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Socio-Economic Factors Shaping the Livelihoods of Maize Smallholders in Central Java, Indonesia

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ABSTRACT: Maize is strategically essential in Indonesia's agricultural sector, supporting food security and farmers' livelihoods. However, maize farmers in Central Java continue to face challenges in achieving stable productivity and income due to socio-economic constraints. This study aims to evaluate the financial feasibility of maize farming and analyze the socio-economic factors that affect farmers' income in Batang District, Central Java. A survey method was applied to 250 maize farmers selected purposively from three central producing districts: Tersono, Pecalungan, and Bandar. Data were analyzed using farm business analysis (R/C ratio) and the Ordinary Least Squares (OLS) multiple regression. The results indicate that maize farming in Batang District is financially viable, with an average R/C ratio of 1.62. Regression analysis reveals that land size, farming experience, land ownership, and participation in agricultural extension services significantly increase farmers' income, while high labor costs exert an adverse effect. Other socio-economic variables, such as education, age, and farmer group membership, were found to be statistically insignificant. The findings suggest that strategies to improve maize farmers' income should focus on expanding land access, enhancing the quality of extension services, improving labor efficiency, and strengthening farmers' technical capacity. This study contributes to the existing literature by combining financial feasibility and socio-economic determinants in a single framework, providing empirical evidence and policy insights to support sustainable maize farming in Indonesia.

1. INTRODUCTION

Maize (*Zea mays* L.) is one of the world's most essential cereals [1]. It is cultivated for its multifunctional role as food, livestock feed, and industrial raw material such as starch, sweeteners, oil, and bioethanol. Global demand for maize has consistently increased with population growth, dietary changes, and the expansion of the livestock and bioenergy sectors [2], [3], [4]. Various food technologies are used worldwide to process maize flour into products such as precooked refined flour, nixtamalized flour, and fermented flour, each with distinct nutritional characteristics depending on processing methods [5]. Over the past decades, maize production has grown significantly, driven by higher yields, technological advancements, and the expansion of cultivated areas. According to FAO projections, maize will remain the most widely cultivated and traded cereal in the coming decades due to its central role in global food and feed systems [6].

In Indonesia, maize occupies a strategic position within the agricultural sector, contributing to national food security and the livelihoods of millions of smallholder farmers across diverse agroecological zones [7]. Domestic demand for maize has increased

sharply, particularly for livestock feed, yet national production has not kept pace, leading to recurrent reliance on imports to meet the shortfall [8]. This demand is expected to continue rising in line with population growth, improved living standards, and the increasing consumption of animal protein, especially chicken and eggs, which further stimulates the feed industry [9]. Despite government initiatives to promote maize self-sufficiency, smallholder farmers face persistent challenges, including limited access to improved seeds, fertilizers, irrigation facilities, and agricultural credit. Institutional support in the form of extension services and farmer training also remains insufficient, constraining the adoption of modern farming practices [10]. These structural barriers directly affect farm income and, ultimately, rural welfare.

Central Java is one of Indonesia's leading maize-producing provinces. Batang District offers substantial potential due to its diverse topography and agroecological conditions, ranging from coastal lowlands to upland areas near the Dieng Plateau. In 2024, the district reported a maize harvest area of 12,798 hectares, making it the second most important food crop after rice [11]. The diversity of land types provides opportunities for expanding maize cultivation. However, local farmers face persistent challenges, including unstable yields, rising labor costs, and low adoption of improved technologies. These structural constraints limit productivity and undermine the region's profitability and long-term sustainability of maize farming.

Previous studies on maize farming in Indonesia have evaluated mainly technical efficiency and financial feasibility, emphasizing cost–benefit ratios, input–output relationships, and productivity performance [12], [13]. Findings from these studies consistently affirm that maize cultivation is generally profitable for smallholder farmers. However, such analyses tend to adopt a narrowly economic lens, often overlooking the broader socio-economic dimensions that also play a decisive role in shaping farm-level income and long-term sustainability.

