Tarjih: Agribusiness Development Journal. Volume 06 Number 01 (2026) Page: 102 – 107
DOI: https://doi.org/10.47030/tadj.v6i01.1144

e-ISSN: 2798 - 0782
Tarjih: Agribusiness Development Journal
Journal Homepage: https://jurnal-umsi.ac.id/index.php/agribisnis

Determinants of Farm Income in Integrated Rice–Beef Cattle Farming Systems in Kahu District, Bone Regency

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Received : June 14, 2026
Revised : June 21, 2026
Accepted: June 27, 2026

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ABSTRACT

Integrated rice–beef cattle farming systems are promoted as a sustainable agricultural strategy to improve resource-use efficiency and enhance farmers' income through the integration of crop and livestock enterprises. However, empirical evidence regarding the determinants of farm income in integrated farming systems remains limited at the local level. This study aimed to analyze the effects of land area, production costs, and labor on farm income in integrated rice–beef cattle farming systems in Kahu District, Bone Regency. A quantitative cross-sectional survey was conducted from January to April 2025 involving 68 integrated farmers selected through simple random sampling. Data were analyzed using a log-linear multiple regression model estimated by Ordinary Least Squares (OLS). The results showed that land area had a positive and significant effect on farm income ($\beta = 0.614$; $p < 0.001$), while production costs ($\beta = 0.115$; $p = 0.550$) and labor ($\beta = 0.048$; $p = 0.800$) had positive but statistically insignificant effects. Simultaneously, all explanatory variables significantly affected farm income ($F = 28.686$; $p < 0.001$), with the model explaining 57.3% of the variation in farm income ($R^2 = 0.573$). These findings indicate that farm scale remains the dominant determinant of income in integrated farming systems. Policies supporting land optimization, integrated farming management, and resource-use efficiency are needed to strengthen the sustainability of smallholder farmers' income.

Keywords: *Farm Income, Integrated Farming, Resource Allocation, Rice–Beef Cattle System*

INTRODUCTION

The transformation of agricultural systems toward more efficient and sustainable models has become increasingly urgent amid resource constraints and volatile commodity prices. Monoculture farming systems tend to be vulnerable to production and market risks, thereby necessitating integrative approaches capable of enhancing efficiency while stabilizing farmers' incomes. One emerging strategy is the integrated crop–livestock farming system, which combines crop production and livestock enterprises within a unified management framework. The integration of rice and beef cattle offers strong synergistic potential. Rice straw may serve as livestock feed, while cattle manure can be utilized as organic fertilizer for paddy fields. This interaction creates a closed production cycle (circular farming) that reduces external input dependency and improves resource allocation efficiency. Theoretically, integrated systems enhance farm income through revenue diversification and cost reduction associated with external inputs.

Increasing farm size has a positive impact on farmers' net profits, as well as economic, technical, and labor efficiency (Ren et al, 2019). increasing the area of agricultural land and/or intensifying production is necessary so that small farmers can earn a decent living income from agriculture (Zailan, 2020) (Hikmah et al, 2024) Strong positive relationship between farm size and productivity (Muyanga & Jayne, 2019). The sustainability perspective states that smaller farms, on average, have higher crop yields and have greater plant and non-crop biodiversity at

farm and landscape scales than larger farms (Ricciardi et al., 2021). Research (Novitri & Ketut, 2020) The variables of land area, seed price, wages, and sapling price have a significant impact, while the variables of nitrogen and phosphorus fertilizer prices do not significantly affect the production costs of integrated rice and livestock farming.

The integration of food crops, horticulture, dairy farming, goat farming, poultry farming, vermicompost production, vegetable gardens, and border planting increases net profits, the B:C ratio, job creation, food security, and the livelihoods of small and marginal farmers (Shanmugam et al., 2024). The integrated farming system through the SMD Program in the Sepakat Livestock Farmers Group has implemented integration between rice farming and livestock farming funded by the SMD Program (Nasution et al., 2024) The contribution and policy resulting from these findings is that integrated farming systems can be developed to increase farmers' income, produce competitive agricultural products, and conserve natural resources (Novitri et al., 2023).

Research (Mukhlis et al., 2019) regarding rice-cattle integration system farming (RCIS) is a farming system that integrates rice plants with livestock that have a reciprocal relationship, rice plants provide straw and bran as animal feed and animal feed produces feces as organic fertilizer for rice plants, thereby increasing production, productivity, and farmer income. The conclusion of this study is that the larger the scale of the RCIS farming business, the greater the RCIS income and the more feasible the RCIS farming. Research (Thaal et al., 2022) shows that rice and corn agricultural waste can help provide animal feed for 4 cows/year. Research (Fyka et al., 2024) There is a difference in income between farmers who apply an integrated rice paddy and livestock system with conventional rice paddy farmers, namely farmers who apply an integrated rice paddy and livestock system obtain an average income of IDR 41,047,139/ha/year.

