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Bridging The Digital Divide: Internet Access And Farmer Poverty In East Java

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ABSTRACT

Poverty among farmers remains a structural challenge in agricultural development in Indonesia; low productivity and limited access to information technology are the main problems. Addressing this issue is crucial for national food security and sustainable rural livelihoods. This study aims to examine the profile of poor farmers and analyze the effect of internet use on the risk of poverty among farmers in East Java Province. The data comes from the March 2023 National Socio-Economic Survey (Susenas) microdata, comprising 21.368 individual observations. The analysis method used is binary logistic regression due to the binary classification of the dependent variable, with model segregation based on urban and rural areas, implemented using Stata software. The results show that poor farmers generally come from the food crop subsector and are concentrated in certain areas such as Madura Island. Digital literacy and internet utilization are still very low, while access to formal financing is also limited. Internet access significantly reduces the poverty risk, with users being 2.72 times more likely to be non-poor, especially in urban areas. This study recommends different policy approaches between urban and rural areas to realize inclusive and adaptive agriculture in the digital era.

Keywords: *binary logistic regression, farmer poverty, internet utilization, Susenas*

BACKGROUND

Poverty remains a fundamental problem in economic development in Indonesia, especially in the agricultural sector, with traditional characteristics, low productivity, and limited access to productive resources. Although this sector absorbs more than 28 percent of the national workforce, its contribution to the national Gross Domestic Product (GDP) has been relatively stagnant in the last decade (Figure 1). Specifically, Figure 1 illustrates that while the agricultural sector's workforce proportion has remained consistently above 27% since 2018, its GDP contribution has hovered around 12-13% during the same period, indicating a notable discrepancy between labor absorption and economic value generated.

The agricultural sector, especially those based on small-scale agricultural businesses, experiences structural limitations such as narrow land ownership, limited access to technology, and low market and digital literacy, ultimately triggering stagnant or declining welfare levels. Furthermore, the 2023 Indonesian Agricultural Census results revealed a significant productivity gap between small-scale and non-small-scale farmers. Nationally, the average productivity of small-scale

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farmers was recorded at IDR 44,507 per working day, while non-small-scale farmers reached IDR 1,929,764 per working day BPS (2024). This disparity shows that small farmers face structural and systemic challenges in accumulating productive capital, whether in technology, information, or market access.

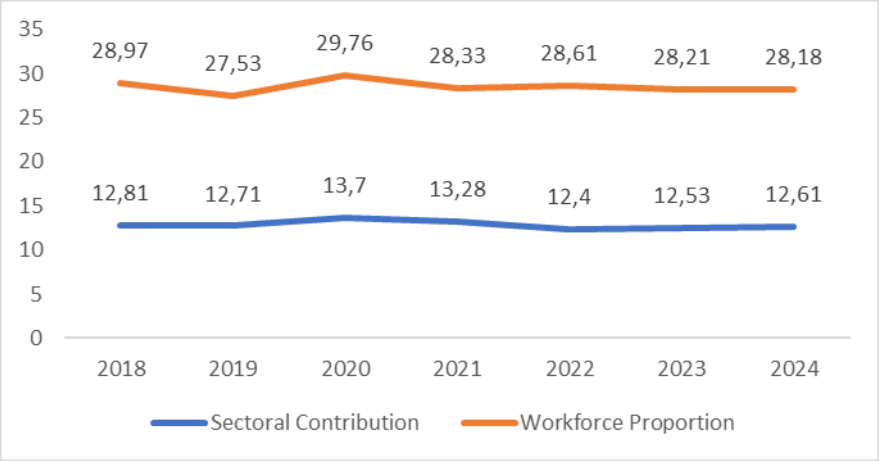

Figure 1. Proportion of Agricultural Sector Workforce and Sectoral Contribution to Indonesia's GDP, 2015-2018
Source: BPS, (2024)

The disparity becomes even more apparent if reviewed in more detail at the provincial level. The province with the highest small farmer productivity is DKI Jakarta (IDR 107,044), followed by Riau (IDR 92,035) and Central Kalimantan (IDR 91,472). On the other hand, the three provinces with the lowest small farmer productivity are DI Yogyakarta (IDR 30,656), East Java (IDR 31,494), and Bali (IDR 31,513) (BPS, 2024). These differences reflect the inequality between farming business actors and regional disparities that need special attention in formulating place-based policies. These provincial disparities are often attributed to varying access to agricultural infrastructure, market integration, and the effectiveness of local agricultural extension services, which can significantly influence farmers' capacity to adopt modern practices and achieve higher yields.