Evidence from other developing countries illustrates that farm profitability is not determined solely by input costs and yield outcomes but is also strongly influenced by structural and institutional factors such as land tenure security, accumulated farming experience, farmers' educational attainment, active participation in farmer organizations, and access to agricultural extension services [14]. These variables affect farmers' decision-making processes, ability to adopt innovations, and capacity to withstand risks and market fluctuations.

Therefore, integrating socio-economic determinants with financial feasibility assessments provides a more holistic framework for understanding smallholder performance. Such an approach enables researchers and policymakers to capture the efficiency of input allocation and the institutional and human capital dimensions that underpin productivity and income distribution. In turn, this comprehensive perspective generates more nuanced insights that can guide the design of targeted interventions to strengthen Indonesia's resilience, inclusivity, and sustainability of maize farming systems.

International literature further underscores that maize profitability is not solely determined by yield but also by trade-offs between productivity, labor demand, risk exposure, and socio-economic constraints. Intensification strategies, for instance, may increase yields but simultaneously raise labor requirements or production risks depending on the context [2], [3]. These insights point to the need for localized studies identifying which socio-economic determinants are most influential in specific regions such as Batang District. Against this backdrop, the present study addresses a critical research gap by systematically examining the financial feasibility of maize farming and the socio-economic determinants of smallholder income in Central Java. By combining farm business analysis with econometric modelling, the study contributes empirical evidence and policy-relevant insights that can inform strategies to enhance smallholders' profitability, strengthen extension services, and promote sustainable rural livelihoods in Indonesia.

2. MATERIALS AND METHODS

This study employed a quantitative research method with a survey approach, involving direct field observation through interviews and questionnaires. This type of research reflects the principles of correlational studies, using appropriate and practical techniques to capture respondents' thoughts, opinions, and emotions. The study was conducted from April to June 2025, and the research locations were three sub-districts with the largest maize harvest areas in Batang District: Tersono, Pecalungan, and Bandar. This study involved a total of 250 maize farmers as respondents. Respondents were selected using purposive sampling based on predefined eligibility criteria, and the sampling procedure was conducted in collaboration with local agricultural extension officers and farmer-group leaders to identify farmers who met the study requirements. Farmers were eligible to participate if they actively cultivated maize during the first cropping season of 2025, and they had previous experience in maize cultivation for at least one cropping season. These criteria ensured that respondents had recent, relevant experience in

maize farming and could provide reliable information on production activities, farm costs, revenues, and income during the study period. The primary data collected included maize farming inputs and outputs.

2.1 Research Design and Study Area

Farm income was defined as the difference between total farm revenue and total explicit costs. Farm costs were measured using the explicit cost approach for one maize production cycle. The explicit costs refer to actual monetary expenditures incurred by farmers during the production process. These costs included expenditures for maize seeds, N single fertilizer, NPK complex fertilizer, manures, pesticides, herbicides, hired labor, land tax, land rental costs, irrigation contributions, harvest transportation, and traditional harvest celebration ceremony. Costs that did not involve actual cash expenditures, such as family labor, were not included in the calculation.

Maize Farm Income = Total Farm Revenue – Total Farm Explicit Costs

To empirically examine the socio-economic determinants of maize farmers' income in Batang District, a set of explanatory variables was identified based on previous studies on farm income analysis in Indonesia and other developing countries [2], [3], [10], [14], [15], indicating that farmer and farm characteristics may influence farm income. The dependent variable is the natural logarithm of net farm income. In contrast, the independent variables consist of land size, input prices (seeds, fertilizers, manure, pesticides, labor), and farmer characteristics (education, age, farming experience). Age and education represent farmers' characteristics, while land size, labor use, and farming experience capture farm resource availability and managerial experience. Institutional and resource-related factors are represented by three dummy variables: land tenure, access to extension services, and farmer group membership. The definition, measurement, type, expected effect, and supporting references for each variable are presented in Table 1.

