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DOES INTEGRATION MATTER? COMPARISON OF CREDIT ACCESSIBILITY BETWEEN INTEGRATED AND NON-INTEGRATED LIVESTOCK FARMING

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Abstract
People's Business Credit (KUR) is a subsidized microcredit scheme launched in 2007 by the Indonesian government to improve small and micro-enterprise financing. This study examines KUR's effects on livestock farm performance in Boyolali Regency, Central Java, focusing on credit access, productivity, income and sustainability. Using primary data from 55 livestock farmers in four subdistricts, and employed binary logistic regression to model credit access as a function of education, experience, family size, land area, group integration (dairy–crop systems), livestock number, and annual turnover. The result showed that education significantly raised the odds of obtaining KUR (odds ratio = 4.43), indicating that more educated farmers are better able to navigate formal credit programs. Farmers engaged in integrated farm groups (dairy–crop) also had higher likelihood of credit access, consistent with evidence that collective structures facilitate loan acquisition. In contrast, experience, family size, farm size, herd size and income showed no statistically significant effects. Notably, only 9% of the surveyed farmers had accessed KUR, underscoring low uptake. These findings suggest that policy and extension efforts should emphasize farmer education and cooperative/group-based approaches to improve credit accessibility. Strengthening farmers' knowledge and promoting credit schemes through organized farmer groups (e.g. cooperatives) could enhance participation in KUR and thereby bolster the productivity and sustainability of livestock enterprises.

Keywords: *Dairy-Crop System, Livestock, People Business Credit, Binary Logistic Regression*

1. INTRODUCTION

The livestock subsector is one of the important components of agriculture sector. It as one of the contributor to the national economy for Indonesia. This subsector is able to contribute 16.51% to GDP from the agricultural sector in 2022 (Hartati et al., 2024). Livestock in Indonesia also has several types of livestock, including cows, sheep, ducks, chickens, pigs, goats, and buffaloes. Cattle, one type of livestock that has two types of business products, namely meat (beef cattle) and milk (dairy cows). Central Bureau of Statistics (BPS, 2023) revealed that the beef cattle population in Indonesia from 2016-2022 experienced a significant increase, from 15.9 million head in 2016 to 17.24 million head in 2022. On the other hand, the dairy population has decreased from 533,920 head in 2016 to 507,075 head in 2022. The decline in dairy cows can be caused by various factors, one of which is environmental conditions (Rachmawanto et al., (2022). The growth of dairy cows is determined by

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their level of welfare. Where good dairy cow care management practices, such as healthy cowsheds, quality feed, good lighting, and adequate ventilation also affect the welfare of dairy farms (Hendriks *et al*., 2025; Sigl *et al*., 2025). This is what can be done for regions that have dairy production centers in Indonesia to be able to improve their welfare, one of which is in the Boyolali area.

Boyolali Regency is a central area for dairy farming and fresh cow's milk producers in Central Java, where Central Java ranks third with the highest dairy cow population in Indonesia in 2022 (BPS, 2023; Wicaksono & Sudarwanto, 2016). This area is located on the slopes of Mount Merapi and Merbabu providing geographical advantages in the form of fertile volcanic soil and a tropical climate with high rainfall, supporting sustainable agricultural and livestock activities. Dairy farms are the backbone of the economy in the region, through the production of fresh milk that not only meets local needs, but also participates in the national market (Retnaningsih & Basuki, 2017; Satiti et al., 2022). In addition, the integration between coffee plantations and dairy farms has created an efficient bioindustrial model, where livestock waste is used as organic fertilizer for coffee plants so that it can increase productivity and reduce dependence on chemical inputs. This integration model can be called a circular agriculture system, which has been applied to peatland management in Kalimantan by integrating corn and cattle crops, which is based on environmental friendliness and sustainability (green economy) (Widiastuti et al., 2024). The another research was conduted by Swastika et al. (2024) also revealed that another term for the integration with the Integrated Crops-Livestock System, which combines crops and livestock so that it can increase crop and livestock yields simultaneously, while maintaining environmental sustainability.