Specifically, East Java Province, which has historically been known as a national food producer and has relatively better agricultural infrastructure than other regions, is ranked third lowest in productivity, especially for small farmers. This condition emphasizes the existence of problems that concern not only production aspects but also the efficiency of farming businesses, access to technology, and the competitiveness of local farmers. Previous studies in East Java, such as those by Ambarwati et al., (2025) and Mariyono et al., (2020) have also highlighted challenges in production efficiency due to fragmented landholdings and limited access to improved seeds, while market competitiveness is hampered by poor post-harvest handling and a lack of direct market linkages.

Based on data from the National Socio-Economic Survey (Susenas) in March 2023, around 36.47 per cent of the total working population in East Java works in the agricultural sector (BPS Provinsi Jawa Timur, 2023). This figure shows that more than a third of the productive population in this province depends on the sector with the lowest productivity. This condition has major implications for the economic resilience of agricultural households, given the direct link between agricultural business productivity and the level of farmer welfare.

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Data on poverty levels by economic sector reinforce this condition. In East Java, based on data processing using Susenas data 2023, workers in the agricultural sector have the highest poverty rate, 14.46 per cent, compared to the manufacturing sector (7.56 per cent) and the service sector (5.19 per cent). This condition indicates the structural vulnerability experienced by farming households, especially those with smallholder farmer status. This vulnerability can be associated with minimal income diversification, low access to financial services, and limitations in utilizing agricultural technology innovations.

The farmers' low productivity and high poverty rates in East Java indicate multidimensional problems. In addition to technical problems in agricultural production, spatial and socio-economic aspects contribute to exacerbating inequality. In this context, spatial mapping is an important approach to identifying areas with high vulnerability to farmer poverty so that intervention policies can be more targeted and evidence-based.

In the last decade, information and communication technology (ICT), especially the Internet, has received attention as a potential solution to increase the productivity and competitiveness of smallholder farmers. The Internet plays a role in opening market access, expanding farming networks, facilitating access to price and weather information, and accelerating the adoption of agricultural innovations (Sargani et al., 2025; Thilakarathne et al., 2025). This has been observed in various Indonesian contexts, such as through studies by Kartiasih et al., (2023), who highlight regional digital development and its socioeconomic associations, and through agricultural digital transformation initiatives in East Java. Therefore, the digitalization of agriculture through internet access is a strategic instrument in reducing the risk of farmer poverty, especially in areas with low productivity.

Several previous studies, have shown that productivity is closely related to farmer welfare, not only in income but also in access to education, health, and a decent life. A study by Nguyen et al., (2023) emphasized that efficiency in the production process greatly determines the contribution of agricultural income to farmer welfare. Research by Mathanda et al., (2025) and Meng et al., (2024) showed that training and farmer group-based approaches can increase productivity while strengthening farmers' social capital. In the digital context, studies by Twumasi Ankrah et al., (2023) and Xie et al., (2023) found that using the Internet to distribute agricultural products reduces transaction costs and increases logistics efficiency. However, these benefits are only significant if accompanied by adequate digital literacy.

While existing literature broadly highlights the potential of digital technologies in agriculture and the challenges posed by the digital divide, there remains a significant gap in comprehensive empirical studies that specifically investigate the direct impact of internet utilization on the risk of poverty among smallholder farmers within a detailed regional context, particularly in provinces like East Java which present unique socio-economic and agricultural development challenges. Furthermore, a robust quantitative analysis that integrates micro-level data with explicit spatial segregation to understand the nuanced effects across urban and rural agricultural settings is often limited. This study aims to bridge these identified literature gaps by providing targeted empirical insights into the digitalization-poverty nexus in East Java, thereby offering a more nuanced understanding that can inform highly targeted policy interventions.

The urgency of this research stems from the imperative that future agricultural development must ensure the sustainability of the farmer household economy alongside achieving food self-sufficiency. Without innovation-based transformation and digitalization, the productivity gap

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between farmer groups will continue to widen and exacerbate farmer poverty in East Java. This study attempts to answer this challenge with an empirical approach based on micro and spatial data and the integration of digital factors in welfare analysis.

The objectives of this study are (i) to examine the profile of East Java farmers in general and specifically for poor farmer groups, equipped with a micro-data-based spatial mapping approach and (ii) to analyze the role of internet use in farming activities on the risk of poverty among East Java farmers through a robust quantitative approach, to identify the potential of the Internet as a tool for alleviating agricultural poverty.