Table 1. Definition and Measurement of Variables Used in the Regression Model

Code	Variable	Definition/Measurement	Type	Expected Effect	Reference
<i>Inc</i>	Farmers' income	Maize farm income, defined as the difference between total revenue and total explicit cost during one production cycle (IDR/cropping season)	Continuous	Dependent	[16], [17]
<i>Land</i>	Land size	Total cultivated land for maize (hectares)	Continuous	+	[18], [19], [20]
<i>Seed</i>	Seed Price	Price of maize seed used (IDR/kg)	Continuous	-	[21], [22], [23]
<i>Ferti</i>	Fertilizer price	Price of single N fertilizer (IDR/kg)	Continuous	-	[24], [25], [26]
<i>Manu</i>	Manure price	Price of manure applied (IDR/kg)	Continuous	-	[18], [27], [28], [29]
<i>Pest</i>	Pesticide price	Price of pesticide applied (IDR/kg)	Continuous	-	[30], [31]
<i>Labo</i>	Hired labor	Price of hired labor (IDR/working day)	Continuous	-	[32], [33], [34], [35]
<i>Educ</i>	Education	Years of formal schooling of the farmer (years)	Continuous	+	[36], [37], [38], [39], [40]
<i>Age</i>	Age	Age of household head (years)	Continuous	±	[15], [41], [42]

<i>Expe</i>	Farming experience	Farmers' experience in maize cultivation (years)	Continuous	+	[43], [44], [45]
<i>Tenu</i>	Land tenure	Own land = 1; otherwise= 0	Dummy	+	[46], [47]
<i>Exte</i>	Extension service	Accessed extension services = 1; otherwise = 0	Dummy	+	[23], [48], [49], [50]
<i>Memb</i>	Farmer group membership	Member of the farmer group = 1, otherwise = 0	Dummy	+	[51], [52]

Model specification:

$$\ln(Inc) = \alpha + \beta_1 \ln Land + \beta_2 \ln Seed + \beta_3 \ln Ferti + \beta_4 \ln Manu + \beta_5 \ln Pest + \beta_6 \ln Labo + \beta_7 \ln Educ + \beta_8 \ln Age + \beta_9 \ln Expe + \gamma_1 Tenu + \gamma_2 Exte + \gamma_3 Memb + e$$

Where, *Inc* is the natural log of maize farmer's income; *Land*, land size (hectare); *Seed*, price of maize seed (IDR/kg); *Ferti*, price of N single fertilizer (IDR/kg); *Manu*, price of manure (IDR/kg); *Pest*, price of pesticide (IDR/kg); *Labo*, price of hired labour (IDR/kg); *Educ*, farmer's education (year); *Age*, farmer's age (year); *Expe*, farming experience (year); *Tenu*, land tenure (own=1, otherwise=0); *Exte*, access to extension service (yes=1, otherwise=0); *Memb*, farmer group membership (yes=1, otherwise=0); α , intercept; $\beta_1, \beta_2 \dots \beta_9$, coefficients for the respective variables; e , error term. $\gamma_1 \dots \gamma_3$, coefficients for the dummy variables.

2.2. Model Diagnostic

To ensure reliability, the OLS diagnostic tests were conducted, including multicollinearity, which was assessed using the Variance Inflation Factor ($VIF < 10$), and heteroskedasticity, which was also examined using the Breusch–Pagan test. A formal residual normality test was not performed, and therefore no claim regarding the normality of residuals is made. The OLS estimation was based on observations consisting of 250 farmers. The model's explanatory power was evaluated using the coefficient of determination (R^2). In contrast, overall model significance was assessed through F-tests, and the significance of individual predictors through t-tests at the 1%, 5%, and 10% significance levels.

3. RESULTS AND DISCUSSION

3.1. Farmers' Characteristics

Farmer characteristics such as age, education, and farming experience are important because they influence decision-making in farm management, technology adoption, and resource allocation. These attributes provide essential context for understanding differences in productivity and income among farming households. Presenting these characteristics at the outset allows for a more straightforward interpretation of subsequent findings on input allocation, cost structures, and regression analysis. The summary of respondents' characteristics is presented in Table 2.

