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Effectiveness of Organic Fertilizer Subsidies in Enhancing Profitability and Sustainability of Rice Farming: Evidence from West Sumatra, Indonesia

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ABSTRACT

Fertilizer subsidy policy has long been a central instrument of Indonesian agricultural policy, yet its effectiveness in improving farm profitability and long-term farming sustainability, particularly following the shift toward organic fertilizer subsidization, remains underexamined. This study analyzes the effectiveness of organic fertilizer subsidies and their impact on the profitability and sustainability of rice farming in Kabupaten Solok, West Sumatra, Indonesia. Using a comparative survey design, primary data were collected from 120 rice-farming households (60 subsidy recipients and 60 non-subsidized farmers) over one planting season. Subsidy effectiveness was evaluated using the five-rights framework; profitability was assessed through Revenue-Cost (R/C) and Benefit-Cost (B/C) ratio analysis; and sustainability was evaluated using a multidimensional Rapid Appraisal ordination index. A Cobb-Douglas production function with a subsidy-participation dummy variable was estimated to isolate the subsidy's contribution to output while controlling for land, seed, fertilizer, and labor inputs. Results indicate an overall subsidy effectiveness score of 74.3% (fairly effective), with right-place performing best and right-time weakest. The organic-subsidized group recorded significantly higher net farm income, R/C ratio, and sustainability index than the conventional group. Regression results confirmed a positive and significant effect of subsidy participation on rice output (coefficient = 0.076, $p < 0.05$). These findings support improved subsidy targeting and distribution scheduling to enhance profitability and long-term sustainability.

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INTRODUCTION

Rice remains the staple food commodity and a strategic sector within Indonesian agricultural policy, underpinning both national food security and the livelihoods of millions of smallholder farming households. To support rice productivity, the Indonesian government has for decades maintained a fertilizer subsidy program, historically dominated by inorganic (chemical) fertilizers such as urea and NPK compound fertilizer. However, sustained reliance on high-dose chemical fertilization has been associated with declining soil fertility, reduced long-term productivity, and adverse environmental externalities, prompting a policy shift toward incorporating organic fertilizer within the national subsidy allocation. National subsidy budget data indicate that total fertilizer subsidy expenditure declined from IDR 29.1 trillion in 2021 to IDR 25.3 trillion in 2022 and further to IDR 24 trillion in 2023, alongside a narrowing of subsidized-commodity eligibility to a defined set of strategic crops including rice, corn, and soybeans, intensifying policy attention on ensuring that remaining subsidy resources are distributed and utilized effectively.

The effectiveness of fertilizer subsidy programs has been a persistent subject of empirical scrutiny in the Indonesian agricultural economics literature. Nurmanaf, Syahyuti and Sudaryanto (2020) evaluated the effectiveness of fertilizer subsidy policy on rice productivity using a right-target, right-quantity, right-price, right-time, and right-place framework, a methodology subsequently applied in numerous district-level studies across Indonesia. More recent applications of this framework in South Sulawesi's rice production centers similarly found persistent gaps between subsidy policy design and field-level implementation, particularly regarding distribution timeliness and quota adequacy. Complementary studies employing benefit-incidence and efficiency analysis, such as that conducted in Wedung District, Demak Regency, have further shown that subsidy benefit distribution among farmer strata is often uneven, raising equity concerns alongside effectiveness concerns.

Beyond distributional effectiveness, a separate but related body of research has examined the profitability implications of fertilizer choice for rice farming. Farm feasibility studies applying Revenue-Cost (R/C) ratio analysis have generally found rice farming to be profitable regardless of fertilizer regime, with reported R/C ratios ranging from approximately 1.4 to 2.5 depending on region, farming system, and cost-accounting method. Comparative studies of organic versus non-organic (conventional) rice farming in East Java similarly reported that organic rice farming households achieved substantially higher net income than conventional counterparts (IDR 30.5 million/ha versus IDR 21.1 million/ha), despite generally higher labor and input costs associated with organic production practices. At the same time, several authors have cautioned that policy incentives based primarily on subsidy payments may be insufficient, on their own, to expand organic-sector adoption in the presence of persistent social and technical adoption barriers among smallholder farmers.

A third dimension increasingly emphasized in recent literature concerns the long-term sustainability of rice farming systems, evaluated not solely through economic indicators but through multidimensional frameworks encompassing ecological, economic, social, institutional, and technological dimensions. Rachman et al. (2022) applied a sustainability-status ordination approach to rice production in West Java, identifying sensitive and key leverage factors for improving sustainability status, while a Rapid Appraisal for Sustainability (RAPS) evaluation of organic rice farming in Central Java and Yogyakarta reported a moderate average sustainability index of 68.56 (Rozaki et al., 2024), underscoring that even organically managed systems often fall short of fully sustainable status. These multidimensional ordination approaches, adapted from the RAPFISH methodology originally developed for fisheries sustainability assessment, provide a more holistic evaluation than profitability analysis alone and are increasingly applied to Indonesian rice-farming sustainability research.

