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Linking financial support and technological innovation to farm income: A case of duck farmers in Central Java, Indonesia

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ABSTRACT

This study investigated the effects of multiple factors including age, access to credit, technology utilization, cultivation patterns, feed quality, business sustainability, cage area, flock size, and veterinary inputs on the income of duck farmers in Brebes Regency, Central Java, Indonesia. Research was conducted in purposively selected sub-districts within Brebes Regency that are known for active duck farming operations and high population density. A total of 350 duck farmers were surveyed using purposive sampling through structured, close-ended questionnaires, complemented by on-farm observations and interviews. Primary data were collected on demographic profiles, farm characteristics, and production practices, while secondary data were obtained from local agricultural offices. Data were analyzed using descriptive statistics, one-sample t-tests, and multiple linear regression, preceded by normality and classical assumption tests. The results show that access to credit, technology utilization, cage area, and flock size significantly and positively influence income ($p < 0.05$), while feed, medicines, and age were statistically not significant. Notably, cultivation pattern and sustainability practices had significant but negative associations with income, suggesting short term inefficiencies or implementation gaps. The model demonstrated strong explanatory power with an adjusted R^2 of 0.948. These findings emphasize the critical role of financial access, digital tools, and farm-scale improvements in enhancing income. Unlike prior studies that focused on isolated variables, this research provides a comprehensive, multi-factor analysis of income determinants in tropical duck farming systems, offering valuable insights for evidence-based rural development policies.

Introduction

Duck farming plays an increasingly strategic role in supporting food and economic security, particularly in tropical countries like Indonesia. As a source of affordable animal protein and rural livelihood, duck production offers significant potential to enhance food resilience, improve nutrition, and stimulate local economies. According to the Central Bureau of Statistics (BPS, 2022), the livestock sub-sector contributed 12.40% to Indonesia's agricultural GDP and 1.52% to the national GDP. Among livestock commodities, ducks are well adapted to diverse ecological conditions and demonstrate high feed efficiency and disease resistance. Central Java ranks third in total duck population nationally, with Brebes Regency leading the province with 49,834 ducks (BPS, 2021). Its strategic location and strong tradition in duck farming make it an ideal area for studying income-related factors in poultry production. However, despite the high production volume, the income levels of duck farmers remain highly variable. This raises questions about which technological, financial, or managerial factors truly drive income in the sector.

While previous studies have examined individual factors such as feed, technology, or credit in isolation, limited research has holistically analyzed their combined impact on duck farmers' income in tropical settings. A recent study in the same region showed that mobile phone use and credit access positively affected farm revenue yet lacked consideration of structural and environmental factors (Santoso *et al*., 2025). Understanding these relationships is crucial for designing effective policy interventions and enhancing farmers' income. Numerous studies have emphasized the importance of financial access and technological adoption in improving agricultural productivity and income (Mariyono, 2019; Negoro *et al*., 2018; Andrianto and Firmansyah, 2019). In poultry production, access to credit enables investment in quality feed, modern equipment, and improved housing, while technology enhances efficiency, market connectivity, and disease control. Moreover, the use of mobile phones has been shown to facilitate access to microcredit and improve marketing and planning strategies (Mariyono *et al*., 2021; Negoro and Mariyono, 2014).

Other factors such as cultivation patterns, sustainable business practices, and the use of medicines also influence production outcomes. Ducks raised in supportive environments show better growth and feed conversion efficiency (Hoque *et al*., 2010; Pham *et al*., 2021). Balanced feed enhances production and final product quality (Santoso *et al*., 2017). Age can influence farmers' openness to innovation or capacity for physical labor, with younger farmers often more adaptable to new technologies (Baba *et al*., 2023; Saputra *et al*., 2023). Medicines can enhance income by preventing disease and increasing egg production (Sani and Sinaga, 2023). Furthermore, access to credit supports equipment investment, land management, and business diversification (Farera and Meirini, 2023; Gaol, 2023), while sustainable practices contribute to long term income through waste management, certification, and ecological benefits (Hasibuan, 2023).

However, most existing studies tend to examine these variables in isolation, overlooking the potential interrelationships among financial, technological, managerial, and structural dimensions. Few have comprehensively analyzed how these factors collectively influence income generation in duck farming, particularly within semi-intensive or traditional systems prevalent in tropical countries. Therefore, this study aims to analyze the combined effects of financial access, technology adoption, production practices, structural capacity, and environmental sustainability on duck farmers' income. By capturing these interactions through an integrated analytical model, the research contributes to a more nuanced understanding of income dynamics in tropical poultry systems. Given the central role of rural livelihoods in national development, the findings are expected to inform evidence-based strategies and policies that not only enhance farm level income and resilience but also directly support the achievement of Sustainable Development Goals, particularly SDG 1 (No Poverty) and SDG 2 (Zero Hunger).

