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Strengthening Agribusiness Competitiveness through Business Innovation, Digital Marketing, and Environmental Sustainability in Bireuen

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Abstract

Agribusiness competitiveness requires adaptation to market, technological, and environmental changes, yet empirical studies integrating business innovation, digital marketing, and environmental sustainability within a single model remain limited, particularly in Bireuen Regency, Indonesia. This study examined the associations of these three factors with agribusiness competitiveness. A quantitative cross-sectional survey conducted in July 2026 involved 80 agribusiness actors selected through purposive sampling. Data were collected using a structured five-point Likert-scale questionnaire and analyzed through partial least squares structural equation modeling (PLS-SEM) in SmartPLS 4. All three factors were positively and significantly associated with agribusiness competitiveness. Environmental sustainability had the largest estimated path coefficient ($\beta = 0.339$, $p < .001$), followed by business innovation ($\beta = 0.292$, $p = .003$) and digital marketing ($\beta = 0.251$, $p = .009$). The model explained 40.6% of the variance in competitiveness ($R^2 = .406$). These findings highlight the relevance of business capabilities and sustainable practices to agribusiness competitiveness in this setting. The study contributes an integrated competitiveness model and identifies innovation, digital marketing, and environmental sustainability as relevant priorities for agribusiness development strategies in Bireuen.

Keywords: Agribusiness Competitiveness; Business Innovation; Digital Marketing; Environmental Sustainability; PLS-SEM

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INTRODUCTION

The agribusiness sector plays a strategic role in the economic development of Bireuen Regency because agricultural activities are not limited to production but also encompass processing, distribution, marketing, and value creation. In 2025, the agricultural sector contributed 34.63% to the Gross Regional Domestic Product (GRDP) of Bireuen Regency and involved 73,589 agricultural households. This potential is also reflected in rice production, which reached 158,432 tons, supported by more than 85,000 units of agricultural machinery and equipment. Despite this strong production base, increased production needs to be accompanied by modernization, downstream processing, product quality improvement, marketing development, broader market access, and stronger supply chains so that local agricultural products can generate higher added value and competitiveness (Badan Pusat Statistik, 2026).

Changes in the business environment indicate that agribusiness competitiveness can no longer rely solely on production capacity (Worku et al., 2024). Business actors are increasingly required to develop and combine resources, adapt products to consumer needs, utilize technology, and respond rapidly to market changes. Digital transformation has been shown to strengthen agribusiness innovation capability and quality by enhancing technological capacity, reducing financing constraints, and improving access to innovation resources, including technology, labor, and capital (Xue et al., 2024). These conditions indicate that improving competitiveness requires more adaptive business capabilities and cannot be separated from innovation, digitalization, and changes in the business environment.

Business innovation is an important capability in building competitiveness because it enables agribusiness actors to renew products, production processes, services, marketing methods, and business management practices. Such capabilities help firms create differentiated value while adapting to market dynamics. In agriculture-related enterprises, digitalization has also been shown to promote green transformation through more efficient resource allocation and stronger innovation capabilities. Thus, innovation not only supports productivity and business differentiation but can also serve as a mechanism for aligning business processes with increasingly strong environmental demands (Yuan et al., 2024).

In addition to business innovation, digital marketing has become an increasingly important capability for strengthening the market position of agribusiness firms (Kanellos et

al., 2024). The use of social media, e-commerce, digital branding, and content-based marketing enables business actors to expand their consumer reach, increase product visibility, obtain market information, and communicate with customers more quickly. Studies on agricultural product marketing show that digital strategies can expand market reach and increase product value. However, their implementation still faces several constraints, including low digital literacy, limited infrastructure, and insufficient technical assistance, particularly in rural areas (Sukmawati et al., 2025). These findings indicate that access to digital technology does not automatically create competitive advantage unless it is accompanied by the strategic ability to utilize that technology effectively (Saruchera & Mpunzi, 2023).