Academically, the results of this study are expected to enrich the literature review on the relationship between digital transformation and poverty alleviation in the agricultural sector, especially in the context of developing countries such as Indonesia. From a policy perspective, this study provides an empirical basis for local governments, farmer organizations, and development institutions to develop area-based and technology-based intervention programs to accelerate the reduction of farmer poverty. Through the integration of spatial and digital approaches, the results of this study have the potential to be strategic input in designing inclusive and innovation-based agricultural policies. Thus, this research seeks to answer: "How does internet use affect the probability of poverty among farmers in East Java, and what are the implications for targeted policy interventions?"

RESEARCH METHODS

This study uses secondary data sourced from the March 2023 National Socio-Economic Survey (Susenas) microdata, which is routinely conducted by the Statistics Indonesia (BPS). Susenas is one of Indonesia's most comprehensive types of household surveys, with a wide range of modules covering demographic data, education, employment, consumption, poverty, and access to socio-economic facilities, including information and communication technology (ICT).

The main reason for using Susenas microdata in this study is its national and provincial representative coverage and the completeness of the variables that allow for poverty analysis at the individual worker level. Unlike other sectoral data, Susenas records employment data about household socio-economic status and provides information on the status of internet usage by individuals. This allows researchers to link the digitalization dimension with welfare status at the micro level. Observations in this study focused on all individuals working in the agricultural sector in the East Java Province. Sector identification was carried out based on the main business field variable (KBLI), where the agricultural sector includes the subsectors of food crops, horticulture, plantations, livestock, fisheries, and forestry. After the data cleaning process and selection of relevant observations, the total observation units analyzed were 21,368 individuals. This number is large enough to produce robust estimates and can be differentiated based on regional characteristics (urban and rural), agricultural subsectors, and various socio-demographic attributes.

In this study, poverty indicators are determined based on the classification of poor households based on the total poverty line (consisting of food and non-food poverty lines) associated with the status of individual agricultural workers in the household. Using this data, the study can answer the main question of how internet use contributes to the probability of poverty among farmers. In

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addition, Susenas data also allows tracing the role of access to business financing such as Kredit Usaha Rakyat (KUR), as well as geographic variations between districts/cities within the province.

To ensure accuracy and consistency in the analysis process, all variables used in this study have been formulated operationally based on references from the March 2023 Susenas metadata and reviewed through relevant literature. This definition formulation includes both dependent and independent variables analyzed in the model. Complete details of each variable, including data type, measurement scale, operational definitions, and relevant additional information, are presented systematically in Table 1. This presentation aims to facilitate reader understanding and allow replication of the study by other researchers in different contexts and times. Statistical analyses in this study were conducted using STATA software. The selection of independent variables for the logistic regression model was guided by established economic theories on poverty determinants and prior empirical studies on agricultural household welfare and technology adoption.

Table 1. Research Variable Categorization

Variable	Categorization	Operational Definition	Measurement Scale	Reference
Poverty Status	0 = affluent (reference category) 1 = poor	Household income below the official poverty line.	Binary (Nominal)	BPS (2023 Susenas Metadata)
Internet Usage	0 = not using internet (reference category) 1 = using internet	Self-reported internet use by individuals for any purpose in the last 3 months.	Binary (Nominal)	BPS (2023 Susenas Metadata)
Gender	0 = female (reference category) 1 = male	Biological sex of the individual.	Binary (Nominal)	BPS (2023 Susenas Metadata)
Age	Continuous Variable	Age of the individual in years.	Ratio	BPS (2023 Susenas Metadata)
Age Squared	Continuous Variable	Age of the individual squared, to capture non-linear effects.	Ratio	Based on econometric best practice
Marital Status	0 = others (never married, divorced, widowed) (reference category) 1 = married	Marital status of the individual.	Binary (Nominal)	BPS (2023 Susenas Metadata)

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Variable	Categorization	Operational Definition	Measurement Scale	Reference
Household Size	Continuous	Number of individuals in the household.	Ratio	BPS (2023 Susenas Metadata)
Area Classification	0 = rural (reference category) 1 = urban	Classification of the individual's residential area.	Binary (Nominal)	BPS (2023 Susenas Metadata)
Agricultural Subsector	0 = other subsector (livestock, fisheries, forestry) (reference category) 1 = food crops 2 = horticulture 3 = plantation	Primary agricultural subsector of the individual's main business field (KBLI).	Categorical (Nominal)	BPS (2023 Susenas Metadata)
Credit access	0 = others (reference category) 1 = formal credit (KUR) 2 = informal credit	Access to different types of business credit.	Categorical (Nominal)	BPS (2023 Susenas Metadata)

Source: Author's compilation based on BPS (2023 Susenas Metadata).

