizes firm- or industry-level analyses, with limited focus on farmer-level perspectives in developing countries. Given farmers' central role as primary producers and quality determinants, this study addresses this gap by empirically examining how innovation and quality improvement at the farm level influence Indonesia's palm oil export competitiveness using quantitative data from palm oil farmers.

Based on the theoretical framework and empirical evidence discussed above, the following hypotheses are proposed:

H1: Innovation has a positive and significant effect on Indonesia's palm oil export competitiveness.

H2: Quality improvement has a positive and significant effect on Indonesia's palm oil export competitiveness.

H3: Innovation and quality improvement simultaneously have a positive and significant effect on Indonesia's palm oil export competitiveness.

3. Research Methods

3.1 Research Design

This study employs a quantitative research design to examine the effect of innovation and quality improvement on the export competitiveness of Indonesia's palm oil industry. A quantitative approach is considered appropriate because it allows for the measurement of relationships among variables using numerical data and statistical analysis. The study is explanatory in nature, aiming to test hypotheses derived from theory and prior empirical studies regarding the influence of innovation and quality improvement on export competitiveness.

3.2 Population and Sample

The population of this study consists of palm oil farmers engaged in palm oil production activities in Indonesia. Given limitations related to time, accessibility, and resources, the sample was selected using a purposive sampling technique, focusing on farmers who are actively involved in palm oil cultivation and have experience supplying fresh fruit bunches to palm oil mills. A total of 85 farmers were selected as respondents, which is considered adequate for quantitative analysis and regression-based statistical testing.

3.3 Data Collection Technique

Primary data were collected through a structured questionnaire distributed directly to the respondents. The questionnaire was designed to capture farmers' perceptions and practices related to innovation, quality improvement, and export competitiveness. Each item in the questionnaire was measured using a Likert scale, typically ranging from 1 (strongly disagree) to 5 (strongly agree), to allow respondents to express the degree of their agreement with each statement. Prior to distribution, the questionnaire items were reviewed to ensure clarity, relevance, and consistency with the research objectives.

3.4 Research Variables and Measurement

This study examines three main variables: innovation (X_1) and quality improvement (X_2) as independent variables, and export competitiveness (Y) as the dependent variable. Innovation refers to the extent to which farmers adopt new or improved practices, technologies, and methods in palm oil cultivation and management, as reflected by the use of improved seedlings, modern farming techniques, enhanced harvesting and post-harvest practices, and openness to new technologies or training. Quality improvement denotes farmers' efforts to enhance product quality through better production and handling practices, including harvesting at optimal maturity, minimizing contamination, maintaining quality consistency, and complying with recommended quality standards. Export competitiveness represents the ability of palm oil products to compete in international markets, measured through perceived market acceptance, capacity to meet quality requirements, competitiveness relative to other producers, and contribution to export demand.

3.5 Data Analysis Technique

Data collected from the questionnaires were coded and analyzed using the Statistical Package for the Social Sciences (SPSS) version 25. The analysis began with descriptive statistics to summarize respondent characteristics and the distribution of responses for each variable, followed by validity and reliability tests to ensure the accuracy and consistency of the measurement instruments, with validity assessed through correlation analysis and reliability evaluated using Cronbach’s alpha. Hypothesis testing was conducted using multiple linear regression to examine both the partial and simultaneous effects of innovation and quality improvement on export competitiveness, with significance assessed through t-tests and an F-test at a 5 percent significance level. The coefficient of determination (R^2) was used to evaluate the model’s explanatory power. Based on the conceptual framework, the research model is expressed as $Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \varepsilon$, where Y represents export competitiveness, X_1 represents innovation, X_2 represents quality improvement, α is the constant, β_1 and β_2 are regression coefficients, and ε is the error term, which is used to assess the extent to which innovation and quality improvement influence Indonesia’s palm oil export competitiveness.

4. Results and Discussions

4.1 Descriptive Statistics

Descriptive analysis was conducted to provide an overview of respondents’ perceptions regarding innovation, quality improvement, and export competitiveness. The results show that, on average, respondents gave relatively high assessments to all variables, indicating that innovation and quality improvement practices have been moderately to strongly implemented by palm oil farmers.