Digital marketing should also not be viewed merely as a promotional instrument. Among micro, small, and medium-sized enterprises in Indonesia, internet marketing, market orientation, and entrepreneurial orientation have been associated with business sustainability, marketing performance, and competitiveness. These findings suggest that digital channels can become part of a firm's strategic capabilities for maintaining customer relationships, expanding markets, and strengthening competitive position (Munandar et al., 2025). Therefore, in this study, digital marketing is positioned as a business capability to use marketing technology to create and deliver value to the market more effectively.

Alongside innovation and marketing orientation, agribusiness competitiveness also needs to consider environmental sustainability. The dependence of agribusiness on natural resources makes input efficiency, waste reduction, resource management, and the adoption of environmentally friendly technologies important components of business strategy. Empirical evidence from agricultural enterprises shows that technology utilization can improve environmental performance through green product and process innovation. This suggests that economic and environmental performance are not necessarily conflicting objectives; rather, they can reinforce each other when environmental practices are integrated into innovation processes and corporate strategy (Lin et al., 2024).

Sustainability orientation is also increasingly relevant at the supply-chain level. A systematic review of 67 recent scientific publications in the agrifood industry shows that innovations such as precision farming, green technology, blockchain, the Internet of Things, and artificial intelligence can improve operational efficiency, traceability, resource management, food safety, and environmentally responsible practices. However, the success

of such transformation continues to depend on infrastructure readiness, human resource capacity, and collaboration among supply-chain actors (Astrima et al., 2025). Therefore, environmental sustainability should not be understood solely as ecological responsibility but also as a potential source of efficiency, differentiation, and business resilience.

Although previous literature has demonstrated the importance of innovation, digitalization, and sustainability, earlier studies have tended to examine these dimensions separately or in limited combinations. Annosi et al. (2024), for example, show that digital transformation has created a new competitive environment in agribusiness that requires strategic change, competency development, and the integration of economic, social, and environmental concerns. At the same time, their study highlights the need for a more integrated research agenda linking digital transformation and agribusiness sustainability. Research in Indonesia has also examined the effects of digital marketing and product innovation on sustainable business performance in agribusiness enterprises, but its primary focus remains on sustainable business performance and has not directly explained how business innovation, digital marketing, and environmental sustainability jointly shape agribusiness competitiveness (Fitri & Halik, 2023).

Based on this synthesis, three research gaps can be identified. First, previous studies have more frequently examined innovation, digital marketing, and environmental sustainability separately or in limited combinations. Second, relatively few studies have simultaneously positioned these three constructs as determinants of agribusiness competitiveness rather than merely business performance or business sustainability. Third, empirical evidence concerning the relationship among these three factors in the context of agribusiness in Bireuen Regency remains limited. This gap is important because a strong agricultural production base does not automatically guarantee the ability of business actors to create added value, expand markets, and sustain their businesses over time. Therefore, a model is needed to explain the internal and strategic factors that can transform production potential into business competitiveness.

The novelty of this study lies in the development of an agribusiness competitiveness model that simultaneously integrates business innovation, digital marketing, and environmental sustainability within the context of Bireuen Regency. The model does not treat technology merely as a tool but positions innovation, digital marketing capability, and environmental orientation as complementary capabilities that need to be developed in an

integrated manner. Theoretically, this study is grounded in the Resource-Based View (RBV) and dynamic capabilities perspectives. These perspectives are relevant because competitive advantage is determined not only by the ownership of resources but also by an organization's ability to recognize change, seize opportunities, and reconfigure resources in response to changes in the business environment. Recent studies in the agrifood sector also show that dynamic capabilities, particularly digital and analytical capabilities, help firms respond to digital transformation and exploit new opportunities more effectively (Ciasullo et al., 2026).

Based on these considerations, this study aims to analyze the effects of business innovation, digital marketing, and environmental sustainability on agribusiness competitiveness and to develop an empirical model of agribusiness competitiveness in Bireuen Regency. This study is expected to extend the literature on agribusiness competitiveness by integrating innovation capability, digital marketing capability, and sustainability orientation within a single analytical framework. Practically, the findings are expected to provide an empirical basis for agribusiness actors and local stakeholders in designing business development strategies that are more adaptive to market changes, better able to utilize digital technology, and more attentive to environmental sustainability.