Data Analysis Method

In this study, the analytical approach used is binary logistic regression, which was chosen to answer the study's second objective, namely to analyze the effect of internet use on the probability of farmer poverty. The selection of this method is considered appropriate considering that the dependent variable in this study is nominal in scale with two categories, namely poor and not poor. The logistic regression model allows the estimation of the probability of a binary event based on a combination of statistically and substantively relevant independent variables. Model testing is carried out in two stages, namely simultaneously and partially. Simultaneous testing of the entire model uses the G statistic to assess the combined significance of all independent variables.

Meanwhile, partial testing of each parameter coefficient is carried out using the Wald test, as suggested by (Hosmer et al., 2013). Interpretation of the regression analysis results is carried out by referring to the odds ratio (OR) value to measure the extent to which a characteristic affects the chances of an individual being in the poverty category compared to the reference category. This study also carried out a segregation analysis consisting of an estimation model with general observations and a specific analysis of urban and rural observations. Moreover, the study utilizes microdata from the National Socioeconomic Survey (Susenas) conducted by Statistics Indonesia, which ensures data accuracy and minimizes potential biases such as undercoverage, as the survey covers all regions of Indonesia and includes respondents across all age groups and education levels.

The binary logistic regression model used in this study follows equation (1) below:

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$$l\left(\frac{(x)}{1-(x)}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_p X_p \# \ldots (1)$$

where:

- (x) represents the probability of an individual being in the poor category.
- X_1 = using internet; X_2 = male ; X_3 = age ; X_4 = age squared ; X_5 = married ; X_6 = household size ; X_7 = urban; X_8 = food crops; X_9 = horticulture ; X_{10}= plantation ; X_{11}= formal credit ; X_{12} = informal credit
- p is the total number of estimated parameters in the model.

All statistical analyses were performed using Stata statistical software (Version 17).

Information related to a general description of the distribution of data used in the research can be seen in Table 2 of summary statistics below.

Table 2. Summary Statistics

Variable	Mean	Min.	Max.	St.Dev
Poor Farmer	0.131	0	1	0.337
Internet	0.078	0	1	0.268
Male	0.629	0	1	0.483
Age	51.126	10	97	14.123
Age Squared	2813.367	100	9409	1423.843
Married	0.929	0	1	0.257
Household SIze	3.442	1	10	1.422
Urban	0.257	0	1	0.437
Others Agriculture Subsector	0.244	0	1	0.430
Foodcrops Subsector	0.603	0	1	0.489
Horticulture Subsector	0.099	0	1	0.298
Plantations Subsector	0.055	0	1	0.227
Other type of credit access	0.085	0	1	0.279
Access to Kredit Usaha Rakyat (KUR)	0.098	0	1	0.297
Access to Informal Credit	0.072	0	1	0.258

Source: Author's calculation (Dias Satria, Christiayu Natalia, Risti Permani, 2025)

RESULT AND DISCUSSION

Profile of Farmers in East Java

The study results show that the profile of poor farmers in East Java is still dominated by business actors from the rice and secondary crops sub-sectors. Around 60 per cent of the total poor farmers come from this sub-sector. This condition shows that the food crop sub-sector, which has been considered the backbone of national food security, actually contributes to the group with the highest socio-economic vulnerability. This phenomenon is not without reason, considering that food crops, especially rice, have low profit margins and are highly dependent on price fluctuations and production costs that increase yearly (Mgale & Yunxian, 2021).

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Delving deeper into the socioeconomic characteristics of poor farmers in East Java (as summarized in Table 2, Research Methods section), the average age of poor farmers is 51.13 years, with a notable male dominance (62.9%). A substantial majority (92.9%) are married, and the average household size is 3.44 individuals. These demographics suggest that poor farming households often support multiple dependents, placing a significant consumption burden on their limited income. While most are concentrated in rural areas (74.3%), approximately a quarter (25.7%) reside in urban settings. The prevalence of poor farmers in the food crops subsector (60.3%) further underscores the vulnerability of this segment, compared to horticulture (9.9%) or plantations (5.5%).

