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Internal Efficiency and Competitiveness of Maize Farming in Indonesia: Evidence from Batang Regency Using the Policy Analysis Matrix

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ABSTRACT: Maize is vital in Indonesia's agricultural economy, serving as a staple food and the primary component of livestock feed. Rising demand from Indonesia's livestock industry has intensified pressure on domestic maize production, raising concerns about farm-level competitiveness and the effectiveness of existing support policies. Despite the strategic role of maize in Indonesia, empirical evidence on internal efficiency and policy distortions at the farm level remains limited. This study contributes to the literature by providing farm-level evidence on the interaction between competitiveness and policy distortions in a representative maize-producing region of Indonesia. This study evaluates the competitiveness, comparative advantage, and policy effects of maize farming using the Policy Analysis Matrix (PAM) framework. Batang Regency, a representative maize-producing area in Central Java, was selected as the study area. Data from 217 farmers were analyzed to assess profitability, comparative advantage, and policy effects. The results show that maize farming generated positive private and social profits, indicating both financial viability and economic efficiency. A DRCR of 0.72 and an SBCR of 1.17 confirm the comparative advantage of maize farming and the efficient use of domestic resources. Policy indicators suggest mixed impacts: NPCI of 0.23 (<1) enhances profitability, while NPCO of 0.87 (<1) reduces farmers' revenues. The EPC of 1.43 (>1) indicates net government protection, however, farmers remain highly dependent on input subsidies. These findings suggest that enhancing farm productivity and reducing market distortions would provide a more sustainable pathway for improving the long-term competitiveness of Indonesia's maize sector than continued reliance on input subsidies.

1. INTRODUCTION

Maize is a strategic commodity in Indonesia, serving as both a major food crop and the primary raw material for the livestock feed industry. Rapid growth in the livestock sector has increased maize demand substantially, placing pressure on domestic production and raising concerns about the sector's long-term competitiveness. According to [1], national maize production in 2025 reached 16.11 million tons. This figure increased by 6.44%, or 0.97 million tons, compared to 2024's 15.14 million tons. While the increase in maize production reflects the sector's growing capacity to meet domestic demand, production growth alone does not necessarily indicate improved competitiveness. In agricultural systems, competitiveness is determined not only by output growth but also by production efficiency, resource use, and the ability to sustain performance under changing market conditions [2] [3]. Similar challenges have been reported across developing countries, where increasing demand for maize has intensified concerns regarding the long-term sustainability and competitiveness of domestic production systems [4] [5].

[6] presents the national maize productivity is 7 tons/ha but has shown considerable fluctuations in recent years. Such variability raises concerns regarding the efficiency and sustainability of maize production, as stable productivity growth is essential for strengthening comparative advantage and maintaining long-term competitiveness [7]. [8] [9] state that agricultural competitiveness depends not only on output expansion but also on production efficiency, comparative advantage, and the extent to which market and policy conditions support sustainable farm performance.

Moreover, it remains unclear whether recent improvements in maize production are primarily driven by efficient resource utilization or by policy interventions that influence production incentives. This issue is particularly important for assessing the long-term competitiveness and sustainability of Indonesia's maize sector. Previous studies in Indonesia have primarily focused on maize productivity [10] [11] technology adoption, or farm profitability. A more comprehensive evaluation is therefore needed to simultaneously assess private profitability, social profitability, comparative advantage, and the effects of government policies. The Policy Analysis Matrix (PAM) provides an appropriate analytical framework because it integrates these dimensions, enabling a more objective assessment of farm competitiveness and the extent to which policy distortions influence production incentives.

This research gap is particularly relevant in Batang Regency, a representative maize-producing region in Central Java. The region is characterized by widespread smallholder farming and substantial exposure to agricultural support programs, yet its farm-level competitiveness has not been comprehensively evaluated. Although numerous studies have assessed maize competitiveness in Indonesia using the Policy Analysis Matrix (PAM), it remains unclear whether the competitiveness reported in previous studies reflects genuine economic efficiency or temporary advantages created by policy support such as input subsidies and output price support. This distinction is critical because competitiveness derived mainly from policy protection may improve short-term profitability but does not necessarily reflect long-term economic efficiency or sustainability.

