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THE ROLE OF OPERATIONAL CAPABILITIES IN TRANSFORMING LONG-TERM PRODUCTION COSTS AND PLANTATION INVESTMENT INTO SUSTAINABLE PRODUCTIVITY : EVIDENCE FROM GAYO ARABICA COFFEE AGRIBUSINESS

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Abstract

Sustainable productivity has become a strategic issue in the development of Gayo Arabica coffee agribusiness due to increasing production costs, the need for plantation investment, and the growing demand for efficient and sustainable farming practices. This study aims to examine the effects of long-term production costs and plantation investment on sustainable productivity through operational capabilities in the Gayo Arabica coffee agribusiness sector in Aceh, Indonesia. A quantitative approach with an explanatory research design was employed. Data were collected through a survey of Gayo Arabica coffee farmers using a structured Likert-scale questionnaire and analyzed using Structural Equation Modeling–Partial Least Squares (SEM-PLS). The results indicate that long-term production costs and plantation investment have positive and significant effects on operational capabilities. Furthermore, both variables positively and significantly influence sustainable productivity. Operational capabilities also have a positive and significant effect on sustainable productivity and mediate the relationships between long-term production costs, plantation investment, and sustainable productivity. These findings suggest that improvements in coffee productivity are not determined solely by the amount of production costs and investments incurred, but also by farmers' ability to effectively manage resources, technology, and operational processes. This study reinforces the Resource-Based View and Dynamic Capability Theory by highlighting the critical role of operational capabilities as a mechanism for transforming resources into sustainable performance. Practically, the findings provide valuable insights for policymakers, cooperatives, and agribusiness stakeholders in formulating strategies to enhance the sustainable productivity of Gayo Arabica coffee through increased investment and the development of farmers' operational capabilities.

Keywords: long-term production costs, plantation investment, operational capabilities, sustainable productivity, Gayo Arabica coffee.

INTRODUCTION

The coffee sector is one of the most strategic agricultural subsectors contributing to national economic development through employment generation, increased farmers' income, and export earnings. Indonesia is among the world's largest coffee-producing countries, with Gayo Arabica coffee from Aceh recognized as a premium specialty coffee with a strong reputation in international markets. Despite this recognition, Indonesia's coffee productivity remains relatively low compared to major coffee-producing countries such as Brazil and Vietnam. Statistical data indicate that Indonesia's coffee productivity ranges between 0.8 and 1.0 tons per hectare, while competing countries have achieved productivity levels exceeding 1.5 tons per hectare. This productivity gap suggests that production growth has not been fully supported by efficient farm management and sustainable production capacity.

Recent literature indicates that agricultural productivity is no longer determined solely by conventional production factors, such as land, labor, and fertilizers. Contemporary studies emphasize the importance of long-term investment, strategic resource management, and the development of organizational capabilities in enhancing sustainable farm performance (Agyemang et al., 2024; Huo et al., 2024). In the context of coffee plantations, long-term production costs—including the use of improved seedlings, plantation rehabilitation, land conservation, and the adoption of cultivation technologies—represent strategic investments that can enhance future production capacity.

Likewise, plantation investment through crop rejuvenation, production infrastructure development, and improvements in post-harvest facilities plays a critical role in strengthening the competitiveness and sustainability of coffee farming. However, previous studies have reported inconsistent findings regarding the relationship between production costs, investment, and productivity. Some studies have identified a strong positive relationship between investment and productivity, whereas others suggest that the benefits of investment largely depend on the ability of farm managers to effectively utilize available resources. These inconsistencies indicate the existence of an internal mechanism that has not been sufficiently explored in previous research.