METHODS

This study employed a quantitative approach with a cross-sectional survey design to examine the effects of business innovation, digital marketing, and environmental sustainability on agribusiness competitiveness. Data were collected at a single point in time and analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM). This method was selected because it is appropriate for examining relationships among latent constructs while simultaneously evaluating the explanatory and predictive capabilities of the endogenous construct (Hair & Alamer, 2022).

The study was conducted in Bireuen Regency, Aceh Province, Indonesia, in July 2026. The population consisted of agribusiness actors engaged in the production, processing, trading, or marketing of agricultural products. A total of 80 respondents were selected using purposive sampling. The respondent criteria were: (1) owners or managers of agribusiness enterprises operating in Bireuen Regency; (2) directly involved in business management or decision-making; (3) having operated the business for at least one year; and (4) willing to

participate in the study. These criteria were applied to ensure that the information was obtained from business actors with direct experience in the agribusiness activities being investigated.

The sample size of 80 respondents was determined by considering the structure of the model, which consisted of three predictor constructs and one endogenous construct, as well as statistical power requirements. Sample size determination in PLS-SEM should not rely solely on simple rules such as the 10-times rule but should also consider model complexity, data characteristics, predictive objectives, and statistical adequacy. Guenther et al. (2023) emphasized the importance of systematically justifying sample size and model evaluation in business research using PLS-SEM. With three predictors, a 5% significance level, 80% statistical power, and an assumed medium effect size ($f^2 = 0.15$), 80 respondents were retained as the final sample size.

Primary data were collected using a structured questionnaire developed based on the conceptual and operational definitions of each construct. The questionnaire consisted of two sections. The first section contained respondent and business characteristics, such as type of agribusiness activity and length of business operation. The second section contained statements measuring four research constructs: business innovation, digital marketing, environmental sustainability, and agribusiness competitiveness. All items were measured using a five-point Likert scale, ranging from 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, to 5 = strongly agree.

The business innovation construct measured the ability of agribusiness actors to introduce improvements in products, processes, services, and business management methods. The digital marketing construct measured the ability to use social media, e-commerce, digital promotion, and online communication to reach and retain customers. Environmental sustainability covered resource-use efficiency, waste reduction, environmentally friendly practices, and the management of business-related environmental impacts. Agribusiness competitiveness measured the ability of firms to create value, maintain their market position, respond to competition, expand market access, and sustain business continuity.

The quality of the measurement model was evaluated through the outer model. Internal consistency reliability was assessed using Cronbach's alpha and composite reliability, while convergent validity was evaluated using outer loadings and Average Variance Extracted

(AVE). Reliability values of **≥ 0.70** and AVE values of **≥ 0.50** were used as acceptance criteria. This evaluation approach is consistent with confirmatory composite analysis practices for assessing measurement quality in PLS-SEM (Hair et al., 2020).

Discriminant validity was assessed using the Heterotrait-Monotrait Ratio (HTMT). An HTMT value below 0.85 was used as a conservative criterion to indicate adequate discriminant validity among the constructs. The use of HTMT was based on its ability to detect discriminant validity problems that may not always be identified through traditional criteria such as the Fornell-Larcker criterion and cross-loadings (Henseler et al., 2015).

Data analysis was conducted using SmartPLS 4 in two stages. The first stage involved evaluating the measurement model through construct reliability and validity. The second stage involved evaluating the structural model through the assessment of the Variance Inflation Factor (VIF), path coefficients, coefficient of determination (R^2), effect size (f^2), and the model's predictive relevance. The structural model was evaluated comprehensively so that interpretation was not based solely on statistical significance but also on explanatory quality and predictive capability, as recommended in PLS-SEM applications in business research (Gudergan et al., 2025).

Hypothesis testing was conducted using a bootstrapping procedure to obtain path coefficients, t-statistics, p-values, and confidence intervals. Relationships between constructs were considered statistically significant at the 5% level ($p < 0.05$). In addition to statistical significance, the direction and magnitude of the path coefficients, R^2, and f^2 values were used to assess the relative contribution of each predictor to agribusiness competitiveness. The hypotheses tested included the effect of business innovation on agribusiness competitiveness, the effect of digital marketing on agribusiness competitiveness, and the effect of environmental sustainability on agribusiness competitiveness.