Despite its contribution to regional maize production, empirical evidence regarding the economic efficiency, comparative advantage, and policy impacts on maize farming in Batang Regency remains limited. Understanding these aspects is particularly important in the context of Indonesia's fluctuating maize productivity, unstable self-sufficiency, and relatively weak comparative position in global maize markets. Therefore, this study applies the Policy Analysis Matrix (PAM) to evaluate the competitiveness, comparative advantage, and policy effects of maize farming in Batang Regency. By distinguishing between competitiveness derived from intrinsic production efficiency and that resulting from policy-induced incentives, this study contributes to the literature on agricultural competitiveness and provides policy-relevant insights for enhancing the long-term sustainability of Indonesia's maize sector.

2. MATERIALS AND METHODS

2.1 Study Material

This study was conducted from June to July 2025 in Batang Regency, Central Java Province, Indonesia. The regency holds substantial potential for agricultural sector development, particularly in its southern region, which is characterized by hilly topography and relatively cool climatic conditions. This region encompasses several districts, namely Pecalungan, Bandar, Bawang, Reban, Limpung, and Tersono. Local farming communities in these areas are actively engaged in cultivating various food crops, with maize being one of the key commodities. Maize production is predominantly concentrated in Pecalungan, Bandar, and Tersono Districts; therefore, these three districts were selected as the primary focus of the present study.

2.2 Sample Collection

The sampling procedure in this study was conducted in several stages. In the first stage, Batang Regency, Central Java Province, was purposively selected as the research site due to its ongoing efforts to strengthen food crop cultivation. In the second stage, three districts recognized as the main centers of maize production Pecalungan, Bandar, and Tersono were identified as the study areas. In the final stage, respondent farmers were randomly selected from these districts using a random sampling technique, ensuring representativeness of the farming population in the selected locations. The number of respondents is 217 maize farmers.

This study employed both secondary and primary data sources. Secondary data was obtained from official publications of the Central Statistics Agency (BPS) and relevant prior research. Primary data were collected through a cross-sectional field survey using a structured questionnaire administered to maize farmers in the selected districts. The questionnaire was designed to elicit

detailed information on production practices, input utilization, cost structures, revenues, and other farm-level characteristics pertinent to the analysis.

2.3 Analytical Methods

All data collected were systematically coded and entered Microsoft Excel prior to being processed and analyzed using the Policy Analysis Matrix (PAM) framework, which provides a comprehensive tool for assessing the profitability, efficiency, and policy implications of maize farming systems.

Table 1. Policy Analysis Matrix Framework

	Cost			
	Revenue	Tradable	Domestic Factor	Profit
Private price	A	B	C	D
Social price	E	F	G	H
Divergence	I	J	K	L

Source: [8]

Before determining the private and social prices, the first step was to classify all inputs and outputs into tradable and non-tradables (primary factors). This classification is indispensable, because shadow prices are often determined differently for primary versus tradable. Primary factors or domestic factors or non-tradable goods are goods that are not normally traded internationally but are supplied locally and these always include land, labor, water, and capital. Labor and capital are considered the primary factors of production in a non-tradable goods economy. Tradable goods are defined as being traded internationally or potentially could be traded. Tradable goods play a crucial role in the economic growth of countries, particularly those that rely on exports as a significant part of their economic strategy. For instance, the economic growth of China and other developing nations is heavily dependent on the output of tradable goods, which can be increased through domestic demand alongside domestic supply.