From the perspectives of the Resource-Based View (RBV) and Dynamic Capability Theory, strategic resources can generate superior performance and competitive advantage only when organizations possess the capability to integrate, manage, and utilize those resources effectively. Therefore, operational capabilities are considered a crucial factor that enables long-term production costs and plantation investments to be transformed into higher productivity. Operational capabilities encompass production planning, quality management, technology utilization, cost control, and adaptation to changing business environments. Furthermore, recent developments in the literature have shifted the focus from merely increasing output toward the broader concept of sustainable productivity, which integrates economic, social, and environmental dimensions. This concept has become increasingly relevant in the coffee industry due to growing global demand for sustainable production practices, climate change challenges, and the need to preserve natural resources for future generations.

Although research on coffee productivity has expanded considerably, several important research gaps remain. First, most previous studies have focused primarily on traditional production factors and have not integrated long-term production costs, plantation investment, and operational capabilities within a single conceptual framework. Second, empirical studies examining the mediating role of operational capabilities in the relationship between investment and productivity remain limited, particularly within the coffee agribusiness sector. Third, research on sustainable productivity in specialty coffee production within developing countries, including Gayo Arabica coffee, is still relatively scarce in the international scholarly literature.

To address these gaps, this study investigates the effects of long-term production costs and plantation investment on sustainable productivity through operational capabilities in the Gayo Arabica coffee agribusiness sector. The study positions operational capabilities as a mediating mechanism that explains how strategic resources can be transformed into sustainable performance outcomes. Consequently, this research contributes to the literature by integrating the Resource-Based View, Dynamic Capability Theory, and the concept of sustainable productivity within the context of coffee agribusiness. Practically, the findings are expected to provide valuable insights for farmers, cooperatives, and policymakers in formulating strategies to enhance the sustainable productivity and competitiveness of Gayo Arabica coffee.

LITERATURE REVIEW

1. Long-Term Production Costs and Sustainable Agricultural Productivity

Recent studies have highlighted the strategic role of long-term production costs in enhancing sustainable agricultural productivity. Unlike short-term operational expenditures, long-term production costs include investments in improved seedlings, balanced fertilization, land conservation, farm rehabilitation, and technological adoption that contribute to future production capacity. According to Agyemang et al. (2024), strategic resource allocation in smallholder farming systems significantly improves productivity and strengthens long-term agricultural resilience. Their findings suggest that production costs should be viewed not merely as operational expenses but as strategic investments that generate sustainable value. However, the study primarily focuses on direct relationships and does not sufficiently explain the organizational mechanisms through which production costs influence sustainable productivity. This limitation indicates the need to explore operational capabilities as a potential mediating factor.

2. Plantation Investment and Agricultural Competitiveness

Plantation investment has been widely recognized as a key driver of agricultural competitiveness and long-term performance. Investments in plantation infrastructure, production equipment, post-harvest facilities, technology, and human resource development enhance operational efficiency and strengthen the competitiveness of agricultural enterprises. Khan et al. (2025) found that long-term agricultural investment positively influences productivity by improving production capacity and increasing farmers' adaptive capabilities in dynamic environments. Their study emphasizes that investment functions as a strategic resource capable of creating sustainable competitive advantages. Nevertheless, previous research has largely concentrated on the direct effects of

investment on productivity, leaving limited empirical evidence regarding the mediating mechanisms that transform investment into sustainable outcomes.

3. Operational Capabilities and Sustainable Performance

Operational capabilities have emerged as a critical determinant of organizational performance and sustainability. These capabilities refer to an organization's ability to effectively manage production processes, maintain quality standards, utilize technology, and continuously improve operational efficiency. Huo et al. (2024) demonstrated that operational capabilities significantly contribute to sustainable performance in agrifood supply chains through improved process integration and resource utilization. Their findings support the Dynamic Capability Theory, which argues that organizations achieve superior performance when they can effectively integrate and deploy available resources. Although the relationship between operational capabilities and sustainable performance has received growing attention, empirical studies focusing on coffee agribusiness, particularly specialty coffee sectors in developing countries, remain scarce.