The great potential of the livestock business in Boyolali turns out to have challenges in its development. The challenges or obstacles faced by farmers include financial limitations that cause constraints on business diversification and limited access to capital which are obstacles in optimizing production scale (Amam et al., 2019; Aprilia et al., 2021; O'Grady et al., 2024). This is the important role of People's Business Credit (KUR) as a government policy instrument. KUR aims to provide access to capital for business actors (SMEs), including breeders, through credit distribution so that they can increase their income, by increasing business competitiveness, diversifying businesses, and improving product quality as well as expanding marketing networks (Elliyana et al., 2020; Riawan & Kusnawan, 2018). This is in the Boyolali area, through the Regency Government, providing KUR to business actors so that it can increase the income of SMEs actors. According to Abdussalam et al. (2023) The existence of Cooperatives and Farmer Groups is also an important part of the social structure of the community so that it can be strategic in distributing KUR, as well as ensuring that the funds are on target and have a significant impact.

This study aims to analyze the influence of KUR on the performance of livestock businesses in Boyolali Regency, focusing on aspects of productivity, farmers' income, and business sustainability. This study is important considering that Boyolali is an area with a strong livestock base, but still requires policy interventions to overcome structural barriers such as capital. Through an integrative approach between geographical potential, socio-cultural mutual cooperation, and adequate infrastructure support, KUR is expected not only to improve business performance economically but also to strengthen the resilience of the livestock sector in the face of market and environmental dynamics. Thus, this study is expected to provide evidence-based policy recommendations for optimizing KUR programs in agropastoral-based areas such as Boyolali.

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Several studies related to analyze the influence of KUR on SMEs Business Performance have been conducted. Meilinda & Mahmud (2020) claims that KUR affects the income of creative economy-based SMEs in Semarang City, dan Ratar et al. (2023) shows that KUR affects the income of tomato farmers in Gorontalo. The study uses multiple linear regression to find out whether it affects partially or simultaneously, without knowing how it affects the performance of a business. Thus, to overcome the above gaps, this study want to explore the influence of People's Business Credit (KUR) on the performance of livestock businesses in Boyolali Regency, Central Java. This study aims to analyze the influence of KUR on the performance of livestock businesses in Boyolali Regency, focusing on aspects of productivity, farmers' income, and business sustainability. This study is important considering that Boyolali is an area with a strong livestock base, but still requires policy interventions to overcome structural barriers such as capital. Through an integrative approach between geographical potential, socio-cultural mutual cooperation, and adequate infrastructure support, KUR is expected not only to improve business performance economically but also to strengthen the resilience of the livestock sector in the face of market and environmental dynamics. Thus, this study is expected to provide evidence-based policy recommendations for optimizing KUR programs in agropastoral-based areas such as Boyolali.

2. METHOD

2.1 *Types and Sources of Data*

This study utilizes primary data collected in January 2025 from four sub-districts within Boyolali Regency. Data were obtained through a survey involving 55 livestock farmers as respondents. A structured questionnaire was employed to gather detailed information regarding farmer characteristics, the nature of their livestock enterprises, and their status as credit recipients.

2.2 *Operational Definition of Variables*

The dependent variable in this study is credit access, which is defined as a binary (dummy) variable, assigned a value of 1 if the farmer obtains credit and 0 if not. The independent variables utilized are, as follows:

- Age (years): the age of the farmer.
- Education Level: the highest educational attainment, measured on an ordinal scale.
- Number of Family Members: the total number of individuals in the farmer’s household.
- Experience (years): the duration of engagement in livestock farming.
- Land Area (hectares): the land owned or managed by the farmer.
- Integration Group (dummy): assigned a value of 1 if the farmer is a member of a group, and 0 otherwise.
- Number of Livestock (head): the total number of livestock owned.
- Turnover (Indonesia Rupiah/IDR): the total value of livestock sales in the past year.

2.3 *Data Analysis*

Binary logistic regression is a robust statistical method for analyzing the relationship between a binary response variable and predictor variables. This model is particularly valuable in contexts such as livestock farming, where decisions regarding the use of credit can be modeled as binary outcomes (0 for not utilizing credit, 1 for utilizing credit). The logit function transforms the probabilities of these outcomes, thereby enabling the estimation of odds ratios that reflect the influence of various factors

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on the decision-making process. A defining characteristic of this model is that the dependent variable is dichotomous, making logistic regression appropriate for scenarios with outcomes limited to two categories (1). The model employs the maximum likelihood estimation method to estimate parameters, which also addresses issues such as heteroskedasticity that are often encountered in ordinary least squares regression (2). This study aims to analyze the factors that influence the probability of farmers obtaining access to credit, utilizing the logistic regression method. Logistic regression is used because the dependent variable is binary, representing whether credit is obtained (1) or not (0). Mathematically, the logistic regression model is formulated as follows:

$$\boldsymbol{P_i} = \ln\left(\frac{\boldsymbol{P_i}}{\boldsymbol{1-P_i}}\right) = \boldsymbol{\alpha} + \boldsymbol{\beta_1 X_1} + \boldsymbol{\beta_2 X_2} + \boldsymbol{\beta_3 X_3} \ldots + \boldsymbol{\beta_8 X_8} + \boldsymbol{\varepsilon_i}$$