Table 1. Descriptive Statistics of Research Variables

Variable	N	Min	Max	Mean	Std. Deviation
Innovation (X_1)	85	2.80	4.90	4.12	0.45
Quality Improvement (X_2)	85	3.00	4.85	4.18	0.42
Export Competitiveness (Y)	85	2.90	4.95	4.20	0.40

The mean value for innovation (4.12) indicates that most farmers agree they have adopted improved practices and technologies in palm oil cultivation. Quality improvement has a slightly higher mean (4.18), suggesting strong awareness and implementation of quality-related practices. Export competitiveness also shows a high mean value (4.20), reflecting farmers’ perception that their products are able to compete in export-oriented markets.

4.2 Validity and Reliability Test Results

Validity testing was conducted using item–total correlation with a critical r-table value of 0.213 for $N = 85$ at a 5% significance level, and the results show that all questionnaire items had correlation coefficients exceeding this threshold, indicating that all items were valid. Reliability testing was subsequently performed using Cronbach’s alpha, with the results presented in Table 2.

Table 2. Reliability Test Results

Variable	Number of Items	Cronbach’s Alpha	Interpretation
Innovation	8	0.842	Reliable
Quality Improvement	8	0.858	Reliable
Export Competitiveness	8	0.836	Reliable

Table 2 shows that all research variables demonstrate strong internal consistency, with Cronbach’s alpha values exceeding the commonly accepted threshold of 0.70. The innovation variable recorded an alpha value of 0.842, indicating that the eight items used consistently measure farmers’ innovation practices. Similarly, the quality improvement variable achieved a Cronbach’s alpha of 0.858, reflecting a high level of reliability in capturing quality-related efforts. Export competitiveness also showed reliable measurement with an alpha value of 0.836, confirming that the instrument is dependable for further statistical analysis and hypothesis testing.

4.3 Multiple Linear Regression Analysis

To examine the effect of innovation and quality improvement on export competitiveness, multiple linear regression analysis was conducted using SPSS version 25.

Table 3. Results of Multiple Linear Regression Analysis

Variable	Regression Coefficient (β)	t-value	Sig.
Constant	0.782	2.317	0.023
Innovation (X_1)	0.312	3.455	0.001
Quality Improvement (X_2)	0.421	4.877	0.000

Table 3 presents the results of the multiple linear regression analysis, indicating that both innovation and quality improvement have a positive and statistically significant effect on export competitiveness. Innovation (X_1) shows a regression coefficient of 0.312 with a t-value of 3.455 and a significance level of 0.001, demonstrating that increased adoption of innovative practices by farmers contributes to higher export competitiveness. Quality improvement (X_2) exhibits a stronger effect, with a coefficient of 0.421, a t-value of 4.877, and a significance level of 0.000, suggesting that efforts to enhance product quality play a more dominant role in strengthening competitiveness in international markets. The constant value of 0.782 is also statistically significant, indicating that export competitiveness is influenced by other factors beyond the variables included in the model.

4.4 Simultaneous Effect Test (F-test)

The simultaneous effect of innovation and quality improvement on export competitiveness was tested using the F-test.

Table 4. F-test Results

Model	F-value	Sig.
Regression	42.368	0.000

The significance value of 0.000 is less than 0.05, indicating that innovation and quality improvement simultaneously have a significant effect on export competitiveness. Thus, Hypothesis H3 is supported.

4.5 Coefficient of Determination (R^2)

The coefficient of determination was used to measure how much variation in export competitiveness can be explained by innovation and quality improvement.

Table 5. Coefficient of Determination

R	R Square	Adjusted R Square
0.713	0.508	0.496

The R^2 value of 0.508 indicates that 50.8% of the variation in export competitiveness can be explained by innovation and quality improvement, while the remaining 49.2% is influenced by other factors not included in this model, such as market access, government policy, infrastructure, and price dynamics.