4. Sustainable Productivity in the Coffee Industry

The concept of sustainable productivity has evolved beyond traditional measures of output and efficiency to encompass economic, social, and environmental dimensions. In the coffee industry, sustainable productivity has become increasingly important due to climate change challenges, market demands for sustainable products, and concerns regarding farmers' livelihoods. Bunn et al. (2024) argued that the sustainability of coffee production depends on farmers' ability to efficiently manage resources while adapting to environmental and market uncertainties. Their study highlights the importance of balancing productivity growth with environmental conservation and social welfare. However, existing research has predominantly focused on climate-related and environmental factors, while managerial and operational determinants of sustainable productivity have received less attention.

METHOD

This study employed a quantitative approach with an explanatory research design to examine the causal relationships among long-term production costs, plantation investment, operational capabilities, and sustainable productivity in the Gayo Arabica coffee agribusiness sector. The quantitative approach was selected because the study aims to test hypotheses developed based on the Resource-Based View (RBV) and Dynamic Capability Theory, while objectively measuring the relationships among variables through statistical analysis. The explanatory design was used to explain how long-term production costs and plantation investment influence sustainable productivity, both directly and indirectly through operational capabilities.

The study was conducted in the major Gayo Arabica coffee-producing regions of Aceh Province, namely Aceh Tengah, Bener Meriah, and Gayo Lues Regencies. These areas were selected because they represent the primary production centers of Gayo Arabica coffee and contribute significantly to Indonesia's coffee production and exports. The study population consisted of all active Gayo Arabica coffee farmers operating within the study area. The sample was selected using a purposive sampling technique based on the following criteria: (1) farmers with at least five years of experience in coffee farming, (2) farmers who own or manage Arabica coffee plantations, and (3) farmers willing to participate in the study. The sample size was determined based on the recommendations of Hair et al. (2022) for Structural Equation Modeling–Partial Least Squares (SEM-PLS). Accordingly, a minimum of 200 respondents was targeted to ensure stable estimation and adequate predictive power.

The study utilized both primary and secondary data sources. Primary data were collected through the direct distribution of structured questionnaires to respondents. The questionnaire employed a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) to measure respondents' perceptions of each research indicator. Secondary data were obtained from publications issued by Statistics Indonesia (BPS), the Food and Agriculture Organization (FAO), the International Coffee Organization (ICO), reports from plantation agencies, and relevant scholarly articles published in reputable academic journals.

The study involved four main variables: long-term production costs as the first independent variable, plantation investment as the second independent variable, operational capabilities as the mediating variable, and sustainable productivity as the dependent variable. Long-term production costs were measured using indicators such as the use of improved seedlings, fertilization, plantation rehabilitation, land conservation, and cultivation technology adoption. Plantation investment was measured through infrastructure investment, production equipment, post-harvest facilities, technology investment, and human resource development. Operational capabilities were assessed through production planning, quality management, technology utilization, process improvement, and risk

management. Sustainable productivity was measured based on economic productivity, income sustainability, resource efficiency, environmental sustainability, and social sustainability dimensions.
The structural model of the study is formulated as follows:

Equation 1 $OPC = \beta_1 LTPC + \beta_2 PI + \varepsilon_1$

Equation 2 $SP = \beta_3 LTPC + \beta_4 PI + \beta_5 OPC + \varepsilon_2$

Where: OPC = Operational Capabilities, LTPC = Long-Term Production Costs, PI = Plantation Investment, SP = Sustainable Productivity, ε = Error term

Prior to data analysis, the research instrument was subjected to validity and reliability testing to ensure that each indicator accurately and consistently measured its intended construct. Convergent validity was assessed using factor loadings and Average Variance Extracted (AVE), with threshold values of factor loadings greater than 0.70 and AVE greater than 0.50. Discriminant validity was evaluated using the Fornell–Larcker criterion and the Heterotrait–Monotrait Ratio (HTMT). Reliability was assessed through Cronbach's Alpha and Composite Reliability, with a minimum acceptable value of 0.70.