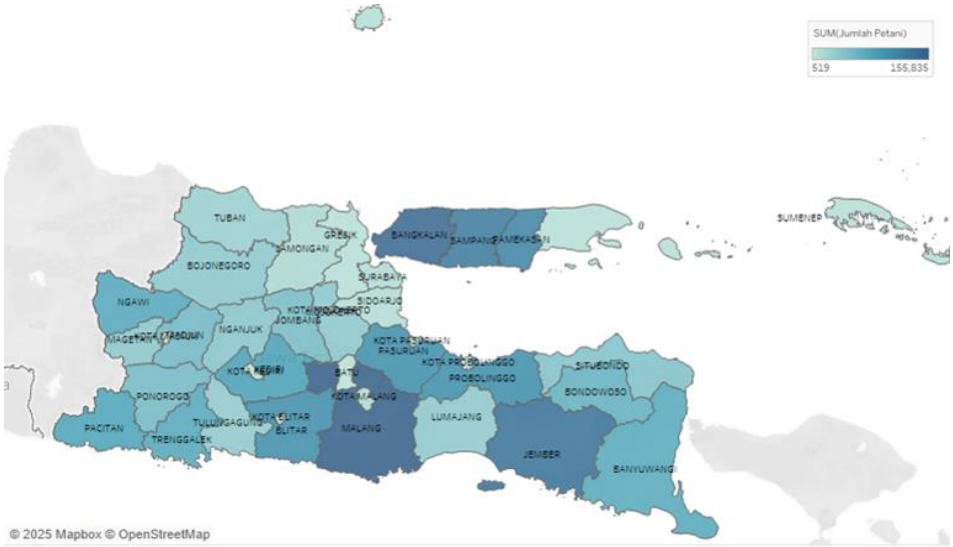

Figure 2. Sum of Poor Farmers in East Java Based on District/city, 2023
Source: Author Calculation

From a spatial aspect (Figure 2), the highest concentration of poor farmers is found in the Madura Island region, including the Bangkalan, Sampang, and Pamekasan Regencies. Collectively, these three regencies account for 20.06 percent of the total poor farmer population in East Java. This area is known to have less favourable agroecological conditions, with limited access to water sources, geographical remoteness, and economic infrastructure that has not developed optimally. Research by (Rutsaert et al., 2021) emphasized that geographical location is important in increasing the risk of agrarian poverty, especially in areas with limited access to markets and agricultural inputs. In the context of Madura, historical underinvestment in irrigation and road networks, coupled with unique cultural and land tenure systems, has often exacerbated these geographical challenges. For example, a study by Abdullah et al. (2020) specifically highlighted how these localized factors, particularly the traditional land inheritance patterns and limited access to irrigation infrastructure, contribute to persistent agricultural poverty in the region.

Demographically and educationally, most poor farmers in East Java have very low levels of digital literacy. Only 3 per cent of them have received Information and Communication Technology (ICT) training. This digital literacy gap creates serious obstacles to adopting digital agricultural innovations. However, according to (Ji & Zhuang, 2023) digital literacy is an important prerequisite for increasing farming businesses' efficiency and added value.

The use of the internet for farming purposes or general information is also very limited. Data shows that less than 5 per cent of poor farmers in East Java actively use the internet. This strengthens

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the findings of (Kartiasih et al., 2023), which state that internet use in agricultural activities is still concentrated in the western region of Indonesia, with significant disparities in the eastern and central regions. These limitations impact low technology adoption, minimal access to market price information, and slow response to climate change or pest attacks.

Regarding access to financing, most poor farmers still rely on informal credit, which is included in the "other business credit" category, such as individual or group loans. The proportion of poor farmers who access credit through this channel reaches 4.80 per cent, higher than access to the more formal Kredit Usaha Rakyat (KUR). Although informal credit offers flexibility, it often lacks fixed interest and term regulations, which can exacerbate farmers' economic vulnerability (Moahid & Maharjan, 2020). In the context of the agrarian economic structure of East Java, these results emphasize the importance of paying attention to the relationship between subsectors, geography, digital literacy, and access to financing as the four main determinants that shape the poverty profile of farmers in this region.

The Impact of Internet Usage on Farmers' Risk of Poverty

Internet Use and Poverty among Farmers

The main findings of this study indicate that access to the Internet significantly reduces the risk of poverty among farmers in East Java. Through a binary logistic regression model (Table 3), strong evidence is obtained that farmers who do not use the Internet have a 2.72 times greater risk of poverty than those who use the Internet in their agricultural activities and daily lives. This figure represents a substantial effect in the context of technology-based policy interventions. In statistical terms, the Odds Ratio (OR) of 2.72 indicates that non-use of the Internet is not just a passive phenomenon but is a structural determinant of poverty that needs to receive primary attention in poverty alleviation policies in the agricultural sector. It is important to note that this regression model controls for other socioeconomic and farm-specific variables, ensuring that these results demonstrate an independent effect of internet use on poverty risk.