Maize farming output, and the inputs had their private prices determined as follows:

Table 2. Policy Analysis Matrix (PAM) Indicators and Decision Criteria

No	Objective	Indicator	Formula	Decision Criteria	Interpretation
1	Financial competitiveness (Competitive advantage)	Private Profit (PP)	$(D=A-(B+C))$	$PP > 0$	Financially profitable.
		Private Cost Ratio (PCR)	$(C/(A-B))$	$PCR < 1$	Competitive Advantage
		Private Benefit-Cost Ratio (PBCR)	$(A/(B+C))$	$PBCR > 1$	Financially feasible.
2	Economic efficiency (Comparative advantage)	Social Profit (SP)	$(H=E-(F+G))$	$SP > 0$	Economically viable.
		Domestic Resource Cost Ratio (DRCR)	$(G/(E-F))$	$DRCR < 1$	Comparative advantage.
		Social Benefit-Cost Ratio (SBCR)	$(E/(F+G))$	$SBCR > 1$	Economically feasible.
3	Government policy effects	Nominal Protection Coefficient on Output (NPCO)	(A/E)	$NPCO > 1$	Output price protection (subsidy).

No	Objective	Indicator	Formula	Decision Criteria	Interpretation
		Nominal Protection Coefficient on Input (NPCI)	(B/F)	$NPCI < 1$	Input subsidy.
		Effective Protection Coefficient (EPC)	$((A-B)/(E-F))$	$EPC > 1$	Positive protection from government policies.
		Profitability Coefficient (PC)	(D/H)	$PC > 1$	Policies increase farm profitability.
		Net Transfer (NT)	$(D-H)$	$NT > 0$	Positive net transfer from policy intervention.
		Subsidy Ratio to Producers (SRP)	$((D-H)/E)$	$SRP > 0$	Producers receive net subsidies.

Source: [8]

3. RESULTS AND DISCUSSION

The study was conducted in the major maize-producing sub-districts of Batang Regency, namely Pecalungan, Bandar, and Tersono, involving 217 maize farmers. The average farm size was 0.34 ha, with an average production of 1.37 tons per planting season, resulting in a productivity level of 4.03 tons/ha. This productivity is considerably lower than the potential maize yield reported in the literature, which ranges from 6–9 tons/ha under optimal production conditions and 7–8 tons/ha in comparable farming systems [12]. The observed yield gap indicates that maize production in the study area has not yet reached its productive potential. Based on farmers' responses, the relatively low productivity may be associated with pest infestations, particularly rats and caterpillars, which were consistently identified as major constraints to maize cultivation. Persistent pest pressure can reduce plant populations, damage ears and grains, and ultimately lower harvestable yields, thereby limiting farm income and weakening the overall competitiveness of maize farming. This productivity gap has implications for the results of the Policy Analysis Matrix (PAM). Following the framework in Table 1, low productivity leads to a decline in revenues both at the private level (A) and the social level (E), which in turn reduces private profits (D) as well as social profits (H). This condition indicates that the competitiveness of maize farming in Batang Regency remains relatively weak and that resource allocation efficiency has not yet been optimized. Low productivity directly reduces the amount of maize harvested, thereby lowering farmers' incomes. For instance, smallholder farmers in Uganda face low productivity and poor quality, which limit the prices they can command and thus their potential income [13]. Similarly, in Nigeria, low maize yields due to poor productivity result in lower incomes for farmers [14]. Therefore, low productivity becomes one of the key determinants in interpreting the PAM results regarding the sustainability and development prospects of maize in the study area.

3.1 Policy Analysis Matrix of Maize Farming

Table 3. The results of the PAM analysis in this study are presented in the following table

Number of respondents (people)	Average farmland (ha)	Cost items	Production cost (RP)			
			Total revenue (RP)	Tradable input cost (RP)	Domestic factor cost (RP)	Profit (RP)
217	0.34	Private	15,467,079.82	1,820,790.00	5,713,702.00	7,932,587.99
		Social	17,602,885.66	8,087,948.14	6,856,442.06	2,658,495.46
		Divergence	-2,135,805.84	-6,267,158.02	-1,142,740.34	7,260,223.52