Table 2. Respondent Characteristics of Maize Farmers in Batang District, Central Java

No.	Variables	Mean	Std Deviation	Minimum	Maximum
1	Age	55	11.48	22	85
2	Education	7	2.96	1	16
3	Farming experience	30	13.68	2	70

Source: Primary data processed, 2025

The socio-economic profile of maize farmers in Batang District shows a combination of opportunities and limitations for agricultural development. The average age of respondents is 55 years, with a range from 22 to 85 years, indicating that maize farming is predominantly managed by middle-aged and older farmers. The average education level is seven years, equivalent to primary schooling, suggesting relatively low formal educational attainment among farmers. Farming experience is relatively

high, with an average of 30 years, reflecting intense exposure to agricultural practices and accumulated local knowledge over time.

3.2 Production and Input Allocation

Understanding the allocation of production inputs is essential for evaluating the efficiency and sustainability of maize farming. Input use, such as seeds, fertilizers, and other production factors, directly determines crop yield and farm profitability. Input allocation provides insights into whether farmers apply resources optimally or face constraints that may hinder productivity improvements. In the case of Batang District, where maize farming is largely small-scale, variations in input use across households reflect differences in resource endowments, access to markets, and technical knowledge. Table 3 presents the descriptive statistics of production and input allocation among the surveyed farmers.

Table 3. Production and Input Allocation of the Maize Farm

No.	Variables	Mean	Std. Deviation
1	Maize Production (kg/hectare)	4,309	5,797.85
2	Maize Seeds (kg/hectare)	12.27	13.10
3	N Single Fertilizer (kg/hectare)	309.60	143.60
4	NPK Complex Fertilizer (kg/hectare)	254.64	133.35
5	Manurer	1,006.24	522.66
6	Pesticides (liter/hectare)	3.51	1.86
7	Herbicides (liter/hectare)	3.67	1.91
8	Hired Labor (working people's day/hectare)	48.76	14.58

Source: Primary data processed, 2025

The result in Table 3 indicates that the average maize yield in Batang District is 4,309 kg per hectare, accompanied by a substantial standard deviation of 5,797.85 kg per hectare. This wide variation reflects considerable productivity differences among farmers, suggesting heterogeneous farm performance within the district. Input allocation data further shows diverse production practices. The average seed application rate is 12.27 kg per hectare is within the typical range for hybrid maize yet substantial variability persists across farmers. Fertilizer use is relatively intensive, with an average of 309.60 kg per hectare of nitrogen fertilizer and 254.64 kg per hectare of NPK fertilizer. Farmers also apply an average of 1,006.24 kg per hectare of organic manure. Chemical inputs are used regularly, with pesticides averaging 3.51 liters per hectare and herbicides 3.67 liters per hectare. Labor use remains high, averaging 48.76 working days per hectare, confirming the labor-intensive nature of maize cultivation in the district.

3.3. Cost Structure

Analyzing the cost structure of maize farming is crucial to assessing its economic feasibility and long-term sustainability. Farmers' costs include variable inputs, such as seeds, fertilizers, labor, fixed land use, and farm maintenance expenses. Understanding how these costs are distributed provides insights into the profitability of maize farming and highlights the efficiency with which resources are utilized. Moreover, evaluating revenues, income, and the R/C ratio offers a comprehensive picture of financial performance, enabling policymakers and farmers to identify potential areas for cost reduction and productivity enhancement. Table 4 summarizes the average costs, revenues, income, and the R/C ratio of maize farming in Batang District.

Table 4. Average Costs, Revenues, Income, and R/C Ratio of Maize Farming (1 IDR = 0.00006 \$ USD)

	Description	Average IDR/hectare	Percentage (%)
1	Explicit Costs		
	Maize seeds	1,431,596	11.05
	N single fertilizer	1,424,160	10.99
	NPK complex fertilizer	1,171,344	9.04
	Manures	1,006,240	7.77
	Pesticides	421,200	3.25
	Herbicides	403,700	3.12
	Hired Labor	4,388,400	33.88
	Land tax	222,526	1.72
	Land rental costs	1,924,087	14.85
	Irrigation contributions	49,086	0.38
	Harvest Transportations	322,412	2.49
	Traditional harvest celebration ceremony	188,538	1.46
	Total Explicit Costs	12,953,289	100.00
2.	Revenue		
	Dried maize kernels sales	20,971,903	
3.	Income	8,018,614	
4.	R/C Ratio	1.62	