Table 3. Estimation Result (All Model)

Variables	Coefficient	*Odds Ratio*
Internet	-1.001***	0.367
Male	-0.235***	0.791
Age	-0.070***	0.932
Age Squared	0.001***	1.001
Married	0.035	1.035
Household Size	0.455***	1.577
Urban	-0.112**	0.894
Foodcrops Subsector	-0.249***	0.780
Horticulture Subsector	-0.551***	0.576
Plantations Subsector	-0.207**	0.813
Access to Kredit Usaha Rakyat (KUR)	-0.976***	0.377
Access to Informal Credit	-0.543***	0.581
Constant	-1.561***	0.210
Pseudo R2	0.0847	
Observasi	21,368	

Signifcance levels: *p< 0.1 ; **p< 0.05; ***p< 0.01

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The use of the Internet in agriculture can play a role in various lines, such as disseminating agricultural product price information, weather forecasts, access to cultivation training, and digital supply chain management. Several previous studies have emphasized the great potential of the Internet as a catalyst for agricultural development. For example, (Zheng & Ma, 2024), in their field study in China, found that farmers who used the Internet to search for information on production inputs experienced an increase in cost efficiency and had a greater probability of accessing non-local markets. The Internet connects farmers with markets and wider socio-economic networks including digital cooperatives, e-commerce, and online training platforms.

In the context of East Java, geographic and infrastructure disparities are important factors in explaining the diversity of impacts of internet access. In urban areas, for example, the regression model results show that urban farmers who do not use the Internet have a 4.48 times greater risk of becoming poor than those who do, while rural farmers who do not use the internet are 2.30 times more likely to become poor (Odds Ratio = 0.433). This highlights that the potential benefits of the Internet in urban areas are considerably greater due to a more mature technology ecosystem, including stable 4G networks, wider smartphone penetration, and established digital platforms such as the Online Farmers Market or agricultural e-Catalogs. Thus, the Internet serves as a medium that significantly expands opportunities for productivity, efficiency, and even innovation in micro-scale agricultural businesses.

Regarding the Pseudo R2 (0.0847) observed in the overall model, it is important to acknowledge that low Pseudo R2 values are common in binary logistic models using cross-sectional socioeconomic data. This is typically due to the inherent complexity and multitude of factors influencing human behavior and socioeconomic outcomes, which often lead to limited explanatory power in terms of variance explained by the model, yet the results remain statistically valid and contribute valuable insights into the directional effects of the independent variables.

The regression results in the overall model show that male farmers have a lower risk of being poor than female farmers, with an odds ratio of 0.791 and a high significance level ($p < 0.01$). This means that men reduce the likelihood of being poor by 20.9% compared to women. This finding aligns with research from (Balehegn et al., 2020) and (Ngomane, 2024), which show that female farmers often experience structural barriers such as limited access to land, technology, training, and markets. Specifically in agriculture in Indonesia, gender inequality in access and participation in the rural economy is also still high, making women more economically vulnerable.

The variables age (Age) and age squared (Age Squared) show a non-linear relationship to poverty. The negative coefficient on the age variable (OR = 0.932) and the positive coefficient on age squared (OR = 1.001) indicate that the risk of poverty decreases at productive ages but increases again at old age. This illustrates a common inverted U-shaped pattern in welfare economics studies, where productive age provides income and work capacity advantages. In contrast, older age groups face physical and financial limitations. (Cunha et al., 2021) showed that transitioning to old age without adequate social protection can worsen poverty among elderly farmers. Therefore, poverty reduction efforts should be gender-sensitive and life-cycle aware, particularly in supporting aging farmers through tailored social protection and economic empowerment programs.

Marital status (Married) did not have a significant effect on poverty status (OR = 1.035; not significant). This shows that marital status does not significantly affect farmers' risk of poverty. This result differs from some literature stating that marriage can provide social and economic protection

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through income synergy and division of labor (Yimam & Holvoet, 2024). However, in this study, marriage only plays a neutral role. In the context of East Java, this neutral role of marital status might be attributed to the widespread prevalence of subsistence farming, where household income diversification often remains limited regardless of marital status, and external support systems (e.g., informal community networks, extended family) may play a more dominant role in welfare than intra-household synergy from marriage alone.

Household size is a significant predictor of poverty. The odds ratio of 1.577 indicates that every additional household member increases the risk of poverty by 1.57 times. This finding is consistent with much of the literature stating that large households have a greater consumption burden. If not balanced with increased productivity or income, the risk of poverty will also increase (Jolliffe & Tetteh-Baah, 2024). This finding is very relevant in the context of farming households in East Java, which generally have many dependents and limited sources of income.

The estimation results show that farmers living in urban areas tend to experience poverty less than those living in rural areas (reference category). This finding is consistent with the structural economic conditions, which show that urban areas generally have better access to supporting infrastructure, such as agricultural distribution networks, technology, access to credit, and a more diverse non-agricultural labor market. This accessibility contributes to greater opportunities to escape poverty than rural areas, which still face limitations in many aspects, such as road infrastructure, digitalization, and financial service penetration (Xiao et al., 2025; Zhao et al., 2022).