Source: Primary Data, 2025

From Table 3, positive private revenue generated by maize farming indicates that the existing production system can generate substantial market returns despite relatively low productivity levels. The figure represents the total income received by farmers from maize production (both output and by-products), calculated using actual market prices. This value serves as the basis for assessing whether maize farming can generate profit at the private price level. The tradable input cost amounts to Rp 1,820,790, which refers to inputs categorized as tradable (such as seeds, imported fertilizers, and pesticides). This cost is relatively small compared to total revenue (A), indicating that the contribution of tradable input costs to the overall production cost is low. The domestic factor cost is Rp 5,713,702, covering domestic production factors such as labor, land rent, and local capital. This amount is substantially higher than the tradable input cost, suggesting that maize farming in the study area relies more heavily on non-tradable domestic factors. The private profit is valued at Rp 7,932,587.99, meaning that at prevailing market prices during the harvest season, maize farming remains profitable for farmers. In other words, maize cultivation is still financially viable, even though productivity is considered low. This situation is consistent with the findings of [15] [16] although the level of productivity remains relatively low, the farming system still demonstrates viability for continuation. This viability is facilitated through improvements in production efficiency and the optimization of existing resources. In this study, land ownership and farming skills are identified as key assets that support the sustainability of farming activities. Hence, even in the absence of optimal productivity, the economic sustainability and viability of the farming system can still be maintained.

The value of social revenue was Rp 17,602,885.66, representing maize output valued at social prices. This amount was higher than private revenue, indicating that the domestic market price of maize was relatively lower than its economic value. In other words, farmers could potentially earn higher revenues if market distortions were eliminated. Evidence from China indicates that distortions in the factor market significantly constrain the growth of farmers' incomes. Moreover, such distortions not only impede development within local regions but also generate adverse spillover effects on neighboring areas, implying that their elimination could lead to substantial improvements in farmers' income levels [17]. The total cost of social tradable inputs such as seeds, fertilizers, and pesticides was Rp 8,087,948.14, which was considerably higher than the private cost. This shows the existence of subsidies or price distortions for tradable inputs in the domestic market, allowing farmers to pay less than the actual economic value. The total cost of social nontradable inputs, including land rent, labor, and local capital, was Rp 6,856,442.06. This value was slightly higher than the private cost, indicating that farmers often obtained domestic factors such as family labor or land at a lower price than their true economic value. Social profit was Rp 2,658,495.46. Although positive, this value was much lower than private profit. This suggests that maize farming in the study area remained economically efficient without market and policy distortions, but the level of profitability decreased significantly. Similarly, evidence from Uasin Gishu, Kenya, shows that the mean profit efficiency (PE) of maize farming was 0.62, indicating substantial room for improvement. Factors such as larger farm sizes and male-headed households were found to reduce inefficiencies, while distance to farms, soil characteristics, and natural disasters increased them. Policies targeting maize prices rather than input prices were suggested as more effective in enhancing profitability [18].

The value of output transfer was Rp -2,135,805.84. The positive sign indicates that private revenue was lower than social revenue. This means farmers received a lower price for maize compared to its social value. Such a condition may result from output market distortions or weak price protection for farmers [19]. The negative output transfer may reflect imperfections in the maize marketing system, where farmers often face limited bargaining power and imperfect price transmission. In many maize-producing regions of Indonesia, producers commonly rely on intermediaries or local traders to market their harvest, which may reduce the farm-gate price received relative to its social value.

The value of tradable input transfer was Rp -6,267,158.02. The positive value indicates that the private cost of tradable inputs was lower than the social cost. In other words, farmers in Batang Regency benefited from subsidies or policies that reduced the price of tradable inputs, such as fertilizer subsidies.

The value of domestic factor transfer was Rp -1,142,740.34. The negative sign shows that the private cost of domestic factors such as land, labor, and local capital was lower than the social cost. This reflects that in Batang Regency the use of family labor or own land, which are valued at a lower price than their economic value. The value of net transfer was Rp 7,620,223.52. The positive value indicates that overall, policies and market distortions provided a net benefit to farmers. This means that although output prices were lower than their social value, the loss was compensated for by subsidies and support for tradable inputs as well as relatively lower domestic factor costs.