The parameters are defined as follows:
Pi: The probability that a livestock farmer obtains credit.
β_0: The intercept term.
$\beta_1, \beta_2, \ldots, \beta_k$: Regression coefficients corresponding to each independent variable.
X_1: Age (years).
X_2: Level of Education (measured on an ordinal scale).
X_3: Number of Family Members.
X_4: Years of Experience.
X_5: Land Area (hectares).
X_6: Integration Group (dummy; dairy-cattle and coffee businesses = 1, dairy-cattle only = 0).
X_7: Number of Livestock (head).
X_8: Turnover (Indonesian Rupiah/IDR).
ε: The error term of the model.

The estimation process was conducted using the Maximum Likelihood Estimation (MLE) approach. To enhance the accuracy of the standard error estimates, robust standard errors in Stata software were employed. Significance testing was performed at confidence levels of 5% and 10%, with P>|z| values taken into consideration. Variables were deemed to have a significant effect if the P value was less than 0.05 or 0.10. In interpreting the results of the logistic regression analysis, both the odds ratio and goodness of fit measures were utilized. The odds ratio, as a coefficient in logistic regression, provides insight into how variations in predictor variables influence the probability of an outcome (3). The evaluation of Goodness of Fit is essential for assessing the suitability of a model, as statistical significance alone does not guarantee that a model appropriately represents the data (1). Results derived from logistic regression analyses are commonly utilized in credit scoring to categorize applicants based on the probability of default, thereby facilitating informed decision-making (3). Furthermore, the applicability of this model extends beyond the financial sector, encompassing fields such as education and healthcare, which demonstrates its versatility in analyzing binary outcomes (Fitzmaurice & Laird, 2015). (4–6). Although binary logistic regression serves as a reliable tool for elucidating decision-making processes, it is imperative to consider its inherent limitations, including the risk of overfitting and the necessity for careful variable selection to ensure the validity of the model (1,2).

Given that the proportion of credit recipiets is relatively small (5 out 55) respondents, or approximately 9%), the logistic regression estimates in this study may be subject to rare-event bias.

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Therefore, the estimation results are interpreted with caution, with greater emphasis placed on the direction and statistical significance of the relationships rather than solely on the magnitude of the coefficiets. This approach is consistent with the literature which recommends caution when applying logistic regression to sample with rare events (7–9).

To assess the overall adequancy of the model, goodess of fit was evaluated using several indicators namely Pseudo R^2 values, the Hosmer Lemeshow test, and classification accuracy. The use of multiple diagnoostic measures aims to ensure that the model is not only statistically significant but also demonstrated adequate explanatory power and predictive performance. King and Zeng (2001) ideedrecommend caution with standard logistic regression for rare events data, as it can produce biased coefficient estimated and underestimate event proailities due to small sample issues in maximum likelihood estimation (7).

Overall, the logistic regression model demonstrates an adequate level of model fit. The pseudo R_2 values indicate that the independent variables are able to explain a meaningful, aleit not high, proportion of the variation in credit access. This result is reasonable given the characteristic of the data, which include a relatively small number of events (rare events). Accordingly, the model is more appropriately used to identify key determinants of credit access rather than as a highly precise predictive tool. The hosmer lemeshow test indicates no evidence of lack of fit, suggesting good agreement between the model's predicted values and the observed data. In addition, the model's classification accurancy falls within an acceptable range, supporting the overall adequancy of the model for further analysis.

3. RESULT AND DISCUSSION

3.1 *Characteristic of Livestock Business in Boyolali*

The characteristics of the livestock businesses included as variables and samples in this study are presented in the statistical summary shown in Table 1. A total of 55 livestock businesses were analyzed, comprising 5 businesses utilizing credit facilities and 50 businesses not utilizing credit. These figures indicate that the adoption of credit within livestock enterprises remains notably limited. Descriptive findings indicate that only 9 percent of farmers accessed credit, highlighting the low utilization of formal financing in smallholder dairyfarming in Boyolali. This condition reflects the persistence of structural and institutional barriers to credit access, despite Boyolali being one of the major milk producing regions in Central Java (10,11).