Data analysis was conducted using Structural Equation Modeling–Partial Least Squares (SEM-PLS) with SmartPLS 4 software. SEM-PLS was chosen because it is capable of analyzing complex relationships among latent variables, testing mediation effects, and providing strong predictive capabilities in social science and agribusiness research. The analysis began with the evaluation of the measurement model (outer model), including tests of construct validity and reliability. Once the measurement model met the required criteria, the structural model (inner model) was evaluated through the assessment of the coefficient of determination (R^2), effect size (f^2), predictive relevance (Q^2), and path coefficients.

Hypothesis testing was conducted using the bootstrapping procedure to obtain t-statistics and p-values. Hypotheses were accepted when the t-statistic exceeded 1.96 and the p-value was below 0.05 at a 5% significance level. In addition to testing direct effects, the study also examined indirect effects through mediation analysis to determine the role of operational capabilities in mediating the relationships between long-term production costs, plantation investment, and sustainable productivity. Overall, the research process consisted of a literature review and conceptual model development, instrument design, field data collection, validity and reliability testing, SEM-PLS analysis, interpretation of findings, and conclusion development. These stages were systematically organized to ensure that the research process is transparent, understandable, and replicable by future researchers in different contexts and settings.

RESULTS AND DISCUSSION

Overview of the Research Object

This study was conducted within the Gayo Arabica coffee agribusiness sector located in the major coffee-producing regions of Aceh Tengah Regency, Bener Meriah Regency, and Gayo Lues Regency in Aceh Province, Indonesia. The Gayo Highlands represent one of the largest Arabica coffee-producing areas in Indonesia and have been granted Geographical Indication (GI) certification. Gayo Arabica coffee is internationally recognized as a premium specialty coffee due to its distinctive flavor profile and high quality standards.Most coffee plantations in the Gayo region are managed by smallholder farmers with relatively limited land ownership. Coffee production is predominantly based on family farming systems. However, in recent years, there has been increasing adoption of cultivation technologies, sustainability certifications, and post-harvest investments aimed at enhancing the competitiveness of Gayo coffee in international markets.

Respondent Characteristics

Respondents were classified based on gender, educational level, farming experience, and land ownership.

Table 1. Respondent Characteristics by Gender

Gender	Frequency	Percentage (%)
Male	168	84.0
Female	32	16.0
Total	200	100

The results indicate that the majority of respondents were male, accounting for 84% of the sample. This finding suggests that coffee farming activities in the Gayo region are still largely dominated by male farmers who serve as the primary decision-makers in farm management.

Table 2. Respondent Characteristics by Educational Level

Education Level	Frequency	Percentage (%)
Elementary School	22	11.0
Junior High School	40	20.0
Senior High School	98	49.0
Diploma	18	9.0
Bachelor's Degree	22	11.0

Most respondents had completed senior high school education (49%), indicating that a considerable proportion of farmers possess the educational background necessary to understand and adopt agricultural innovations and technological advancements.

Descriptive Analysis of Research Variables

Table 3. Descriptive Statistics of Research Variables

Variable	Mean	Standard Deviation
Long-Term Production Costs	4.11	0.62
Plantation Investment	3.95	0.71
Operational Capabilities	4.02	0.66
Sustainable Productivity	4.08	0.59

The mean values of all variables exceed 3.50, indicating that respondents generally perceived long-term production costs, plantation investment, operational capabilities, and sustainable productivity positively. These findings suggest that farmers have increasingly adopted strategic production practices and investment-oriented management approaches.

Measurement Model Evaluation (Outer Model)

Convergent Validity Test

Table 4. Factor Loadings

Indicator	Loading	Indicator	Loading
LTPC1	0.812	OC1	0.878
LTPC2	0.845	OC2	0.884
LTPC3	0.824	OC3	0.823
PI1	0.835	SP1	0.851
PI2	0.867	SP2	0.873
PI3	0.852	SP3	0.846

All indicators exhibit factor loadings above the recommended threshold of 0.70, confirming adequate convergent validity.

Table 5. Average Variance Extracted (AVE)

Variable	AVE
Long-Term Production Costs	0.701
Plantation Investment	0.735
Operational Capabilities	0.752
Sustainable Productivity	0.728

All AVE values exceed the recommended minimum value of 0.50, indicating that the constructs possess satisfactory convergent validity.