Materials and methods

This study employed a quantitative approach using purposive sam-

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pling in Brebes Regency, Central Java, Indonesia, a key center for duck farming. The research focused on three purposively selected sub-districts Larangan, Wanasari, and Losari, chosen for their active duck farming operations, high duck population density, and accessibility for data collection (Sugiyono, 2010). A total of 350 duck farmers were selected as respondents using a purposive sampling approach with proportional allocation based on duck population in each sub-district Larangan (120 farmers), Wanasari (115 farmers), and Losari (115 farmers). Data collection methods included direct on farm observations and structured, close ended interviews with farmers.

Primary data encompassed demographic profiles, farm characteristics, and production practices. Secondary data were sourced from local government agricultural offices and official statistics. It is important to distinguish income from profitability and revenue. Income refers to the net monthly earnings from duck farming, while profitability generally relates to profit ratios, and revenue indicates total sales without deducting costs. The dependent variable in this study was monthly income (Y) of duck farmers, measured in Indonesian Rupiah (IDR), Income is defined as the net monthly earnings obtained from duck farming activities, calculated as total revenue minus production costs. The independent variables and their operational measurements were as follows Likert scale variables were validated using item total correlation and reliability was confirmed with Cronbach's Alpha (threshold ≥ 0.70) (Nunnally and Bernstein, 1994).

Statistical analysis

Data analysis included descriptive statistics, one sample t-test to compare income with the regional minimum wage (UMR), and multiple linear regression to identify the influence of independent variables on income. Classical assumption tests were conducted: normality (Kolmogorov-Smirnov), multicollinearity (VIF and Tolerance), and heteroscedasticity (scatterplot method) (Ghozali, 2006).

Multicollinearity occurs when independent variables in a regression model are highly correlated with each other, which can distort the estimation of regression coefficients and weaken the model's explanatory power. To detect multicollinearity, this study uses the Variance Inflation Factor (VIF) and Tolerance values as diagnostic indicators, following thresholds recommended by Ghozali (2006) and Santoso (2002), where a VIF value less than 10 and a Tolerance value greater than 0.10 indicate the absence of multicollinearity.

Heteroscedasticity refers to the condition where the variance of residuals is not constant across observations, which violates one of the key assumptions of ordinary least squares regression. To detect this, a scatterplot of standardized residuals versus standardized predicted values is analyzed (Santoso, 2002).

Results

The respondents in this study were households engaged in duck farming in Brebes Regency. Data on respondent characteristics included name, gender, age, Primary Occupation, highest educational attainment, and farming experience. The respondent population in Brebes Regency was predominantly male. The majority of duck farmers were aged between 41 and 50 years, accounting for 27% of the total respondents. This age group is considered to be in a productive stage of life, and the data suggest that individuals within this range are well positioned to carry out the physical and managerial demands of duck farming, including breeding activities. The detailed socio-demographic characteristics of the respondents are presented in Table 2.

Table 2 shows that the majority of duck farmers in Brebes Regency have low levels of education, with 45% having completed only elementary school and 16% having no formal education. In addition, the data reveal that 99.4% of respondents identified animal husbandry as their primary occupation, indicating that duck farming serves as the main source of livelihood for most households in the area. This suggests that livestock-based enterprises, particularly duck farming, are perceived as more economically viable than other occupations. The majority of respondents (86%) were engaged in egg laying duck farming, while only 1% focused on meat duck production. The remaining 13% managed mixed duck farming operations, involving both egg and meat production. This dominance of egg laying duck farming suggests a preference for enterprises that offer more consistent income streams, reflecting both market demand and the relative stability of egg production compared to meat duck farming.

In addition to basic demographic data, this study also collected detailed information on key variables affecting duck farming income. Technology utilization referred to the use of mobile phones, agricultural applications, and social media platforms for accessing market information, veterinary services, or weather forecasts. Access to credit encompassed both formal loans from banks and informal borrowing from cooperatives or peer groups. Business sustainability involved practices such as using local feed resources, recycling farm waste, and adopting environmentally friendly farming methods. The number of livestock referred to the total number of productive ducks currently raised for either egg or meat purposes. These contextual definitions provide a practical understanding of how each variable manifests in the daily operations of the duck farmers.

Table 1. Operational Definition of Variables.