The observed disparity between urban and rural areas in East Java in terms of poverty risk can be attributed to the concentration of economic activities and superior infrastructure in urban centers, which facilitate better market access, higher off-farm income opportunities, and easier adoption of modern agricultural practices due to better connectivity and service availability. Conversely, rural areas often contend with geographical isolation, underdeveloped digital and physical infrastructure, and limited access to diversified livelihood options, thus perpetuating higher vulnerability to poverty.

Regarding subsectors, farmers in the food subsector (Foodcrops) have a lower risk of becoming poor than farmers in the reference subsector (livestock, fisheries, forestry). This shows that although income from food is relatively low, food farmers have production stability and better access to government programs. The higher poverty susceptibility in the reference category (livestock, fisheries, forestry) compared to food crops might stem from several factors, including higher capital intensity for initial investment, greater exposure to price volatility for specialized products, and potentially less extensive government support or safety nets compared to staple food production. Additionally, these subsectors might have more fragmented value chains and less organized market linkages, leading to reduced bargaining power for small-scale producers. Meanwhile, the horticulture subsector showed a greater reduction in the risk of poverty (OR = 0.576; $p < 0.01$), indicating that horticulture as a high-value subsector contributes significantly to increasing farmers' income. Research by (Fremmpong et al., 2023) supports this finding that diversification into horticulture effectively reduces poverty. The plantation subsector (Plantations) is also significant, although its influence is less significant than that of horticulture.

The variable of access to Kredit Usaha Rakyat (KUR) has the greatest impact on poverty reduction (OR = 0.377; $p < 0.01$). This shows that access to affordable and subsidized formal financing is key in lifting farmers out of poverty. KUR allows farmers to purchase production inputs, expand their businesses, and increase economic scale. (Douyon et al., 2022) emphasizes the importance of

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inclusive financing for productive economic growth in the agricultural sector. In addition to KUR, access to informal credit positively reduces the risk of poverty (OR = 0.581; p <0.01). This reflects that informal credit is still a vital source of financing for agricultural businesses in conditions of minimal banking access. However, high interest rates and risks in informal credit remain a concern and must be balanced with the expansion of formal financial inclusion (Zhai et al., 2023).

Given the continued effectiveness of informal credit in rural areas (OR = 0.615), a blended finance approach might be beneficial. This approach would combine the expansion of formal financing mechanisms like KUR with strategies to improve the transparency and fairness of informal systems, thereby meeting both long-term investment needs and short-term or urgent liquidity demands of farmers.

Segmented Analysis Based on Rural and Urban Farmers

In the urban farmer model (Table 4), the analysis results show that access to the internet has a very strong influence in reducing the risk of poverty. Farmers who do not use the internet are 4.48 times more likely to become poor than those who use the internet. This finding confirms that digital connectivity plays an important role in increasing the economic resilience of farmers in urban areas. Through internet access, farmers can obtain real-time market information, interact with buyers through online platforms, and access training and technical knowledge relevant to modern agricultural practices. A recent study by (Alfonsi et al., 2024) shows that the use of information and communication technology (ICT) can increase production efficiency and expand business opportunities for small farmers in urban areas.

Table 4. Estimation Result (Urban-Rural Model)

Variables	Urban		Rural	
	Coefficient	*Odds Ratio*	Coefficient	*Odds Ratio*
Internet	-1.500***	0.223	-0.837***	0.433
Male	-0.386***	0.679	-0.186***	0.830
Age	-0.091***	0.913	-0.065***	0.937
Age Squared	0.001***	1.001	0.001***	1.001
Married	0.137	1.147	0.006	1.006
Household SIze	0.459***	1.583	0.456***	1.578
Foodcrops Subsector	-0.094	0.910	-0.304***	0.738
Horticulture Subsector	-0.322*	0.725	-0.627***	0.534
Plantations Subsector	0.011	1.011	-0.282**	0.755
Access to Kredit Usaha Rakyat (KUR)	-1.298***	0.273	-0.892***	0.410
Access to Informal Credit	-0.709***	0.492	-0.487***	0.615
Constant	-1.156***	0.315	-1.696***	0.183
Pseudo R2	**0.0973**		**0.0817**	
Observasi	**5,485**		**15,833**	

Signifcance levels: *p< 0.1 ; **p< 0.05; ***p< 0.01

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Meanwhile, in the rural farmer model, although the effect of internet access remains significant, the magnitude of the impact is relatively smaller compared to urban areas. Rural farmers who do not use the internet are 2.30 times more likely to become poor than those who use it (odds ratio = 0.433). This shows that although the internet remains an important factor in supporting farmer welfare, limited infrastructure and digital literacy in rural areas may reduce the effectiveness of its use. These results are consistent with the findings of (Kosasih & Sulaiman, 2024) who emphasized the importance of infrastructure and local context in determining the success of digital transformation in rural areas. For rural areas, this highlights the critical importance of not only building digital infrastructure but also fostering digital literacy and providing robust user support for effective technology adoption.