3.2 Profitability of Maize Farming Production

The Policy Analysis Matrix (PAM) calculation results indicate that maize farming in the research area generates a private profit of Rp7,932,578.99. This positive value implies that farming activity remains feasible and profitable under the prevailing market conditions. It demonstrates a competitive advantage, as farmers can cover all production costs while obtaining profit surplus from their farming activities. Therefore, from a financial perspective, maize farming is sustainable and holds potential for further development at the farm level. Meanwhile, the social profit was also positive, amounting to Rp 2,658,495.40. Social profit reflects farming efficiency when evaluated under shadow prices or international prices free from policy distortions. This finding suggests that the production system adopted by farmers is economically efficient at the national level, as domestic resources, including labor, land, and other inputs, generate output with substantial added value. Such evidence confirms that maize farming in the study area has a comparative advantage, indicating that it can remain fundamentally competitive without government protection or policy intervention. These findings are important as they suggest that the sustainability of maize farming is not only supported by domestic market mechanisms but is also grounded in strong economic efficiency. In line with previous studies on agricultural competitiveness, comparative advantage allows this commodity to remain viable even under trade liberalization and increasing global market competition. Thus, the PAM results reaffirm that the farming system under study delivers dual benefits: on the one hand, it ensures direct financial gains for farmers, and on the other, it contributes positively to the national economy through the efficient allocation and utilization of domestic resources.

Based on the calculations using the Policy Analysis Matrix (PAM), values were obtained to assess the competitiveness and government policy indicators influencing maize farming in the study area

Table 4. Summary of Competitiveness and Policy Indicators of Maize Farming Production in Batang Regency

No	Indicators	Value	Remarks	Explanation
1	PP (Rp)	7.932.587,99	Positive	Profit
2	SP Rp (Rp)	2.658.495,40	Positive	Profit
3	NPCI	0,23	<1	Denotes tax
4	EPC	1,43	>1	Indicates subsidy
5	SRP	0,30	>0	Means subsidy
6	PCBR	2,05	>1	Competitive
7	NPCO	0,87	<1	Denotes tax
8	PCO	2,98	>1	Private profit

Source: Primary Data, 2025.

The Nominal Protection Coefficient on Input (NPCI) was 0.23 (<1), indicating that the prices of tradable inputs paid by maize farmers were lower than their corresponding social prices. This finding suggests the presence of government interventions that reduced farmers' input costs below their economic costs. Within the Policy Analysis Matrix (PAM) framework, an NPCI value below one reflects positive policy transfers to producers through lower tradable input prices, thereby enhancing the financial competitiveness of maize farming [8]. One possible explanation for this result is Indonesia's fertilizer subsidy policy. Fertilizer represents one of the major tradable inputs in maize production, and subsidized fertilizer enables farmers to purchase inputs at prices below market or social prices. Consequently, private production costs become lower than social costs, resulting in higher financial returns and improved farm competitiveness. These findings are consistent with [20], who reported that an NPCI value below one indicates government protection of tradable inputs, leading to lower private production costs relative to social costs. Similarly, [21] found that an NPCI below one reflects policy-induced distortions that provide production incentives for farmers. Nevertheless, these findings also suggest that part of the observed competitive advantage remains policy-driven rather than efficiency-driven. Therefore, improving technical efficiency, productivity, and technological innovation remains essential to sustain competitiveness in the long term.

The Effective Protection Coefficient (EPC) was 1.43 (>1), indicating that the combined effects of input and output policies increased the private value added received by farmers relative to its social value. An EPC greater than one implies that government policies provide effective protection to domestic production by creating economic incentives that exceed those under undistorted market conditions. According to [8], EPC is a key indicator for evaluating the effectiveness of policy interventions affecting value added in agricultural production. The present findings are consistent with those of [20], who reported that an EPC greater than one in maize farming reflects enhanced competitiveness resulting from government protection policies. These results demonstrate that current policy interventions have strengthened domestic value added and improved the financial performance of maize producers.