Table 1. Statistical summary of livestock business samples in Boyolali

Variable	Mean	Std. Deviation	Significance
Age	51.85	13.39	0.910
Education Level	1.50	1.00	0.003
Number of Family Members	4.49	1.85	0.624
Business Experience	12.87	15.35	0.911
Land Area	0.77	1.92	0.473
Integration Group	0.09	0.28	0.085

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Number of Livestock	3.07	4.54	0.123
Turnover	19,271,109	24,846,536	0.606
Observation (n)	55	55	0.910

Source: Primary Data (2025)

The livestock enterprises in Boyolali selected as research samples were drawn from seven hamlets: Dukuh (23.64%), Gedungsari (7.27%), Gumuk (12.73%), Jumbleng (3.64%), Ngemplak (21.82%), Sidorejo (14.55%), and Wangan (16.36%). Geographically, data collection was carried out across five villages: Banyuanyar (63.64%), Mriyan (12.73%), Sampetan (14.55%), Seruni (7.27%), and Wangan (1.82%). In terms of sub-districts, the research encompassed four areas: Ampel (65.46%), Gladaksari (14.55%), Musuk (7.27%), and Tamansari (12.73%). Additionally, the study involved eight farmer groups, namely: Berkah Kopi Dukuh (23.64%), Jumbleng (1.82%), Rukun Santoso (14.55%), Sido Makmur (12.73%), Subur Makmur (12.73%), Subur Tani (7.27%), Sumber Agung (3.64%), and Sumber Widodo (16.36%).

In Indonesia, particularly on the island of Java, access to credit is notably higher than in other regions, which has resulted in positive outcomes for agricultural performance and community welfare. Nevertheless, the distribution of credit remains limited and is predominantly concentrated within the Java region. When assessed in terms of credit utilization, the majority of farmer groups in Boyolali have yet to make extensive use of credit facilities. Despite this, credit accessibility in Java tends to be greater than beyond the island. The utilization of credit for productive enterprises, therefore, has the potential to assist farmers in enhancing their business performance. According to prior studies, the disbursement of credit remains restricted and is mainly focused on Java (12).

Several prior studies have demonstrated that investments on the island of Java yield significant positive outcomes regarding improvements in community welfare, agricultural business performance, and reductions in poverty levels (12–14). This evident disparity underscores the necessity of expanding credit access to support agricultural activities across all regions of Indonesia. The subsequent sections provide a comprehensive discussion on the effects of credit accessibility upon the performance and productivity of agricultural enterprises, drawing upon findings from a range of scholarly research.

Access to credit plays a pivotal role in enhancing the productivity and technical efficiency of agricultural enterprises. Empirical evidence demonstrates that formal credit sources, such as institutional loans, are markedly more effective in stimulating productivity gains compared to informal credit mechanisms (15). Government-initiated credit programs, in particular, exert a positive albeit modest impact on agricultural productivity. The efficacy of such initiatives is contingent upon various socio-economic factors, as well as the availability of complementary incentives such as agricultural extension services and irrigation infrastructure (16).

In the context of Java, improved access to credit has been closely associated with elevated agricultural productivity and enhanced community welfare, suggesting that analogous programs could yield comparable benefits in other regions of Indonesia. Government incentives, including interest rate subsidies and credit guarantee schemes, are critical in expanding credit accessibility and supporting food security programs (17). Research conducted in Ghana indicates that input credit access not only improves farm performance, but also enhances nutritional intake and

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increases net profits for smallholder farmers. These findings underscore the multidimensional advantages that credit access provides, extending beyond mere productivity improvements (18,19). While credit accessibility in Java has generated demonstrable positive outcomes, the limited reach of such programs outside Java highlights the urgent need for policy interventions to establish equitable access across Indonesia. Expanding credit access and providing sufficient support are crucial in advancing agricultural productivity and promoting comprehensive economic development.

Education holds a pivotal role in determining access to credit across various sectors. Individuals with higher levels of education generally possess greater financial literacy and managerial competencies, which enable them to access and manage credit more effectively. According to survey results, the educational attainment of livestock farmers in Boyolali varies, consisting of those with no schooling (1.82%), incomplete elementary education (12.73%), elementary school graduates (41.82%), junior high school graduates (23.64%), senior high school graduates (18.18%), and those with associate degrees (1.82%). The prevalence of elementary school graduates among the farmers reflects the overall low level of formal education in this group. Nevertheless, higher educational attainment is expected to enhance farmers' awareness of funding sources such as credit (22,23).Advanced education levels positively influence farmers' ability to manage their businesses, their activeness in seeking information regarding livestock techniques, adoption of technology, technical efficiency, and involvement in organizations such as cooperatives, associations, and farmer groups, as well as their access to extension services and credit-related socialization (24–28).