Source: Primary data processed, 2025

The cost structure of maize farming in Batang District, as presented in Table 4, shows a strong dependence on hired labor, which constitutes 33.88% of total explicit costs (12,953,289 IDR/ha). Land rental expenses also represent a substantial portion of production costs at 14.85%, indicating considerable reliance on non-owned land. Despite these relatively high input expenditures, maize farming generates an average revenue of 20,971,903 IDR/ha and a net income of 8,018,614 IDR/ha, resulting in an R/C ratio of 1.62. This demonstrates that maize cultivation is profitable, although the profit margin remains moderate.

3.4. Socio-Economic Factors

Beyond technical inputs and cost considerations, socio-economic factors play a crucial role in determining the performance and profitability of maize farming. Variables such as land size, education, farming experience, and land tenure status can significantly influence farmers' decision-making processes and efficiency in resource allocation. These factors often shape how farmers can adopt improved technologies, access markets, and sustain farm productivity. A multiple linear regression model was employed to examine these relationships systematically. This approach identifies key determinants of farm income while controlling for potential multicollinearity among explanatory variables (Table 5). The regression analysis results highlight the relative importance of different socio-economic factors in explaining variations in maize farmers' income in Batang District.

Table 5. Analysis Results of Multiple Linear Regression.

Model		Coefficients ^a	t-ratio	VIF
1	Intersep	11.949***	3.26	
	Land size	0.500***	8.07	1.39
	Price of Seeds	0.104	0.41	1.07
	Price of N single fertilizer	-0.146	-0.74	1.21
	Price of manure	0.038	1.28	1.21
	Price of Pesticides	-0.040	-1.61	1.09
	Hired Labor wages/day	-0.146**	-2.18	1.13
	Farmer's Education	0.066	0.64	1.92
	Farmer's Age	0.426	-1.52	2.12
	Farmer's Experience	0.268***	3.05	
	Land Tenure	1.383***	9.80	1.40
	Access to extension service	0.644***	4.43	1.38
	Farmer Group membership	-0.083	-0.71	1.15
	R ²	0.6389		
	Adj-R ²	0.6206		
	F-table	34.94***		
	Cook-Weisberg	0.061		
a.	Dependent Variable: Maize Farmers' Income			
b.	Significance: *** significant at $\alpha=1\%$ (0.01)			
	** significant at $\alpha=5\%$ (0.05)			

Source: Primary data processed, 2025

The multiple regression analysis demonstrates that farmers' income in Batang District is influenced by a combination of biophysical, economic, and institutional factors. The heteroskedasticity test produced a p-value of 0.0601 which is greater than $\alpha = 0.05$, indicating that there is no statistically significant evidence of heteroskedasticity in the OLS model. The multicollinearity test, in which all VIF values were below 10, indicates that multicollinearity was also not a serious concern in this estimated regression model. The model is statistically significant, as indicated by an F-statistic of 29.87 ($p < 0.01$), while the adjusted R-squared value of 0.6188 indicates that approximately 62% of the variation in income is explained by the selected variables.

Among the predictors, land size, farming experience, land tenure status, and extension participation exhibit positive and significant effects on income. The positive effect of land size indicates that farmers cultivating larger areas tend to obtain higher income, while the positive effect of farming experience, secure land tenure, and extension participation suggest that farm resources, farming knowledge, tenure conditions, and access to extension services are associated with higher income. Conversely, labor costs show a significant negative effect, indicating that higher wage expenditures reduce net farm returns, holding other factors constant.

Meanwhile, seed cost, fertilizer and pesticide costs, education, age, and group membership were found to be statistically insignificant. The absence of statistical significance indicates that variations in these variables were not associated with statistically detectable differences in income within the study sample. This may be related to limited variation in some farmer

characteristics or input expenditures across respondents. Therefore, the findings indicate that there were no statistically detectable differences in maize farm income, whereas the effects of the non-significant variables could not be established statistically in this sample.