Reliability Test

Table 6. Composite Reliability

Variable	Composite Reliability
Long-Term Production Costs	0.912
Plantation Investment	0.924
Operational Capabilities	0.931
Sustainable Productivity	0.919

All constructs demonstrate Composite Reliability values above 0.70, confirming the reliability and internal consistency of the measurement instruments.

Structural Model Evaluation (Inner Model)

Coefficient of Determination (R^2)

Table 7. R-Square Values

Endogenous Variable	R^2
Operational Capabilities	0.624
Sustainable Productivity	0.701

The results indicate that long-term production costs and plantation investment explain 62.4% of the variance in operational capabilities. Furthermore, long-term production costs, plantation investment, and operational capabilities jointly explain 70.1% of the variance in sustainable productivity.

According to Hair et al. (2022), these R^2 values can be categorized as substantial, indicating strong explanatory power of the proposed model.

Hypothesis Testing

Table 8. Hypothesis Testing Results

Hypothesis	Path Coefficient	T-Statistic	P-Value	Decision
LTPC → OC	0.412	6.827	0.000	Supported
PI → OC	0.396	5.931	0.000	Supported
OC → SP	0.465	8.214	0.000	Supported
LTPC → SP	0.214	2.745	0.006	Supported
PI → SP	0.256	3.491	0.001	Supported

Effect of Long-Term Production Costs on Operational Capabilities

The results reveal that long-term production costs have a positive and significant effect on operational capabilities ($\beta = 0.412$; $p < 0.05$). This finding indicates that greater allocations of resources toward strategic activities such as plantation rehabilitation, the use of improved seedlings, and production technology development enhance farmers' operational capabilities. These findings support the **Resource-Based View (RBV)**, which argues that valuable resources strengthen an organization's ability to create and sustain competitive advantages.

Effect of Plantation Investment on Operational Capabilities

Plantation investment has a positive and significant effect on operational capabilities ($\beta = 0.396$; $p < 0.05$). The findings suggest that investments in production facilities, plantation infrastructure, and post-harvest technologies improve farmers' ability to manage production processes more effectively. This result is consistent with the findings of Haryono et al. (2024), who reported that long-term investment contributes to enhanced operational efficiency and improved coffee quality.

Effect of Operational Capabilities on Sustainable Productivity

Operational capabilities exert the strongest influence on sustainable productivity ($\beta = 0.465$; $p < 0.05$). This finding demonstrates that production planning, quality control, technology utilization, and risk management are critical determinants of sustainable coffee productivity. The result supports Dynamic Capability Theory, which posits

that organizations with superior capabilities to adapt, integrate, and deploy resources are more likely to achieve higher levels of performance and sustainability.

Mediation Analysis

Table 9. Mediation Test Results

Mediation Path	Indirect Effect	T-Statistic	P-Value
LTPC → OC → SP	0.191	4.876	0.000
PI → OC → SP	0.184	4.221	0.000

The mediation analysis indicates that operational capabilities significantly mediate the relationship between long-term production costs and sustainable productivity, as well as the relationship between plantation investment and sustainable productivity.

These findings suggest that increased production costs and investments do not automatically lead to higher productivity. Their impact becomes substantially more effective when supported by strong operational capabilities. In other words, strategic resources such as long-term production expenditures and plantation investments must be accompanied by effective operational management to generate sustainable productivity outcomes. This finding reinforces the central propositions of both the Resource-Based View (RBV) and Dynamic Capability Theory, emphasizing that resources create value only when organizations possess the capabilities required to utilize them effectively.