Variable Code	Variable Name	Measurement Unit / Scale	Operational Definition
Y	Income	Indonesian Rupiah (IDR/month)	Total monthly income generated from duck farming activities.
X1	Age	Years	Age of the respondent at the time of data collection.
X2	Access to Credit	Binary (1 = Yes, 0 = No); Amount in IDR	Whether the farmer has access to formal/informal credit, and total amount received.
X3	Technology Utilization	5 point Likert scale 1=Never, 2=Rarely, 3=Sometimes, 4=Often, 5=Very Often	Frequency of using technology (e.g., mobile phones, applications) in farm management.
X4	Cultivation Pattern	Nominal score (1 = monoculture, 2 = integrated)	Type of duck farming system used, such as monoculture or integrated with rice/fish farming.
X5	Feed Usage	Kilograms per day	Total amount of feed used per day for duck farming.
X6	Business Sustainability	5 point Likert scale 1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree	Implementation of sustainable practices (e.g., waste management, local feed sourcing).
X7	Cage Area	Square meters (m^2)	Total floor area of duck housing or enclosures.
X8	Number of Ducks	Units (birds)	Total number of ducks raised by each farmer.
X9	Medicine Expenditure	Indonesian Rupiah (IDR/month)	Monthly expenditure on veterinary medicines or treatments for duck health.

Net monthly income was calculated as the total monthly revenue from duck product sales (eggs and/or meat) minus all production costs, including feed, medicine, labor, and operational expenses. This reflects the net profit farmers earn from duck farming each month.

Table 2. Characteristics of Respondents.

No	Aspect	Category	n	%
1	Gender	Male	337	96
		Female	13	4
2	Age (years)	21–30	78	22
		31–40	70	20
		41–50	94	27
		51–60	60	17
		> 60	48	14
3	Education Level	No School	57	16
		Elementary School	157	45
		Junior High School	58	17
		Senior High School	54	15
		Diploma	3	1
		Undergraduate	21	6
4	Primary Occupation	Animal Husbandry	348	99.4
		Civil Servant	1	0.3
		Private Company	1	0.3
5	Experience (years)	0–5	47	13
		6–10	57	16
		11–15	67	19
		16–20	69	20
		21–25	43	12
		26–30	45	13
		> 30	22	6

Table 3. One-Sample t-Test of Duck Farmers' Income Compared to Regional Minimum Wage (UMR) in Brebes Regency.

Indicator	Value
Average Monthly Income (IDR)	2,456,525
Regional Minimum Wage (IDR)	2,018,837
p-value (Sig. 2-tailed)	0
95% Confidence Interval	247,586 – 627,791

As presented in Table 4, the average monthly income of duck farmers in Brebes Regency is IDR 2,456,525. To assess whether this income level significantly exceeds the regional minimum wage (UMR) of IDR 2,018,837 (as stipulated in 2023), a one-sample t-test was conducted. The results show a t-value of 4.528 with a significance level of 0.000 ($p < 0.05$), indicating a statistically significant difference between the average income of duck farmers and the UMR. The 95% confidence interval for the income difference ranges from IDR 247,586 to IDR 627,791, confirming that the income of duck farmers is not only higher than the minimum wage but also reliably so. This finding suggests that duck farming provides a viable and potentially superior source of income compared to general employment in the region, reinforcing its role as an economically sustainable livelihood in rural Brebes.

Classical Assumption Test

Multicollinearity test

Based on the results, all VIF values are well below 10, and all Tolerance values exceed 0.1, this confirms that the regression model is free from multicollinearity issues.

Table 4. Multicollinearity Test (VIF and Tolerance).

Variable	Tolerance	VIF	Conclusion
Age (X1)	0.95	1.06	No multicollinearity
Credit (X2)	0.94	1.07	No multicollinearity
Technology (X3)	0.78	1.28	No multicollinearity
Cultivation Pattern (X4)	0.81	1.23	No multicollinearity
Feed (X5)	0.56	1.78	No multicollinearity
Business Sustainability (X6)	0.54	1.86	No multicollinearity
Enclosure Area (X7)	0.84	1.19	No multicollinearity
Number of Ducks (X8)	0.94	1.06	No multicollinearity
Medicines (X9)	0.91	1.11	No multicollinearity

Heteroscedasticity test

Fig. 1. illustrates the distribution of standardized residuals and predicted values. While the residuals are distributed on both sides of the zero line, the presence of two visually distinct clusters suggests potential data segmentation or non-linearity within certain subgroups. Although no clear systematic pattern is visible, further diagnostic testing is recommended to validate the assumption of homoscedasticity.