Field surveys indicate that the average age of livestock farmers in Boyolali is 51 years. The age distribution of livestock farmers in Indonesia, based on the household livestock enterprise survey, falls within the productive age range of 15 to 80 years. Although these farmers are considered to be in the productive age bracket, those in Boyolali are entering an age segment where productivity may begin to decline. In this context, younger farmers tend to be more receptive to knowledge regarding business funding sources, thereby improving their decision-making related to business direction and goals, as well as the use of credit facilities (29–36). In addition to greater physical stamina compared to older farmers, younger individuals generally exhibit higher curiosity, allowing for the more efficient adoption of technology, which ultimately enhances added value and positively impacts business turnover and the regeneration of farmers in Indonesia (22). Besides educational attainment, age also significantly influences access to credit. In Burkina Faso, the younger generation is more readily able to access credit and savings than the older age group, who are confronted with physical barriers in accessing financial institutions (37). Conversely, in South Africa, older individuals have higher financial literacy, which positively affects their access to credit (38). Socio-economic status is also closely linked to education. In Vietnam and India, both education and income have been shown to be strong predictors of financial inclusion, while individuals with low educational levels or lacking assets face considerable challenges in accessing financial services (39,40).

The number of family members in a farming household, as exemplified in Boyolali, exerts a considerable influence on both labor allocation and financial dynamics within the family business. On one hand, households with a larger number of members can supply additional labor, thereby reducing reliance on external workers and potentially enhancing business productivity. Conversely, a greater family size may result in increased household expenditure, which can ultimately constrain

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the funds available for reinvestment in the agricultural enterprise. This dual effect has been documented in various studies, which emphasize both the advantages and the challenges associated with family labor in the agricultural sector. The active participation of family members in farming operations can improve productivity by ensuring a consistent labor supply, a factor that is especially critical for micro and small businesses with limited capital and resources. Furthermore, family members who possess technical expertise can substantially raise household income, indicating that investment in human capital can augment the economic benefits derived from family labor (41).

Nevertheless, an increase in family size inevitably leads to higher household expenditures, which in turn restricts the amount of capital that may be reinvested in the business. This circumstance can adversely affect the overall financial health and growth potential of agricultural enterprises (42). Achieving a balance between labor contribution and financial burden is essential, as an excessively large family without parallel income growth may deplete resources (43). While family labor represents a valuable asset, it is not without its limitations. The flexibility afforded by family management can be advantageous; however, should family members no longer fulfill labor requirements, productivity could diminish. Additionally, the challenge of balancing household expenditures with business investment remains a significant issue for many farming families (43). These considerations underscore the necessity of strategic management and external support to optimize both family welfare and business outcomes.

The average number of family members in livestock farming households in Boyolali is four individuals. This figure may be utilized as an indicator of the available family labor force. Several previous studies have demonstrated that the accumulation of family labor can enhance business capital, as it reduces expenditures for external labor and thereby supports business success (23). Nonetheless, other research indicates that a larger number of family members may result in increased household expenses, which in turn can limit the allocation of funds for business capital (28,36,44–46). Additionally, this circumstance may have a negative impact on the rate of credit repayment (35,47).

The average business experience of livestock farmers in Boyolali is thirteen years. Such experience is likely to affect their managerial skills and their capacity to mitigate business risks. Research reveals that more experienced farmers are better equipped to address challenges and manage credit effectively, which is associated with lower rates of business failure. The use of credit is often correlated with the length of business experience, thus reinforcing operational capabilities and financial (48,49). Extended business experience fosters improvements in management skills, enabling farmers to make more prudent decisions. Experienced farmers are better prepared to overcome operational challenges, thereby reducing the probability of business failure (50). Farmers who utilize credit generally possess broader experience, which facilitates access to the financial resources necessary for business development (48).The ability to manage credit effectively is closely linked to the level of experience, influencing overall profitability (44,51–53). Conversely, although experience is an important factor, some studies indicate that the relationship between experience and business performance may be inconsistent, signifying that other factors also play a substantial role in determining the success of a farmer (50).