The Subsidy Ratio to Producers (SRP) was 0.30, indicating that approximately 30% of producers' income originated from policy transfers. This result suggests that government interventions continue to make a substantial contribution to farmers' income through various policy instruments. According to [8], a positive SRP indicates net transfers from government policies to agricultural producers. The relatively high SRP observed in this study confirms that public policy remains an important source of financial support for maize farmers. However, while such policy support enhances short-term profitability, sustainable competitiveness should ultimately rely on productivity improvement, technological innovation, and production efficiency rather than continued dependence on policy interventions.

The Private Cost Benefit Ratio (PCBR) was 2.05 (>1), indicating that maize farming generated substantial financial returns. Specifically, every IDR 1.00 of private production cost generated IDR 2.05 in revenue, confirming the financial feasibility of maize farming. The high PCBR value indicates that the existing production cost structure remains efficient and provides attractive economic returns for farmers. These findings are consistent with those reported by [20] [22] who found that maize farming in major production regions of Indonesia possesses strong competitive advantages and remains financially viable. Nevertheless, this financial performance should be interpreted alongside other PAM indicators because part of the observed profitability may still result from government interventions that reduce production costs rather than purely from production efficiency.

In contrast, the Nominal Protection Coefficient on Output (NPCO) was 0.87 (<1), indicating that the output prices received by farmers remained below their corresponding social prices. This finding suggests that maize producers continue to face disincentives on the output side and therefore do not fully capture the economic value of their products. Such conditions may result from imperfect market structures, weak bargaining power among farmers, lengthy marketing chains, or trade policies that keep domestic prices below international price levels. Similar findings were reported by [23] for soybean farming and [22] for maize farming, both of which found NPCO values below one, indicating that domestic producers received output prices lower than their social values. Therefore, strengthening maize competitiveness requires not only reducing production costs through input policies but also improving marketing systems, strengthening farmers' bargaining position, and implementing output pricing policies that provide stronger incentives for producers.

The Profitability Coefficient Output (PCO) was 2.98 (>1), indicating that private profits exceeded social profits. Within the Policy Analysis Matrix (PAM) framework, a PCO value >1 implies that the prevailing policy environment provides economic incentives that allow producers to earn higher profits under domestic market prices than would be achieved under undistorted market conditions [8]. This finding suggests that maize farming benefits from supportive policy interventions, resulting in financial profitability that exceeds its underlying economic profitability. The results are consistent with [20], who reported that government interventions in input and output markets increased private profitability and strengthened the financial competitiveness of maize farming in Indonesia. Likewise, [22] found that the competitive advantage of maize production in major producing regions was influenced by both production efficiency and government policy support. However, the degree of protection differed across regions, suggesting that policy effectiveness depends on agroecological conditions, market accessibility, production systems, and farmers' institutional capacity. Consequently, although government policies play a significant role in enhancing farm profitability, long-term competitiveness should be built upon improvements in technical efficiency, productivity, technological innovation, and value chain development rather than relying solely on policy protection.

3.3 Government Protection Policy for Maize Farming

The policy indicators reveal an asymmetric incentive structure in maize farming. The NPCI of 0.23 indicates that farmers incurred tradable-input costs equivalent to only approximately 23% of their social valuation. In contrast, the NPCO of

approximately 0.88 indicates that the output price received by farmers was approximately 12% below its social price. Thus, maize farmers benefited substantially from lower input costs but did not receive comparable protection in the output market. Similar patterns were reported in Pacitan, Belu, and Grobogan, where NPCI and NPCO values below unity indicated that maize farmers benefited from lower tradable-input costs while facing relatively unfavorable output prices [20] [23] [24].