Discussion

The Effect of Long-Term Production Costs on Operational Capabilities

The results indicate that long-term production costs have a positive and significant effect on operational capabilities. This finding suggests that greater allocation of resources to strategic activities such as the use of improved seedlings, sustainable fertilization, plantation rehabilitation, land conservation, and the adoption of cultivation technologies leads to higher operational capabilities among coffee farmers and agribusiness organizations. From a theoretical perspective, this finding supports the Resource-Based View (RBV), which argues that valuable resources enhance an organization's ability to create competitive advantages. Long-term production costs should no longer be viewed merely as business expenses but rather as strategic investments that strengthen farmers' operational capabilities in managing production processes. In the context of Gayo Arabica coffee, long-term production expenditures enable farmers to access better cultivation technologies, improve crop quality, and enhance plantation management systems. Consequently, farmers become more capable of planning production activities, controlling harvest quality, and optimizing resource utilization. This finding is consistent with the study by Agyemang et al. (2024), which reported that investments in technological development and plantation maintenance contribute significantly to improved operational capabilities and sustainable agricultural production efficiency.

The Effect of Plantation Investment on Operational Capabilities

The analysis demonstrates that plantation investment has a positive and significant effect on operational capabilities. This finding indicates that increased investment in plantation infrastructure, post-harvest technologies, production facilities, and human resource development enhances the operational capabilities of coffee farmers. Plantation investment provides opportunities for farmers to improve production facilities and optimize operational processes. Such improvements may include the adoption of modern post-harvest equipment, the construction of better coffee drying facilities, and the enhancement of farmers' technical skills through training programs. According to Dynamic Capability Theory, investment creates value only when it strengthens an organization's ability to effectively manage and utilize its resources. In this study, plantation investment was found to improve farmers' capabilities in production planning, quality control, technology utilization, and adaptation to changing business environments.

Within the Gayo Arabica coffee agribusiness sector, plantation investment has become increasingly important because many coffee trees have reached advanced productive ages and require rejuvenation programs and cultivation modernization. Therefore, plantation investment not only improves physical assets but also strengthens the operational capabilities necessary to compete in global coffee markets. This finding supports the study of Haryono et al. (2024), which concluded that long-term investment in coffee farming contributes to improved operational efficiency and higher product quality.

The Effect of Operational Capabilities on Sustainable Productivity

The results reveal that operational capabilities have a positive and significant effect on sustainable productivity. This finding suggests that farmers' abilities to manage production processes, maintain quality standards, adopt technology, and manage business risks play a crucial role in enhancing sustainable productivity. Sustainable productivity is not solely reflected in increased production output but also in the efficient utilization of resources, improved farmer income, and the preservation of environmental quality. Therefore, operational capabilities serve as a key factor linking available resources to sustainable performance outcomes. From the perspective of Dynamic Capability Theory, organizations that possess the ability to adapt to environmental changes are better positioned to maintain long-term productivity. In the Gayo coffee agribusiness context, these capabilities are reflected in adaptive cultivation practices in response to climate change, compliance with export quality standards, and effective coffee supply chain management. This finding is consistent with Huo et al. (2024), who identified operational capabilities as a major determinant of sustainable performance in agribusiness and resource-based industries.

The Effect of Long-Term Production Costs on Sustainable Productivity

The findings indicate that long-term production costs have a positive and significant effect on sustainable productivity. This result suggests that expenditures aimed at enhancing future production capacity generate greater benefits than short-term operational spending. The use of improved seedlings, balanced fertilization, plantation rehabilitation, and production technology adoption enables farmers to increase land productivity while preserving natural resources. Consequently, long-term production costs function as strategic investments that contribute to higher output and greater operational efficiency over time. In Gayo Arabica coffee farming, strategic production expenditures are particularly important because many farmers face financial constraints that limit their ability to rejuvenate aging coffee trees and modernize cultivation practices. Therefore, improving access to financing and investment support becomes essential for promoting sustainable productivity growth. This finding supports the study by Khan et al. (2025), which demonstrated that strategic expenditures aimed at expanding production capacity contribute positively to long-term agricultural productivity.