3.4 Discussion

3.4.1. Farmers' Characteristics

The dominance of older farmers in maize cultivation has several important implications. Older farmers tend to be more risk-averse and less willing to adopt improved technologies, which can reduce production efficiency if not supported by adequate institutional services [53]. This demographic trend also signals challenges for generational renewal and the long-term sustainability of maize farming.

Although education is a key determinant of productivity and decision-making capacity [40], the low average education level in Batang District may hinder farmers' ability to access, interpret, and apply modern agricultural information or participate effectively in extension activities. This underscores the need for farmer training and knowledge transfer approaches tailored to local literacy levels.

Extensive farming experience contributes positively to resilience and adaptive strategies [54]. However, experience alone does not necessarily translate into openness to innovation, especially when coupled with aging demographics and low education. This combination may slow the adoption of improved technologies and limit modernization efforts in maize production.

These findings highlight that despite strong experiential knowledge, structural constraints, particularly age and education, pose barriers to innovation. Strengthening extension services, enhancing institutional support, and encouraging youth participation in agriculture are essential for ensuring sustainable maize production in Batang District.

3.4.2. Production and Input Allocation

The large variability in yield observed among farmers is likely driven by differences in management practices, access to input resources, biophysical land conditions, and levels of technology adoption. This substantial yield gap also reported in other maize-producing regions of Indonesia suggests that farmers with optimized input use perform significantly better than those constrained by resource limitations. Variations in seed rate reflect differences in seed quality and agroecological suitability, which are key factors influencing yield outcomes. Seeds, fertilizers, and labor are major determinants of maize productivity, especially when integrated with subsidy policies [55].

The high but uneven fertilizer application suggests that both overuse and underuse occur due to financial constraints and variable access. Nitrogen fertilizer generally contributes positively to yield, whereas inappropriate NPK application may reduce productivity without proper soil and water management [56]. The integration of organic manure highlights efforts toward maintaining soil fertility, with studies showing that organic inputs can enhance nutrient uptake and improve yields in suboptimal soils [57].

Chemical pest and weed control remain common, although sustainability concerns persist. The effectiveness of pesticides and herbicides depends on dosage and timing, reinforcing the need for Integrated Pest Management (IPM) to balance productivity with ecological health. High labor use reflects the limited mechanization typical of smallholder systems. Rising wages and labor shortages further elevate production costs, while mechanization, even at small scales, has been shown to improve efficiency [58].

Diverse input-allocation patterns demonstrate both adaptive strategies and inefficiencies. Strengthening extension services is essential to promote balanced fertilizer use, adoption of IPM, and gradual mechanization. Extension plays a critical role in improving farmers' capacity to adopt sustainable practices [59]. Targeted interventions will help enhance productivity while promoting an inclusive and environmentally sound maize production system in Batang District.

3.4.3. Cost Structure

The heavy reliance on hired labor highlights the labor-intensive nature of maize farming in smallholder systems. Prior evidence from Indonesia shows that mechanization can significantly enhance economic efficiency by lowering labor requirements and reducing the financial burden on farmers [60]. In contexts where family labor or machinery is limited, fluctuations in wage rates

can substantially erode profitability. The substantial share of land rental costs also reflects structural constraints, as studies on small-scale maize farmers indicate that secure land ownership and access to mechanization tend to increase farm income [61].

Although maize farming remains profitable, the moderate R/C ratio suggests vulnerability to changes in input prices, particularly labor costs. Comparative findings from Bali show that early harvested maize achieved a higher R/C ratio owing to more efficient cost management and optimal timing of sales [62]. This underscores the importance of improving cost efficiency and strengthening market-oriented decision-making.

To address these challenges, policy measures should prioritize accelerating mechanization to reduce dependence on hired labor, enhancing land tenure security, facilitating farmer access to cultivable land, and promoting more efficient use of seed and fertilizers. Strengthening extension services is also essential to support farmers in managing production costs and optimizing the timing of farming operations. Furthermore, investments in digital agricultural infrastructure have been shown to improve smallholder performance and yield outcomes [63]. Collectively, these interventions can enhance profitability and reduce economic risks for maize farmers in Batang District.