Despite the lower private output price, the EPC in this study reached 1.43, indicating that private value added was approximately 43% higher than social value added. The input-cost advantage was therefore sufficiently large to compensate for the output-price disadvantage. This result differs from those reported for maize farming in Pacitan, Belu, and Grobogan, where EPC values generally remained below unity, indicating that input incentives were insufficient to offset the adverse effects of output-price divergence. A different incentive structure was reported in Tanah Datar, where an NPCI of 0.63 and an NPCO of 1.20 produced an EPC of 1.76, reflecting the combined benefits of lower input costs and favorable output prices [25] [26] reported positive protection for maize production in Andhra Pradesh through favorable output-price and aggregate policy effects. These comparisons demonstrate that the overall level of protection depends on the relative magnitude of input incentives and output-price effects rather than on either component alone.

This pattern is further reflected in the profitability coefficient of approximately 2.98, indicating that private profit was almost three times higher than social profit. The SRP of 0.30 also shows that the net effect of policy and market divergences was equivalent to approximately 30% of social output revenue. Together, these indicators confirm that prevailing policies and market conditions provided a substantial overall incentive for maize farming. However, this advantage was primarily derived from lower tradable input costs rather than from favorable output prices. The findings therefore reveal an imbalance in the distribution of incentives: farmers benefited considerably during the production stage but remained disadvantaged when selling their maize.

The NPCO below unity indicates that the prices received by farmers remained below their social valuation. Previous studies have shown that output-price disadvantages are frequently associated with longer marketing channels, limited bargaining power, restricted market access, and the unequal distribution of marketing margins among market actors. [27] found considerable differences in farmers' shares across maize marketing channels in Central Sulawesi, with direct marketing generating the highest share. [28] similarly reported that direct sales were more efficient than marketing channels involving multiple intermediaries in South Sulawesi. In Central Java [29] found that the farmer-cooperative-consumer channel generated a farmer's share of 68.19%, whereas a longer channel involving village, subdistrict, and district traders provided farmers with only 39.22% of the consumer price. These findings suggest that shorter and more coordinated marketing channels may increase the proportion of the final market price retained by maize farmers.

The combination of an NPCO below unity and an EPC above unity further indicates that the profitability advantage observed in this study remains highly dependent on low tradable-input costs. Such dependence may increase farmers' vulnerability to rising input prices, changes in subsidy arrangements, or reduced access to affordable production input. By contrast, improvements in output prices could strengthen farm revenue more directly and provide a more stable basis for long-term profitability. [18] found that maize profitability in Kenya was more responsive to changes in maize prices than to changes in input prices, highlighting the strategic importance of output-market conditions. [30] also found that participation in buffer-stock procurement increased the income of smallholder maize farmers in Ghana by at least 12%, although the magnitude of the benefits was influenced by market access, extension services, transportation, and packaging costs. These findings indicate that output-market interventions are likely to be more effective when accompanied by adequate institutional and logistical support.

Improving farmers' access to procurement programs, formal buyers, market information, and collective marketing could therefore complement existing input incentives. Cooperative-based marketing is particularly relevant because collective sales may increase marketing volume, reduce individual transaction costs, strengthen bargaining power, and shorten marketing chains. The higher farmer's share obtained through cooperative marketing in Central Java supports this direction [29]. However, the effectiveness of this approach depends on the capacity of cooperatives to aggregate production, maintain product quality, negotiate contracts, provide reliable price information, and establish stable relationships with buyers.

The low NPCI further demonstrates the central role of affordable tradable inputs in maintaining the competitiveness and profitability of maize farming. Lower expenditures on seeds, fertilizers, pesticides, and other tradable inputs reduced production

costs and increased private value added. Similar findings across maize-producing regions indicate that input-related support remains important for sustaining farmers' short-term profitability, particularly when output prices provide only limited incentives. Nevertheless, the considerable difference between the NPCI and NPCO confirms that input- and output-side incentives remain unbalanced. Farmers obtained substantial advantages when purchasing production inputs but continued to face unfavorable conditions when selling their output.