Research (Ambarwati et al., 2022) (Mahmud et al., 2022) land area, and labor simultaneously have a significant influence on farmers' income. Research (Kadir, 2020) Integrated farming contributes to the interconnectedness of subsystems through the flow of inputs and outputs between crops and livestock. Integrated livestock farming can contribute to income generation, as evidenced by a reduction in business output, thus increasing household income. Research (Listiani et al., 2020) Factors that influence rice farmers' income are land and labor costs. In line with research (Klau et al., 2025) Land area, seeds, and fertilizer have a positive and significant effect on rice production, while labor and farming experience are not significant.

Despite these findings, previous studies generally examined rice and livestock farming separately. Empirical investigations specifically addressing the determinants of income in integrated rice–beef cattle systems at the sub-district level remain limited, particularly in Bone Regency. Kahu District possesses considerable potential for integration due to its adequate paddy land area and livestock population. However, the effectiveness of integration in increasing farmers' income has not been comprehensively examined. Previous studies on integrated crop–livestock farming systems generally emphasize three major themes. First, integrated farming contributes to resource-use efficiency, environmental sustainability, and agricultural productivity through the recycling of agricultural by-products and reduced dependence on external inputs (Shanmugam et al., 2024). Second, integrated farming systems have been reported to improve farmers' income and economic resilience through income diversification and better utilization of local resources (Kadir, 2020; Novitri et al., 2023; Fyka et al., 2024). Third, studies on agricultural production economics indicate that land area, labor, and production inputs are important determinants of productivity and farm income (Muyanga & Jayne, 2019; Ambarwati et al., 2022; Mahmud et al., 2022; Fyka, 2022).

Despite these contributions, empirical studies specifically examining the determinants of farm income within integrated rice–beef cattle farming systems remain limited. Most previous studies focus on income comparison, feasibility analysis, or the general benefits of integrated farming systems. Very few studies estimate the relative contribution and elasticity of production factors in determining farm income within integrated farming systems at the local level. Consequently, evidence regarding the dominant production factors influencing farmers' income in integrated rice–beef cattle farming systems remains insufficient.

The novelty of this study lies in the application of a log-linear regression approach to estimate the elasticity of farm income with respect to land area, production costs, and labor within integrated rice–beef cattle farming systems. Unlike previous studies that primarily focused on comparative income analysis, this study identifies the relative contribution of key production factors to farm income at the farm-household level in Kahu District, Bone Regency.

This study aims to analyze the effects of production costs, land area, and labor on the income of integrated rice–beef cattle farming in Kahu District, both partially and simultaneously. Furthermore, this study identifies the most dominant production factor determining farm income. The novelty of this research lies in the application of an econometric approach to evaluate income determinants within a locally implemented integrated crop–livestock system, as well as in assessing production factor efficiency within a sustainable agriculture framework.

Research Hypotheses

H1: Land area positively and significantly affects farm income.

H2: Production costs positively and significantly affect farm income.
H3: Labor positively and significantly affects farm income.
H4: Land area, production costs, and labor simultaneously affect farm income.

RESEARCH METHODS

This study employed a quantitative approach using a survey method. The research site was purposively selected in Kahu District, Bone Regency, due to its potential for rice–beef cattle integration. The study population comprised all farmers implementing integrated rice–beef cattle farming systems. The sample size was determined using the Slovin formula with a 5% margin of error and selected through simple random sampling. Farm income was calculated as the difference between total revenue and total production costs. The analytical model employed was a log-linear multiple regression model to obtain elasticity interpretations:

$$\ln Y = a + b_1X_1 + b_2X_2 + b_3X_3$$

Where:
Y = Farm income
X_1 = Land area
X_2 = Production costs
X_3 = Labor

The model was evaluated using classical assumption tests (normality, multicollinearity, heteroscedasticity, and autocorrelation), followed by t-tests, F-tests, and the coefficient of determination (R^2).

Tablel 1. Operational Definition of Variables

Variable	Definition	Unit
Farm Income (Y)	Net income from integrated rice and beef cattle farming per production cycle	IDR
Land Area (X1)	Total cultivated paddy field area	ha
Production Cost (X2)	Total production expenditure incurred during one production cycle	IDR
Labor (X3)	Total labor used in rice and cattle farming activities	HOK

Data collection was conducted from January to April 2025 involving 68 integrated farmers selected through simple random sampling.