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The average landholding size among livestock farmers in Boyolali is 0.7 hectares. The effect of land size on credit accessibility and its impact on the performance of livestock enterprises in Boyolali can be analyzed through several dimensions, including land ownership, access to credit, and the role of extension services. Collectively, these factors shape the operational capacity of livestock businesses. Greater land ownership is positively associated with the likelihood of utilizing credit for livestock production, as those possessing larger tracts of land may use them as collateral (54,55). Nevertheless, the advantages of land ownership tend to decline as holdings become exceedingly large, suggesting a non-linear relationship wherein surplus land does not invariably confer proportional access to credit (55). Access to credit substantially enhances the performance of livestock enterprises by enabling farmers to acquire the necessary inputs and technologies, which are critical for productivity (56). The effectiveness of credit access is further amplified when combined with targeted and needs-based extension services, particularly for households headed by women (54). While increases in both land size and credit access generally foster improvements in the performance of livestock businesses, challenges such as unsound borrowing relationships and limited financial literacy may impede these gains. Farmers may still encounter difficulties in accessing credit despite adequate landholdings, indicating that systemic barriers must be addressed to fully unlock the potential of livestock enterprises in Boyolali.

A bio-industry development model has been established in Boyolali, exemplified by the integration group that combines dairy cattle farming with coffee plantation enterprises. This relationship plays a vital role in enhancing both productivity and the sustainability of agricultural practices. The subsequent sections delineate the principal aspects of this correlation. Coffee farmers frequently encounter significant obstacles in accessing credit, with only 41.94% utilizing bank loans, while the majority depend on non-formal financial institutions (57). Financial support proves indispensable for the implementation of integrated farming systems, as many small-scale farmers lack the necessary capital to optimize the integration of coffee and livestock (58). In Brazil, a high rate of credit utilization is associated with superior management practices, indicating that improving access to credit can measurably enhance operational efficiency in coffee production (59).

In this study, the concept of “integration” primarly refers to farmers’ participation in an organized integrated farming group rather than a fully measured level of technical or economic integration at the production system level. The variable capture institutional involvement, including collective activities, information sharing, and administrative coordination within the group, and therefore serve as a proxy for organizational and institutional participation rather than a comprehensive indicator of integration intensity or duration. Although this study does not explicity incorporate quantitative environmental or sustainability indicators, references to sustianability and the circular economy are grounded in observable production practices withi integrated farming groups in Boyolali. These pratices include reducing reliance on commercial feed by utilizing coffe husks as supplementary feed for dairy cattle, as well as recycling cattle manure as organic fertilizer for coffee plantations, thereby creating a close-loop nutrient cycle between livestock and crop production. While these practices reflect an emerging integrated dairy-coffee farming sustem aligned with circular agriculture principles, the sustainability implications are interpreted in a contextual and illustrative manner rather than as quantified environmental impacts.

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The average number of dairy cattle owned by livestock enterprises in Boyolali is three. Although this figure is modest, various studies underscore that access to credit is crucial for boosting both productivity and efficiency in livestock production, as it enables farmers to invest in requisite inputs and technology. This dynamic is particularly pronounced in regions such as Ethiopia and Rwanda, where research demonstrates that land ownership and access to extension services are primary determinants in credit allocation for livestock production. Multiple studies have identified a significant, positive relationship between credit accessibility and the performance of agricultural cooperatives, accounting for approximately 17.6% of the variation in cooperative performance (60). In Ethiopia, factors such as land ownership and access to livestock-focused extension services substantially influence farmers' decisions with regard to credit allocation for livestock activities ternak (54,55). Access to formal sources of credit has been shown to improve agricultural performance more effectively than informal sources, underscoring the importance of reliable credit channels (15).

Despite these considerable advantages, numerous small-scale livestock farmers face impediments such as high interest rates and collateral requirements, which constrain their ability to obtain credit. Security of land ownership is also highly pertinent, as farmers possessing formal land certificates generally secure more favorable credit terms, highlighting the necessity of policies that reinforce land tenure security (61). Although the positive impact of credit accessibility on livestock enterprises is well established, it is important to acknowledge that increased access alone does not guarantee enhanced productivity. Tailored extension services and supportive policy frameworks are essential to ensure that credit facilities lead to substantial improvements in livestock business performance.