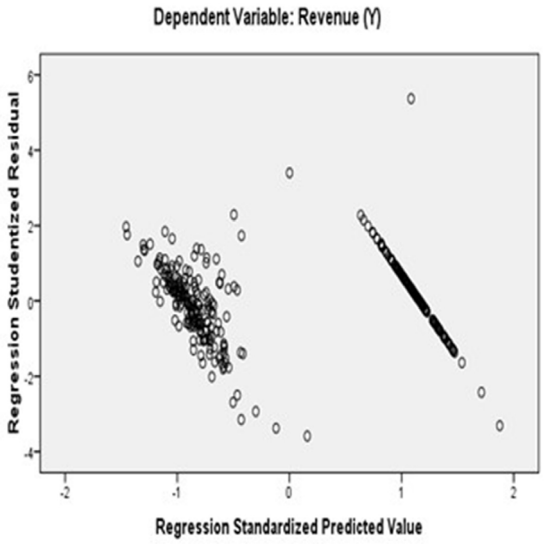

Fig. 1. Scatter Plot.

Multiple linear regression analysis

Based on multiple regression calculations between Age (X1), Credit (X2), Technology (X3), Cultivation Pattern (X4), Feed (X5), Business Sustainability (X6), Enclosure Area (X7), Number of ducks (X8), Medicines (X9), on net monthly income (Y) of duck farmers, with the help of the SPSS program in its calculations the following results can be obtained. Based on the regression output, variables such as Credit (X2), Technology (X3), Cultivation Pattern (X4), Business Sustainability (X6), Enclosure Area (X7), and Number of Ducks (X8) have a statistically significant effect on income, with p-values < 0.05. In contrast, Age (X1), Feed (X5), and Medicines (X9) are not statistically significant predictors of income, as their significance values exceed the 0.05 threshold.

The regression equation derived from the model is as follows:

$Y = 3{,}226{,}000 + 0.000X_1 + 0.062X_2 + 0.065X_3 - 0.041X_4 - 0.027X_5 - 0.917X_6 + 0.043X_7 + 0.134X_8 - 0.008X_9$

Where:

Y = Farmer's income

X1 = Age
X2 = Credit access
X3 = Technology adoption
X4 = Cultivation pattern
X5 = Feed
X6 = Business sustainability
X7 = Enclosure area
X8 = Number of ducks
X9 = Medicines

The multiple linear regression analysis revealed that six variables significantly influenced farmers' income ($p < 0.05$) credit access, technology utilization, cultivation pattern, business sustainability, enclosure area, and number of ducks.

Meanwhile, age, feed usage, and veterinary medicines were not significant predictors. Overall, the high adjusted R^2 of 0.948 suggests a robust model, underscoring the importance of structural, financial, and technological factors in shaping income within tropical duck farming systems.

Coefficient of determination

To assess the extent to which the independent variables Age (X_1), Credit (X_2), Technology (X_3), Cultivation Pattern (X_4), Feed (X_5), Business Sustainability (X_6), Enclosure Area (X_7), Number of Ducks (X_8), and Medicines (X_9) influence farmers' income, the value of the Adjusted R Square is examined.

The adjusted R^2 value of 0.948 indicates that approximately 94.8% of the variation in farmers' income can be explained by the combined influence of the nine independent variables included in the model. The remaining 5.2% is attributable to other factors not captured in this study. This high value suggests that the model has strong explanatory power and provides a robust estimation of the determinants of income among duck farmers in Brebes Regency.

Discussion

The regression results reveal that access to credit (X2), technology utilization (X3), cage area (X7), and number of ducks (X8) significantly and positively affect the income of duck farmers in Brebes Regency. These findings confirm the pivotal role of financial and technological inputs in enhancing productivity and income, in line with Santoso *et al.* (2025), who emphasized the importance of mobile tools and credit access in rural poultry systems. Unlike prior studies that focused primarily on digital-financial variables, the present research integrates structural and environmental dimensions, offering a more comprehensive analytical model. The positive impact of cage area and flock size supports the view that structural capacity and scale economies are critical for increasing farm income (Pham *et al.*, 2021; Hoque *et al.*, 2010). Access to credit enables investment in infrastructure and input quality (Mariyono, 2019), while technology adoption improves information access and operational efficiency (Negoro *et al.*, 2018; Andrianto and Firmansyah, 2019). Together, these findings suggest that income generation is not solely a function of input use but also of how farms are equipped and managed.