4.6 Discussion

The results of this study demonstrate that innovation plays a significant role in enhancing export competitiveness in the palm oil industry. Farmers who adopt improved cultivation techniques, better harvesting practices, and new technologies are more capable of producing palm oil that meets international market requirements. This finding supports arguments in the agricultural economics literature that innovation enhances productivity and allows producers to adapt more effectively to changing market conditions and competitive pressures [9], [18].

Furthermore, innovation not only improves production efficiency but also strengthens farmers' ability to respond to evolving sustainability standards and consumer expectations in global markets. The adoption of innovative practices can reduce production risks, optimize resource utilization, and enhance product consistency, which are essential factors in maintaining long-term competitiveness. By integrating technological advancements with practical field management, farmers can increase value creation while minimizing operational constraints, reinforcing the importance of continuous innovation as a strategic driver of export performance in the palm oil sector.

Quality improvement was found to have an even stronger influence on export competitiveness, as indicated by its higher regression coefficient. This result underscores the central role of product quality in determining market acceptance in international trade. Consistent quality, compliance with technical standards, and proper handling practices strengthen buyer confidence and reduce the likelihood of product rejection, which is particularly critical in the palm oil industry where quality specifications are strictly regulated [5], [19].

In addition, quality improvement contributes to the long-term sustainability of export performance by enhancing product differentiation and strengthening Indonesia's reputation in global markets. High-quality standards not only increase the potential for price premiums but also open access to more demanding market segments that prioritize sustainability and reliability. For farmers, maintaining consistent quality requires continuous monitoring of cultivation practices, proper post-harvest management, and adherence to certification requirements, which collectively reinforce the strategic importance of quality-oriented management in sustaining competitiveness within the palm oil industry.

The simultaneous significance of innovation and quality improvement suggests that these factors operate in a complementary manner rather than independently. Innovation enables farmers to adopt more efficient and effective quality management practices, while quality improvement ensures that the outcomes of innovation translate into measurable competitive advantages in export markets. This interaction highlights the importance of integrating innovation initiatives with quality-oriented interventions at the farm level.

Moreover, the complementary relationship between innovation and quality improvement indicates that policy interventions should not treat these dimensions as separate development agendas. Programs that promote technological adoption will be more effective when accompanied by training on quality control, certification processes, and standardized production practices. Likewise, quality enhancement initiatives can achieve stronger results when supported by innovative tools and modern farming methods that improve efficiency and consistency. By fostering an integrated approach, stakeholders can create a more resilient production system that strengthens farmers' capacity to compete in increasingly demanding global export markets.

Overall, the findings confirm that strengthening both innovation capacity and quality improvement among palm oil farmers is essential for sustaining Indonesia's export competitiveness. The results provide empirical support for policies and development programs that prioritize farmer training, improved access to technology, and quality-focused extension services, thereby contributing to the long-term sustainability and resilience of Indonesia's palm oil export sector.

In addition, these findings highlight the importance of collaborative efforts among government agencies, industry stakeholders, and research institutions to create an enabling environment for continuous improvement at the farmer level. Strengthening institutional support, expanding access to innovation-driven resources, and promoting knowledge exchange can accelerate the adoption of best practices across the palm oil value chain. By aligning policy initiatives with the practical needs of farmers, Indonesia can enhance its global competitiveness while ensuring that the growth of the palm oil sector remains sustainable, inclusive, and responsive to evolving international market demands.

5. Conclusion

This study concludes that innovation and quality improvement play a crucial role in maintaining Indonesia's palm oil export competitiveness. The empirical results demonstrate that farmers who adopt innovative practices and continuously improve product quality are better positioned to meet international market requirements and sustain export performance. Quality improvement was found to have a stronger influence than innovation, highlighting the importance of consistent quality standards and proper production practices in export-oriented agricultural

commodities. The simultaneous effect of innovation and quality improvement confirms that both factors are complementary and should be developed together. Therefore, efforts to enhance Indonesia's palm oil export competitiveness should focus on strengthening farmers' access to technology, training, and quality management systems. By promoting innovation and quality improvement at the farm level, Indonesia can reinforce the sustainability and resilience of its palm oil industry in an increasingly competitive global market.

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