The average annual sales revenue achieved by livestock farmers in Boyolali amounts to IDR 19,271,109, representing an estimated total of milk sales over the course of one year. Generally, farmers in Boyolali utilize the government’s microcredit scheme (Kredit Usaha Rakyat) as a primary source of business capital. While access to credit enables farmers to invest in essential resources—thereby enhancing productivity and efficiency—the nuances of this relationship are further elaborated in the subsequent sections. Credit serves as a facilitator for the procurement of crossbred dairy cattle, which are pivotal for increasing milk production (62). Research indicates that access to formal credit sources results in improved farm business performance, as it enables farmers to acquire superior inputs and technological advancements (15). Enhanced credit access has a positive impact on farmers’ income and overall welfare, in addition to encouraging structural transitions in agricultural practices (63). Nevertheless, factors such as low financial literacy, insufficient collateral, and high transaction costs present significant obstacles for small-scale dairy farmers in accessing credit facilities (64). In certain contexts, non-financial factors exert a greater influence on business performance than financial constraints, underscoring the complexity of the interplay between credit accessibility and agricultural productivity (65). While credit accessibility is essential for improving the outcomes of dairy farming enterprises, it is equally important to address the various barriers that prevent farmers from optimizing the use of these financial resources. Addressing these intricate issues necessitates a comprehensive approach to enhance both credit access and overall farm business management practices.

3.2 Binary Logistic Regression

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Logistic regression analysis was conducted to identify the factors influencing the likelihood of farmers obtaining access to credit. The dependent variable in this study is credit recipient status (as a dummy variable: 1 = received, 0 = not received), while the independent variables include age, education level, number of family members, farming experience, land size, participation in integration groups (dairy cattle and coffee), number of livestock, and turnover. The logistic regression estimation results are shown in the following table:

Table 2. Result of binary logistic regression

Variable	Odds Ratio	P-Value	Description
Age	1.0045	0.910	Not significant
Education Level	4.4342	0.003	Significantly positive*
Number of Family	1.2248	0.624	Not significant
Experience	1.0046	0.911	Not significant
Land Size	0.9187	0.473	Not significant
Integration Group	1.1231	0.085	Significantly positive**
Number of Livestock	1.1556	0.123	Not significant
Turnover	1.0000	0.606	Not significant

Source: Primary Data (2025)

Note: *significant at 5% level; **significant at 10% level

Based on the logistic regression result, the Wald chi-squared statistic of 14.27 with 8 degrees of fredom and Prob > Chi^2 value of 0.0750 indicate that the set of independent variables is jointly significant at the 10 percent significance level, suggesting that the model is statistically acceptable, although not significant ath the more stringent 5 percent level. The pseudo R^2 value of 0.2588 implies that the independent variables explain a moderate proportion of the variation in credit access. While pseudo R2 can be interpreted in the same manner as the R^2 in linear regression, this magnitude is commonly observed in cross-sectional studies and in models with a limited number of events. Overall, there diagnistic results indicate that the logistic regression model has an adequate level of fit and is suitable for identifying key determinants of credit access, though it is more appropriate for inferential analysis than for highly precise prediction.

Based on the estimation results presented above, it is evident that education level exerts a positive and statistically significant influence on access to credit (p = 0.003). This finding indicates that the higher the level of education attained by farmers, the greater their likelihood of obtaining credit. The odds ratio of 4.43 implies that each increase in educational attainment raises the probability of securing credit by 4.43 times compared to farmers with lower levels of education. This result underscores the critical role of literacy and managerial capacity in the application and management of credit facilities. The study conducted by (66) demonstrated that entrepreneurs possessing higher educational backgrounds are more inclined to apply for credit and receive more favorable loan conditions. These individuals are capable of developing superior business plans, exhibiting enhanced creditworthiness, and making more prudent investment decisions. Within the context of small and medium-sized enterprises (SMEs), owners with higher educational qualifications tend to access bank credit more readily due to their advanced understanding of financial management and risk mitigation (67). The regression results indicate that education level is a key determinant of credit access. In Boyolali context, the dominance of farmers with only basic education contributes to low financial literacy and limited understanding of formal credit producers (20,21). This condition explains

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why education exerts a much stronger influence than conventional economic variables. The findings suggests that the primary constraints to credit access is not merely farm capacity, but farmers' cognitive and administrative capacity.

In the spheres of trade and distribution, business owners with elevated education levels are better positioned to leverage networks and relationships with banking institutions, thereby facilitating access to credit. Education serves to improve credit accessibility for both men and women, although women frequently encounter structural barriers that limit their opportunities. In Bangladesh, evidence suggests that education is more influential than credit itself in empowering women's decision-making authority within households (68). In sub-Saharan Africa, secondary education plays a pivotal role in bridging the gender gap with regard to financial inclusion (69). Within the agricultural sector, farmers with higher educational attainment are more likely to utilize formal credit, resulting in increased income and diminished income disparities (70). Conversely, in the microenterprise sector, the beneficial impact of education on credit access is even more pronounced, as educated entrepreneurs are better equipped to manage credit and implement technological innovations (66). Furthermore, managerial skills encompassing financial literacy, investment capability, and judicious business decision-making often stem from formal education. These competencies are essential for effective credit management, particularly in the SME and microenterprise sectors. In Sri Lanka, individuals exhibiting high financial literacy are more adept at utilizing bank credit responsibly (71). In Pakistan, financial literacy mediates the relationship between access to financing and enterprise performance (72).