Interestingly, cultivation pattern (X4) and business sustainability (X6) exhibit significant but negative relationships with income. This may reflect short-term inefficiencies, higher implementation costs, or a lack of immediate returns from sustainable or integrated practices (Hasibuan, 2023). These models may prove beneficial in the long term, but currently present adoption challenges due to insufficient technical support or incentive structures. In contrast, age (X1), feed (X5), and medicines (X9) were found to be statistically insignificant. These results likely reflect the semi-extensive nature of duck farming in Brebes, where ducks graze in rice fields and require less commercial feed and medical intervention. Such systems promote natural disease resistance and efficient feed conversion, as also found in studies by Huo *et al.* (2021); Broyer and Calenge (2010), and Pham *et al.* (2021). The insignificance of age further suggests that income variation is more closely linked to access and scale than to demographic characteristics, supporting the argument by Saputra *et al.* (2023) that both young and older farmers face similar structural constraints.

These findings have important policy implications. Interventions should prioritize access to credit and digital technologies, which directly improve income. Programs that support microcredit, mobile-based extension services, and farm infrastructure upgrades are essential for scaling operations. Simultaneously, longer-term investments are needed to promote sustainable practices through financial incentives, certification systems, and participatory training models such as farmer field schools. By incorporating economic, technological, structural, and environmental variables into a single empirical framework, this study contributes to a holistic understanding of income dynamics in tropical duck farming. It offers a strong foundation for evidence-based policy design that supports income stability, food security, and smallholder resilience, thereby advancing Sustainable Development Goals 1 (No Poverty) and 2 (Zero Hunger).

Although the average monthly income of IDR 2,456,525 may seem modest, incremental improvements at the farm level can significantly enhance rural livelihoods by reducing poverty and improving food security. Small but consistent income gains increase farmers' capacity to invest in better inputs, nutrition, and education, which are key pathways for achieving Sustainable Development Goals 1 and 2. Therefore, these findings underline the importance of tailored interventions that recognize the cumulative impact of income enhancement on broader socio-economic development goals.

According to Mardikanto (1993), age plays a crucial role in influencing physical capacity, openness to innovation, adoption behavior, and

Table 5. Summary of Multiple Linear Regression Results.

Variable	Unstandardized Coefficients (B)	Std. Error	Beta	t	Sig.
(Constant)	3,226,000	322,250	-	10.01	0
Age (X1)	58.68	1984.95	0	0.03	0.98
Credit (X2)	50,075.11	10,202.24	0.06	4.91	0
Technology (X3)	42,890.31	9,150.89	0.07	4.69	0
Cultivation Pattern (X4)	-201,204.74	65,729.73	-0.04	-3.06	0.00
Feed (X5)	-2,491.69	1,477.50	-0.03	-1.69	0.09
Business Sustainability (X6)	-129,781.13	2,357.44	-0.92	-55.05	0
Enclosure Area (X7)	21,509.15	6,659.16	0.04	3.23	0.00
Number of Ducks (X8)	995.81	93.42	0.13	10.66	0
Medicines (X9)	-38,001.53	60,675.30	-0.01	-0.63	0.53
Model Fit	R = 0,974	R^2 = 0,948	Adj R^2 = 0,948	Std. Error = 412,237	

dynamism. Prasetyo *et al*. (2005) further emphasize that age related human capital is a critical resource that should be leveraged to advance the duck farming sector.

Education level significantly affects farmers' capacity to absorb and implement agricultural knowledge and technologies Prasetyo *et al*. (2005) further highlight that limited education may impede the growth of duck farming enterprises, emphasizing the importance of targeted interventions such as farmer training programs, counselling, and technical guidance to enhance productivity and long term sustainability.

Access to credit and use of technology had positive effects, highlighting their role in improving productivity and income consistent with Mariyono (2019) and Andrianto and Firmansyah (2019). Enclosure area and flock size also contributed positively, reflecting economies of scale. Conversely, cultivation pattern and sustainability practices had significant but negative coefficients, potentially indicating inefficiencies in implementation or delayed returns from integrated and eco-friendly systems (Hasibuan, 2023). Meanwhile, age, feed usage, and veterinary medicines were not significant predictors. This may be due to the semi-extensive system practiced in Brebes, where ducks graze in rice fields with minimal reliance on commercial feed and treatment. Such low-input systems may foster strong immunity and feed efficiency, as supported by Hoque *et al*. (2010); Huo *et al*. (2021) and Pham *et al*. (2021).

Conclusion

These findings confirm the research objective to examine income determinants in tropical duck farming and offer practical direction for improving farmer welfare. They also support broader development priorities by showing that improved access to finance, technology, and farm infrastructure can directly enhance rural income. As such, the study contributes to Sustainable Development Goals specifically SDG 1 (No Poverty) and SDG 2 (Zero Hunger) through evidence-based strategies for strengthening livelihoods in the poultry sector.

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Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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