3.4.4. Socio-Economic Factors

The strong significance of land size confirms the importance of economies of scale in smallholder maize production. Larger landholdings allow farmers to distribute fixed costs more efficiently and generate a higher marketable surplus. This finding aligns with those of previous studies, indicating that land area is a key determinant of technical and economic efficiency [64]. These insights highlight the need for land consolidation programs or cooperative land-use arrangements to enhance income stability and sustainability.

The negative effect of labor costs underscores the vulnerability of smallholders to rising wage rates, especially in labor-intensive systems. Similar evidence from rural Asia shows that increasing labor costs erode farm profitability unless compensated for by labor-saving technologies [65]. Mechanization, therefore, becomes essential for improving efficiency in Batang District.

Farming experience significantly contributes to income, reflecting the importance of tacit knowledge, risk management, and adaptive capability, particularly when supported by extension services [66]. This finding reinforces the role of human capital as a critical intangible asset in agricultural performance.

Land tenure security has emerged as another major determinant. Farmers who own their land have greater incentives for long-term soil management and are exempt from rental payments, resulting in a higher income. This finding is consistent with global evidence that demonstrates that stronger property rights enhance productivity and investment [67].

Extension participation also significantly boosts income, confirming its role in improving technology adoption, knowledge access, and decision-making. Similarly, findings from Banten Province show that extension services increase smallholder income [66], emphasizing the importance of effective agricultural advisory systems.

In contrast, farmer group membership is not significant, indicating a gap between the formal existence of farmer organizations and their functional capacity. Challenges such as weak organizational management, free-riding, and ineffective collective marketing limit their impact issues, which are also noted in comparative studies [68].

The insignificance of variables such as input prices, education, and age likely reflects the relative homogeneity of production practices across farmers and the indirect nature of these demographic factors in influencing income.

Overall, the findings highlight that improving income requires strengthening land access and tenure security, reducing labor constraints through mechanization, enhancing extension support, and revitalizing farmer groups to operate as effective institutions for collective action.

This study is limited by its geographical scope, conducted solely in Batang District and the use of purposive sampling; consequently, the generalization of results requires caution. The use of cross-sectional data fails to capture the dynamics of farming operations over time, particularly regarding fluctuations in maize prices and input costs. The research variables are limited and do not encompass other factors such as technology, financing, market access, and farmer institutions.

4. CONCLUSION

This study demonstrates that maize farming in Batang District remains financially feasible, as reflected by an average R/C ratio of 1.62, signifying that the enterprise generates profit and serves as an essential livelihood source for smallholder farmers. Nonetheless, income levels are not exclusively shaped by financial performance; socio-economic and institutional dimensions also play a critical role. The empirical findings indicate that cultivated land size, years of farming experience, land tenure, and involvement in extension programs significantly enhance farmers' income. At the same time, rising labor costs exert a negative influence due to their dominance in production expenses. In contrast, other variables such as input prices (seeds, fertilizers, and pesticides), education, age, and farmer group membership were found to be statistically insignificant. This outcome underscores that structural and institutional determinants influence income more than individual demographic attributes. From a policy perspective, the study highlights the urgency of strategies to expand access to land ownership, promote labor efficiency through mechanization or labor-saving innovations, and strengthen extension services with more targeted and participatory approaches. Additionally, enhancing farmers' technical competencies and revitalizing the economic role of farmer organizations are essential to sustaining income growth and ensuring the long-term viability of maize farming in Batang District. Future research should expand the study area and observation period, as well as utilize panel or time-series data, to obtain more comprehensive results.

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AUTHOR CONTRIBUTIONS

Migie Handayani: Conceptualization, Design, Statistical Analysis, Literature Research.

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Muhammad Luthfie Fadhilah: Design, Data Collection, Literature Research, Writing—Review & Editing.

CONFLICT OF INTEREST

We declare that there is no conflict of interest.

ETHICS STATEMENT

Not applicable in this study.

DATA AVAILABILITY STATEMENT

Data supporting the findings of this study are available from the corresponding author upon reasonable request.

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