Participation in integration groups—specifically, those involving livestock and coffee crop enterprises—also demonstrates a positive and statistically significant effect at the 10% level ($p = 0.085$). Farmers affiliated with such integration groups are more likely to obtain access to credit compared to their unaffiliated counterparts. This finding suggests that the existence of formal organizations or groups enhances the confidence of financial institutions in farmers as prospective borrowers. The integration of coffee farming with dairy cattle operations facilitates improved productivity through the joint utilization of resources and better waste management, commonly known as agricultural biomass (73). Access to credit enables farmers to invest in superior technologies and practices, thereby increasing technical efficiency and narrowing the technological gap between those who implement integration and those who do not (74). Despite the considerable potential exhibited by integrated farming systems, low adoption rates and financial constraints highlight the necessity for targeted interventions to enhance credit access and support sustainable practices. This duality underscores the importance of addressing both financial and educational barriers in order to maximize the benefits of integrated farming systems. Participation in integrated dairy coffee farming groups has a positive effect on credit access, although at the 10 percent significance level. In Boyolali, these inegrated groups function as social and institutional guarantee mechanisms that enhance the credibility of farmers in the eyes of financial institutions. This finding indicates that credit access is more effectively facilitated through collective approaches rather than individual-based mechaisms.

Notably, conventional economic variable such as land size, herd size, and turnover do not have a significant effect on credit access. This finding indicates that, in the context of smallholder dairy

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farming in Boyolali, credit access is not determined by farm scale but rather by institutional capacity and administrative capability. This result challenges the conventional assumption that physical assets are the primary basic for creditworthiness and suggests a shift from asset-based lending toward institution-based lending within microcredit schemes such as KUR.

3. CONCLUSION & IMPLICATION

This study demonstrates that access to the Kredit Usaha Rakyat (KUR) program among dairy farmers in Boyolali Regency is more strongly influenced by education level and paticipations in integrated agricultural institutions than by conventional economic factors. Farmers with higher levels of formal education are 4.43 times more likely to access credit compared to those with lower education levels, underscoring the importance of financial literacy and managerial capability in navigating formal credit systems. Additionally, farmers involved in integrated farming systems—specifically dairy-crop integration—are more likely to secure credit, highlighting the institutional trust and social capital embedded in collective organizations.Other variables such as age, farming experience, household size, landholding size, number of livestock, and annual turnover were not statistically significant, although some showed expected directional relationships—. The findings underscore that credit access in smallholder livestock systems in shaped not merely by farm scale, but by farmers' cognitive and institutional capacity. The low proportion of credit recipients (9%) further reflects the limited level of financial inclusion in the livestock sector, despite Boyolali's status as a major milk producing area.

Goverment and finacial institution are encouraged to design KUR schemes specifically tailored to integrated farming groups, where group membership car partially subtitute for physical collateral requirements. Farmer groups and cooperatives can be strenghened to function as credit facilitators by providing administrative assistance, business verification, and monitoring of credit utilization. The integrated dairy-coffee farming model in Boyolali may serve as a pilot project for developing circular economy based schemes, supported by technical assistance and targeted financing incentives. Financial literacy programs should be oriented toward farmer's practical needs, including the preparation of simple credit proposals, farm record keeping, and cash flow management. The managerial implications of this study emphasize the importance of strengthening the capacity of farmers through education and financial literacy, so that they are able to effectively utilize credit schemes to increase productivity and business resilience. Increased participation in farmer groups and the implementation of business integration models—such as an integrated system between livestock and crops—can strengthen resource efficiency and expand access to financing. In addition, expanding the inclusivity of credit schemes such as KUR with more flexible terms, institutional support, and the involvement of cooperatives as intermediaries can increase the reach and accuracy of financing targets. A circular economy approach through bioindustry integration also has the potential to be replicated in other agropastoral regions to encourage sustainability and income diversification. The effectiveness of this policy will be more optimal if it is accompanied by counseling support, technical assistance, and collaboration between local governments, financial institutions, and non-governmental organizations

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