Before analysis, the data underwent editing, coding, screening, and cleaning procedures to ensure completeness and response consistency. Incomplete responses or responses that did not meet the research criteria were excluded from the analysis. Participation was voluntary after respondents received information about the purpose of the study. Respondent identities were kept confidential, and the research findings were reported in aggregate form for academic purposes.

RESULTS

Respondent Characteristics

The study involved 80 agribusiness actors in Bireuen Regency. The largest proportion of respondents was engaged in staple crop cultivation, with 22 respondents (27.50%), followed by agricultural product processing with 14 respondents (17.50%) and horticulture with 13 respondents (16.25%). Livestock/fisheries and agricultural product trading each accounted for 11 respondents (13.75%), while plantation businesses represented 9 respondents (11.25%). The respondents had been operating their businesses for between 2 and 21 years, with an average business duration of 6.59 years and a standard deviation of 3.50 years.

Table 1. Respondent Characteristics by Type of Agribusiness Activity

Type of agribusiness activity	Frequency	Percentage (%)
Staple crop cultivation	22	27.50
Horticulture	13	16.25
Plantation	9	11.25
Livestock/fisheries	11	13.75
Agricultural product processing	14	17.50
Agricultural product trading	11	13.75
Total	80	100.00

Table 1 shows that respondents represented a range of agribusiness activities in Bireuen Regency, with staple crop cultivation forming the largest group and plantation businesses the smallest group.

Descriptive Statistics of Research Constructs

Table 2. Descriptive Statistics of Research Constructs

Construct	Mean	SD
Business Innovation (X1)	3.731	0.632
Digital Marketing (X2)	3.353	0.664
Environmental Sustainability (X3)	3.847	0.695
Agribusiness Competitiveness (Y)	3.755	0.620
Construct	Mean	SD

Table 2 shows that environmental sustainability had the highest mean score, while digital marketing had the lowest. Specifically, environmental sustainability recorded a mean

of 3.847, followed by agribusiness competitiveness at 3.755, business innovation at 3.731, and digital marketing at 3.353.

Measurement Model Evaluation

The outer loading results indicate that all indicators had values above 0.70, ranging from 0.777 to 0.897. Therefore, all indicators were retained in the measurement model.

Table 3. Indicator Outer Loadings

Construct	Indicator	Outer Loading
Business Innovation	X1.1	0.792
	X1.2	0.782
	X1.3	0.853
	X1.4	0.814
Digital Marketing	X2.1	0.863
	X2.2	0.777
	X2.3	0.797
	X2.4	0.831
Environmental Sustainability	X3.1	0.897
	X3.2	0.890
	X3.3	0.865
	X3.4	0.840
Agribusiness Competitiveness	Y.1	0.808
	Y.2	0.777
	Y.3	0.839
	Y.4	0.808
	Y.5	0.808

Table 3 confirms that all indicators had outer loading values above 0.70, indicating that each indicator adequately reflected its respective construct.

Reliability and convergent validity were subsequently evaluated using Cronbach's alpha, composite reliability, and Average Variance Extracted (AVE).

Table 4. Reliability and Convergent Validity

Construct	Cronbach's Alpha	Composite Reliability	AVE	Decision
Business Innovation (X1)	0.826	0.885	0.658	Meets criteria
Digital Marketing (X2)	0.834	0.890	0.669	Meets criteria
Environmental Sustainability (X3)	0.897	0.928	0.763	Meets criteria
Agribusiness Competitiveness (Y)	0.865	0.904	0.653	Meets criteria

As shown in Table 4, all constructs met the criteria for internal consistency reliability and convergent validity. Cronbach's alpha and composite reliability values exceeded 0.70, while all AVE values were above 0.50.

Discriminant validity was evaluated using the Heterotrait-Monotrait Ratio (HTMT).