However, in the rural model (Table 4), the most dominant variable in reducing the risk of poverty is access to Kredit Usaha Rakyat (KUR). Farmers who have access to non-KUR credit are 2.45 times more likely to become poor than farmers who receive KUR. This emphasizes the importance of inclusive financing schemes such as KUR which are designed with low interest rates, government guarantees, and technical assistance. Unlike informal credit which is often accompanied by high interest rates and the risk of default, KUR provides a guarantee of sustainable farming businesses. Research by (Haryanto et al., 2023) shows that KUR significantly increases the income and productivity of smallholder farmers in Indonesia.

CONCLUSION AND SUGGESTION

This study concludes that farmer poverty in East Java is a multidimensional problem, stemming not only from income aspects but critically exacerbated by limited access to digital technology, low ICT literacy, and restricted access to formal business financing. The profile of poor farmers is predominantly characterized by smallholder food crop producers, with a notable concentration in the agro-ecologically challenging Madura Island region. Specifically, our findings indicate that low ICT literacy (only 3% with ICT training) and minimal internet use (less than 5% active users) are significant obstacles to enhancing farming business productivity and efficiency. Furthermore, formal credit access remains limited, compelling a dominant reliance on financially high-risk informal credit. The logistic regression analysis robustly demonstrates that internet use significantly reduces the risk of poverty, particularly in urban areas where its impact is more pronounced (non-users 4.48 times more likely to be poor). In contrast, in rural areas, while internet access remains beneficial, formal financing through Kredit Usaha Rakyat (KUR) plays a comparatively greater and more dominant role in poverty risk reduction (non-KUR users 2.45 times more likely to be poor than KUR recipients). This nuanced geographical distinction underscores the heterogeneous drivers of poverty alleviation.

Based on these specific findings, several strategic and actionable policy recommendations emerge:

1. **Targeted Digital Literacy Expansion**: It is imperative to expand community-based digital literacy programs, especially for poor farmers in high-poverty concentration areas such as Madura Island. These programs should move beyond basic introduction to technology, directly integrating with practical farming activities like digital marketing, real-time weather monitoring, and access

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to dynamic price information, and be delivered through farmer group-based approaches to leverage social capital.

2. **Reinforced Rural ICT Infrastructure**: The government must prioritize strengthening information technology infrastructure in underserved rural areas. This foundational investment is crucial for enabling the broader digital transformation of agriculture and maximizing the potential benefits of internet use for rural farmers.
3. **Enhanced Inclusive Formal Financing**: Access to formal farming financing, particularly Kredit Usaha Rakyat (KUR), needs substantial expansion. This requires streamlining application procedures, increasing the capacity of distribution institutions, and strengthening the role of farmer cooperatives as strategic partners in facilitating access to and utilization of KUR. Furthermore, considering the continued role of informal credit in rural areas, exploring blended finance approaches that combine formal expansion with improvements in informal systems could address diverse farmer needs.
4. **Gender and Life-Cycle Sensitive Interventions**: Poverty reduction efforts should be gender-sensitive and life-cycle aware. Specific programs supporting aging female farmers, for instance, through tailored social protection schemes, access to technology, and economic empowerment initiatives, are essential to address structural vulnerabilities identified in the study.
5. **Subsector-Specific Support & Diversification**: Policies should consider subsector-specific vulnerabilities. While supporting stable food crop production, efforts should also actively promote diversification into higher-value horticulture and plantation subsectors, potentially through specialized training and market linkage programs, to enhance income resilience.
6. **Place-Based Policy Customization**: A more granular, regional-based policy approach is essential. Interventions must consider unique local characteristics, such as agro-ecological conditions in Madura, to ensure that support programs are highly targeted, effective, and sustainable, rather than one-size-fits-all solutions.

These concerted efforts are crucial not only for building agriculture that is productive but also for ensuring it is socially inclusive and adaptively responsive to the rapid technological changes of the digital economy era. Future research could further explore the causal mechanisms through which digital literacy and internet engagement translate into tangible economic benefits for farmers, possibly through longitudinal studies or qualitative investigations into farmers' actual usage patterns and perceived barriers in different regional contexts within East Java.

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