RESULT AND DISCUSSION

Classical Assumption Tests

The normality test indicates that residuals are normally distributed. The multicollinearity test shows that no independent variable has a tolerance value below 0.10 or a Variance Inflation Factor (VIF) exceeding 10, indicating the absence of multicollinearity. The heteroscedasticity test demonstrates no systematic pattern in the scatterplot, confirming homoscedastic residuals.

Multiple Linear Regression Analysis

The estimated regression equation is as follows:

$$\ln Y = 16.171 + 0.614X_1 + 0.115X_2 + 0.048X_3$$

The interpretation of the coefficients is as follows:

1. The constant value of 16.171 indicates the expected farm income when all independent variables are held constant.
2. The coefficient of land area (0.614) implies that a 1% increase in land area leads to a 0.614% increase in farm income, ceteris paribus.
3. The coefficient of production costs (0.115) indicates that a 1% increase in production costs results in a 0.115% increase in farm income, holding other factors constant.

4. The coefficient of labor (0.048) suggests that a 1% increase in labor input raises farm income by 0.048%, ceteris paribus.

Effect of Land Area on Farm Income

Land area emerged as the most influential production factor because larger farms provide greater opportunities for production expansion and resource integration. In integrated rice–beef cattle farming systems, larger paddy fields generate more rice straw that can be utilized as livestock feed, while larger livestock enterprises produce more manure that can be recycled as organic fertilizer. This reciprocal relationship strengthens biological integration and improves resource-use efficiency. The result supports the theory of economies of scale, which suggests that larger production units tend to achieve higher productivity and profitability through better allocation of production resources. Similar findings were reported by Muyanga and Jayne (2019) and Ambarwati et al. (2022), who found that farm size significantly contributes to agricultural income and productivity.

Effect of Production Cost on Farm Income

The insignificant effect of production costs indicates that higher expenditures do not automatically generate higher income. This condition suggests the presence of allocative inefficiency among farmers. Several respondents continued to depend on external inputs, such as chemical fertilizers and commercial feed, despite the availability of internal resources derived from integrated farming practices. Consequently, increased expenditures were not always accompanied by proportional increases in output and income. This finding supports the argument that production efficiency is often more important than input intensity in determining farm profitability.

Effect of Labor on Farm Income

The insignificant effect of labor indicates that additional labor utilization did not substantially improve farm income. Most respondents relied heavily on family labor, which reduced measurable labor productivity. Furthermore, integrated rice–beef cattle farming in the study area remains dominated by traditional management practices with limited technological innovation. This condition reflects the phenomenon of disguised unemployment commonly found in smallholder agriculture, where additional labor inputs do not necessarily increase output or profitability.

Partial Test (t-Test)

The t-test results reveal that:

- Land area significantly affects farm income ($p < 0.05$).
- Production costs do not significantly affect farm income ($p > 0.05$).
- Labor does not significantly affect farm income ($p > 0.05$).

These findings suggest that land area plays a more critical role in determining income compared to production costs and labor within the integrated farming context.

Simultaneous Test (F-Test)

The F-test results indicate that land area, production costs, and labor simultaneously have a statistically significant effect on farm income ($p < 0.05$).

Coefficient of Determination (R^2)

The R^2 value of 0.573 indicates that 57.3% of the variation in farm income is explained by land area, production costs, and labor. The remaining 42.7% is influenced by other variables not included in the model.

Policy Implications

The findings imply that policies aimed at improving farm income should focus primarily on strengthening farm scale and resource-use efficiency. Local governments may encourage land consolidation programs, optimize the utilization of agricultural by-products, and strengthen integrated crop–livestock farming development. Agricultural extension services should prioritize technical training on manure processing, rice straw utilization, and integrated farm management to improve production efficiency and reduce dependence on external inputs. Furthermore, support for sustainable agricultural technologies may enhance the economic and environmental performance of integrated farming systems.

CONCLUSION

The integrated rice–beef cattle farming system in Kahu District contributes positively to farmers' income through the integration of crop and livestock resources. Land area was identified as the dominant determinant of farm income, whereas production costs and labor exhibited positive but statistically insignificant effects. These findings indicate that improving farm scale and resource-use efficiency is more important than merely increasing input use. Therefore, policies supporting land optimization, integrated farming development, and efficient resource management are essential for enhancing the sustainability of smallholder farmers' income. Future studies should incorporate technical efficiency and economic feasibility analyses to provide a more comprehensive assessment of integrated farming performance

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