Table 5. Heterotrait-Monotrait Ratio (HTMT)

Construct	X1	X2	X3	Y
X1	—			
X2	0.211	—		
X3	0.325	0.413	—	
Y	0.501	0.494	0.564	—

The HTMT values ranged from 0.211 to 0.564, all of which were below 0.85. Thus, discriminant validity was established for all constructs.

Structural Model Evaluation

The structural model evaluation included collinearity, effect size, explanatory power, and predictive relevance.

Table 6. Structural Model Evaluation

Predictor	VIF	f^2	f^2 Category
Business Innovation (X1)	1.095	0.131	Small
Digital Marketing (X2)	1.155	0.092	Small
Environmental Sustainability (X3)	1.214	0.159	Medium

Table 6 shows that all VIF values range from 1.095 to 1.214, indicating no substantial collinearity among the predictor constructs. Based on the f^2 values, environmental sustainability has a medium effect size ($f^2 = 0.159$), while business innovation ($f^2 = 0.131$) and digital marketing ($f^2 = 0.092$) have small effect sizes.

Table 7. Explanatory and Predictive Power of the Structural Model

Model measure	Value
R^2	0.406
Adjusted R^2	0.382
Q^2predict	0.213

Table 7 shows that the structural model explains 40.6% of the variance in agribusiness competitiveness ($R^2 = 0.406$), with an adjusted R^2 of 0.382. The Q^2predict value of 0.213 is positive, indicating that the model has predictive relevance for agribusiness competitiveness.

Hypothesis Testing

Hypothesis testing was conducted using a bootstrapping procedure with 5,000 subsamples and a two-tailed test.

Table 8. Hypothesis Testing Results

Hypothesis	Relationship	β	t-statistic	p-value	95% CI	Decision
H1	Business Innovation → Agribusiness Competitiveness	0.292	3.088	0.003	0.121–0.489	Supported
H2	Digital Marketing → Agribusiness Competitiveness	0.251	2.686	0.009	0.065–0.432	Supported
H3	Environmental Sustainability → Agribusiness Competitiveness	0.339	4.395	<0.001	0.193–0.497	Supported

As shown in Table 8, business innovation had a positive and significant effect on agribusiness competitiveness ($\beta = 0.292$; $t = 3.088$; $p = 0.003$), supporting H1. Digital marketing also had a positive and significant effect on agribusiness competitiveness ($\beta = 0.251$; $t = 2.686$; $p = 0.009$), supporting H2. Environmental sustainability had a positive and significant effect on agribusiness competitiveness ($\beta = 0.339$; $t = 4.395$; $p < 0.001$), supporting H3.

All 95% confidence intervals excluded zero. Among the three predictors, environmental sustainability had the largest path coefficient, followed by business innovation and digital marketing. Overall, the measurement model met the required reliability, convergent validity, and discriminant validity criteria, while the structural model showed no substantial collinearity problems and demonstrated positive predictive relevance.

DISCUSSION

The results show that business innovation, digital marketing, and environmental sustainability have positive and significant effects on agribusiness competitiveness in Bireuen Regency. Together, the three constructs explain 40.6% of the variance in agribusiness competitiveness. Among them, environmental sustainability has the largest path coefficient, followed by business innovation and digital marketing. These findings indicate that agribusiness competitiveness is determined not only by the ability to produce and market products but also by the capacity of business actors to renew business practices, utilize technology, and manage resources more sustainably. This result is consistent with Vahdanjoo et al. (2025), who show that digital transformation and sustainability pressures have reshaped

the competitive environment in the agri-food sector and require more adaptive competencies and strategies.

The positive effect of business innovation on agribusiness competitiveness indicates that the ability to improve products, processes, services, and business management methods can help agribusiness actors respond more effectively to market changes. Innovation enables firms to create added value, improve efficiency, and differentiate their products from competitors. In the context of Bireuen, this capability is particularly important because increased production does not automatically lead to a stronger market position without improvements in the way products are developed and marketed. This finding is consistent with Sulemana et al. (2026), who found that entrepreneurial innovation and absorptive capacity can strengthen business competitiveness. The result also supports the view that competitive advantage develops when firms are able to use and renew their resources in response to changes in the business environment.