The Effect of Plantation Investment on Sustainable Productivity

Plantation investment was found to have a positive and significant effect on sustainable productivity. This finding indicates that investments in physical assets, technology, and human resources enhance the capacity of farming enterprises to generate higher and more sustainable levels of output. Investment contributes to improved harvest quality, greater operational efficiency, and enhanced capability to meet international market standards. Moreover, investment helps farmers reduce production risks associated with climate change and pest infestations. In the context of Gayo coffee agribusiness, investments in post-harvest technologies and sustainability certifications play a strategic role because they increase product value-added and expand access to export markets. Therefore, plantation investment not only improves productivity but also strengthens the overall competitiveness of coffee agribusiness. This finding is consistent with the reports of FAO (2024) and Haryono et al. (2024), which identified investment as a critical factor in enhancing the sustainability of coffee production systems.

The Mediating Role of Operational Capabilities

The mediation analysis reveals that operational capabilities significantly mediate the relationship between long-term production costs and sustainable productivity. Likewise, operational capabilities also mediate the relationship between plantation investment and sustainable productivity. These findings suggest that production costs and investments do not automatically translate into higher productivity. Their effects become more effective when farmers possess adequate operational capabilities to manage and utilize available resources efficiently. From the perspectives of the Resource-Based View (RBV) and Dynamic Capability Theory, strategic resources generate superior performance only when organizations have the capability to integrate and exploit those resources effectively. In other words, operational capabilities function as a transformation mechanism that converts production expenditures and investments into sustainable productivity outcomes. For the Gayo Arabica coffee agribusiness sector, these findings imply that productivity enhancement programs should not rely solely on financial assistance or physical investment. Instead, they should also focus on strengthening farmers' capabilities through technical training, extension services, technology transfer, and institutional development initiatives. By enhancing operational capabilities, farmers can maximize the benefits of production investments and achieve sustainable productivity in the long run.

CONCLUSION

Based on the findings regarding the effects of long-term production costs and plantation investment on sustainable productivity through operational capabilities in the Gayo Arabica coffee agribusiness sector, several conclusions can be drawn.

First, long-term production costs have a positive and significant effect on operational capabilities. This finding indicates that increased expenditures on strategic activities, such as the use of improved seedlings, plantation rejuvenation, sustainable fertilization, land conservation, and the adoption of cultivation technologies, enhance farmers' operational capabilities in managing production processes more effectively and efficiently.

Second, plantation investment has a positive and significant effect on operational capabilities. Investments in plantation infrastructure, production and post-harvest technologies, as well as human resource development, have been proven to strengthen farmers' capabilities in production planning, quality control, technology utilization, and risk management.

Third, operational capabilities have a positive and significant effect on sustainable productivity. The better farmers are at managing resources, adopting innovations, and optimizing operational processes, the higher the level of productivity achieved across economic, social, and environmental dimensions.

Fourth, long-term production costs have a positive and significant effect on sustainable productivity. Cost allocations aimed at enhancing production capacity contribute to increased production output, improved resource-use efficiency, and the long-term sustainability of coffee farming operations.

Fifth, plantation investment has a positive and significant effect on sustainable productivity. Investments made by farmers not only improve production capacity but also strengthen coffee product competitiveness, enhance harvest quality, and expand market access.

Sixth, operational capabilities significantly mediate the relationship between long-term production costs and sustainable productivity. This finding suggests that the benefits of strategic production expenditures can be maximized when supported by adequate operational capabilities to effectively manage and utilize available resources.

Seventh, operational capabilities significantly mediate the relationship between plantation investment and sustainable productivity. Therefore, investments generate greater impacts on productivity when accompanied by improvements in managerial, technical, and operational capabilities.

Overall, this study demonstrates that sustainable productivity in the Gayo Arabica coffee agribusiness sector is determined not only by the magnitude of production costs and plantation investments but also by farmers' operational capabilities in effectively managing these resources. These findings reinforce the perspectives of the Resource-Based View (RBV) and Dynamic Capability Theory, which emphasize the critical role of organizational capabilities as a mechanism for transforming strategic resources into superior and sustainable performance.

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