3.4 Comparative Advantage of Maize Farming

The Policy Analysis Matrix (PAM) results from the comparative advantage perspective reveal that the social profit (H) amounts to Rp 2,658,495.46, a positive value. This outcome indicates that the farming system under investigation is economically efficient when evaluated at social prices, reflecting international market conditions without policy distortions. A positive social profit further suggests that using domestic resources in production generates tangible value added to the national economy, reinforcing the sector's comparative advantage from a broader perspective, such findings imply that the maize farming system studied is fundamentally resilient and could remain competitive even under conditions of trade liberalization or reduced government protection [31]. This efficiency in resource allocation provides a strong basis for integration into global markets, where competitiveness is determined not by policy distortions but by the capacity to generate real economic value. Hence, the positive social profitability underscores the potential of maize farming to contribute to farm-level welfare and national economic growth in the context of increasingly open and competitive trade regimes.

The Domestic Resource Cost (DRC) ratio of 0.72 (< 1) further strengthens the evidence of comparative advantage in the study area. This suggests that, to generate an additional unit of foreign exchange through maize output, domestic resources expended amount to just 72 % of the foreign exchange earned. In other words, the production system uses domestic input efficiently, confirming that maize farming in this context possesses a genuine comparative advantage. The relatively low DRC value may be attributed to the modest cost of domestic production factors, particularly family labour and land resources, which enable maize production to generate value added at a cost lower than the corresponding foreign exchange savings. Similar findings have been observed in recent Indonesian studies. The DRC value obtained in this study (0.72) is comparable to those reported by [32] who found DRC = 0.29 values below unity for maize production systems in Indonesia, suggesting that comparative advantage is consistently observed across different production environments. This finding implies that domestic maize production can substitute for imported maize at a lower opportunity cost, thereby supporting national food security objectives and reducing dependence on international markets.

Furthermore, the Social Benefit Cost Ratio (SBCR) of 1.17 (> 1) indicates that social benefits exceed social costs. In other words, each rupiah of social cost incurred yields a social return of Rp 1.17. This ratio reinforces that the farming system is not only privately profitable but also socially beneficial from a broader economic perspective. The positive social profitability reflected by the SBCR indicates that maize production contributes positively to national economic welfare, even after removing market distortions and policy interventions. The combination of positive social profit, a DRC below unity, and an SBCR above unity provides consistent evidence that maize farming in Batang Regency remains economically efficient and socially desirable under undistorted market conditions.

4. CONCLUSION

The Policy Analysis Matrix (PAM) results confirm that maize farming in the study area is both privately and socially profitable, reflecting strong financial viability at the farm level and economic efficiency at the national level. The positive private profit (Rp7,932,578.99) demonstrates that farmers can cover production costs while generating surplus income, indicating short-term sustainability and competitiveness. At the same time, the positive social profit (Rp2,658,495.40), a DRC ratio of 0.72 (< 1), and an SBCR of 1.17 (> 1) highlight the sector's comparative advantage, efficient use of domestic resources, and broader contributions to national economic welfare. At the same time, government policy plays a dual role: while input subsidies (NPCI = 0.23) provide incentives that reduce production costs and enhance competitiveness, output price distortions (NPCO = 0.87) impose disincentives by suppressing farmers' revenues. The overall protection effect (EPC = 1.43; SRP = 0.30) shows policy support substantially enhances profitability, although maize farming remains socially profitable under undistorted market conditions. These findings suggest that maize farming is fundamentally competitive and resilient, with competitiveness driven not only by policy support but also by underlying economic efficiency and comparative advantage. Future policy strategies should therefore emphasize productivity growth, technological innovation, and farmer capacity building to ensure long-term

sustainability and competitiveness. Future studies should examine how market access, value chain integration, and technological adoption influence the long-term competitiveness of maize farming across different production systems.

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AUTHOR CONTRIBUTIONS

Liska Simamora: Conceptualization, Methodology, Formal analysis, Investigation, Data curation, Writing – original draft-review and editing;

Irma Fauziah: Conceptualization, Methodology, Collecting the data-Writing – review & editing;

Nur Indah Cahyaningtyas: Collecting the data-Validation, Writing – review & editing.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ETHICS STATEMENT

Ethical approval was not required for 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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