Digital marketing also has a positive and significant effect on agribusiness competitiveness, although its path coefficient is smaller than those of the other two predictors. The use of social media, e-commerce, digital promotion, and online communication helps business actors expand market reach, increase product visibility, and build more direct relationships with consumers. However, its relatively smaller contribution may be associated with the uneven ability of business actors to utilize digital technology optimally. Yelfiarita et al. (2025) show that digital marketing can expand markets and increase the value of agricultural products, although its effectiveness remains influenced by digital literacy, infrastructure, and technical assistance. Therefore, strengthening competitiveness through digital marketing requires strategic capabilities in managing platforms, content, and customer relationships rather than merely establishing a presence in digital media (Wulandari et al., 2026).

The finding that environmental sustainability has the largest path coefficient indicates that resource efficiency, waste reduction, and environmentally friendly business practices are closely associated with agribusiness competitiveness. Sustainability practices can help firms reduce resource waste, improve efficiency, and create greater product value (Myshko et al., 2024). This finding is in line with Fülöp (2025), who shows that sustainability-related factors are associated with competitiveness and marketing performance among SMEs. In the broader agri-food context, Paredes-Rodríguez et al. (2024) also show that innovation and

technology can support operational efficiency, traceability, and more sustainable supply-chain management. Thus, environmental sustainability can be understood not only as an ecological responsibility but also as part of a strategy to strengthen business efficiency and resilience (Cao & Tang, 2025).

Theoretically, the findings support the idea that agribusiness competitiveness is shaped by a combination of complementary capabilities. Business innovation enables the renewal of business activities, digital marketing strengthens the ability to reach and respond to markets, while environmental sustainability supports long-term efficiency and business resilience. This pattern is consistent with the Resource-Based View and dynamic capabilities perspectives, which emphasize the importance of firms' ability to develop and reconfigure resources when the business environment changes. Wang and Zhang (2025) show that digital transformation can strengthen innovation capabilities and business performance, while Wijayanto et al. (2024) found that digital marketing and related digital capabilities are associated with market reach and competitiveness among Indonesian MSMEs. The present study extends these findings by demonstrating that business innovation, digital marketing, and environmental sustainability can be positioned simultaneously as determinants of agribusiness competitiveness in a regional context.

From a practical perspective, strengthening agribusiness competitiveness in Bireuen Regency should be directed toward the integrated development of innovation capacity, digital marketing skills, and sustainable business practices. Agribusiness actors should be encouraged to differentiate their products, improve the use of digital platforms, and adopt more efficient resource-management practices. Local governments and business-support institutions can contribute through innovation training, digital literacy programs, branding development, improved access to technology, and assistance in implementing sustainable agribusiness practices.

This study has several limitations. It involved only 80 agribusiness actors in Bireuen Regency and employed a cross-sectional design. In addition, the R^2 value of 0.406 indicates that other factors outside the model may also explain agribusiness competitiveness. Future studies may therefore expand the geographical coverage and sample size, apply a longitudinal design, and consider additional variables such as market orientation, access to finance, human resource capability, institutional support, and digital capability.

CONCLUSION

This study demonstrates that business innovation, digital marketing, and environmental sustainability have positive and significant effects on agribusiness competitiveness in Bireuen Regency. Together, the three constructs explain 40.6% of the variance in agribusiness competitiveness, with environmental sustainability showing the strongest relationship. These findings indicate that improving agribusiness competitiveness depends not only on production and marketing capabilities but also on the ability of business actors to innovate, utilize digital technologies, and implement sustainable business practices.

The contribution of this study lies in the development of an agribusiness competitiveness model that integrates business innovation, digital marketing, and environmental sustainability within a single empirical framework. From a practical perspective, the findings can provide a basis for agribusiness actors and local stakeholders to strengthen innovation, improve digital marketing capabilities, and promote more efficient and environmentally responsible agribusiness practices.

Future research is recommended to expand the geographical coverage and sample size, employ longitudinal research designs, and consider additional variables such as market orientation, access to finance, digital capability, human resource quality, and institutional support.

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