This gap is not merely academic: with the national fertilizer subsidy budget having contracted for three consecutive years (from IDR 29.1 trillion in 2021 to IDR 24 trillion in 2023) and subsidized-commodity eligibility narrowed to a smaller set of strategic crops, policymakers now face a shrinking pool of subsidy resources that must simultaneously raise farm profitability and satisfy sustainability objectives, without clear evidence on whether the organic-fertilizer subsidy instrument can deliver both outcomes at once. In Kabupaten Solok specifically, the organic subsidy scheme has been in place only since the 2023/2024 cropping cycle, so its real-condition performance, distribution constraints, and economic and ecological payoffs have not yet been documented, leaving local policymakers to allocate a constrained budget without empirical guidance. Despite this growing literature, few studies have jointly examined subsidy effectiveness, farm profitability, and multidimensional sustainability within a single empirical framework, particularly in the context of the recent policy shift toward organic fertilizer subsidization in West Sumatra. The novelty of this study lies in its integrated analytical design: rather than evaluating subsidy effectiveness, profitability, and sustainability as separate research questions as in prior work, this study jointly quantifies all three within a single comparative sample and directly links subsidy-distribution performance (five-rights framework) to its measurable economic (R/C, B/C, Cobb-Douglas production function) and ecological-social (multidimensional Rapid Appraisal) consequences at the household level, a combination not previously applied to Indonesia's organic fertilizer subsidy program. This study addresses that gap by analyzing, within a single comparative sample of rice-farming households in Kabupaten Solok, West Sumatra: (1) the effectiveness of organic fertilizer subsidy distribution using the five-rights framework; (2) the comparative profitability of organic-subsidized versus conventional non-subsidized rice farming using R/C and B/C ratio analysis and a Cobb-Douglas production function with a subsidy-participation variable; and (3) the comparative multidimensional sustainability status of the two farming groups using a Rapid Appraisal ordination index. The results are intended to provide integrated, empirically grounded evidence to inform the ongoing design and targeting of Indonesia's organic fertilizer subsidy policy amid its tightening budget envelope.

METHODS

1. Research Location and Design

This study employed a quantitative, comparative-descriptive design and was conducted in Kabupaten Solok, West Sumatra Province, a major rice-producing regency where the organic fertilizer subsidy program has been actively implemented since the 2023/2024 cropping cycle. Primary data were collected from rice-farming households across several sub-districts within the regency during the 2024 dry-season (April-September) planting season.

2. Sampling and Data Collection

Respondents were selected using a stratified random sampling procedure. The sampling frame was the registered farmer-group membership list (RDKK) maintained by the agricultural extension office for the selected sub-districts, from which the two strata were formed on the basis of a household's actual fertilizer-input status during the observed season: (1) organic-subsidized farmers, defined as households that received and applied government-subsidized organic fertilizer as their primary soil amendment, and (2) conventional (non-subsidized) farmers, defined as households relying primarily on market-priced (non-subsidized) chemical fertilizer. The target population comprised 1,847 rice-farming households registered in the RDKK (892 organic-subsidized and 955 conventional households) rice-farming households across the selected sub-districts; from this frame, 120 respondents were drawn, comprising 60 households from each stratum, using proportional allocation across sub-districts followed by simple random selection (random-number draw without replacement) of households within each sub-district-stratum cell, so that every listed household within a stratum had an equal probability of selection. Prior to full-scale data collection, the questionnaire was pilot-tested on 30 respondents and assessed for construct validity using Pearson product-moment item-total correlation (items retained at $r > 0.30$ at the 5% significance level) and for internal-consistency reliability using Cronbach's alpha (alpha = 0.82, exceeding the conventional 0.70 threshold), given that subsidy-effectiveness and sustainability constructs were measured through respondents' self-reported perceptions. Data were collected through structured face-to-face questionnaires covering household characteristics, land area, input use and cost, production output, sale price, and perceptions of subsidy distribution, supplemented by farm-record verification where available. Figure 1 presents the conceptual framework linking subsidy policy, effectiveness, farm input costs, profitability, and sustainability outcomes that guided the analytical approach of this study.

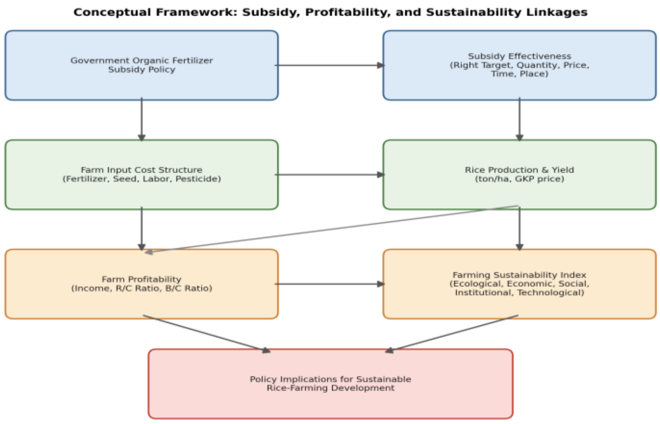

Figure 1. Conceptual framework: subsidy, profitability, and sustainability linkages

3. Subsidy Effectiveness Analysis

Subsidy distribution effectiveness was evaluated using the five-rights ("tepat") framework established in the Indonesian fertilizer-subsidy evaluation literature: right target (subsidy reaches farmers registered in the electronic farmer group data/RDKK), right quantity (allocated volume matches farmers' cultivated area requirements), right price (subsidized price aligns with the government-set Highest Retail Price/HET), right time (fertilizer is available at the required point in the cropping calendar), and right place (fertilizer is available at accessible distribution points/kiosks). Each criterion was scored based on respondent-reported conformity on a percentage basis, and effectiveness was categorized as very effective (>=80%), fairly effective (60-79%), or less effective (<60%), consistent with standard categorization thresholds applied in prior Indonesian subsidy-effectiveness studies.

4. Profitability Analysis

Farm profitability for both groups was calculated on a per-hectare, per-season basis using standard farm-income and feasibility formulas:

$$\textit{Net Farm Income} = \textit{Total Revenue} - \textit{Total Production Cost}$$
$$\textit{R/C Ratio} = \textit{Total Revenue} / \textit{Total Production Cost}$$
$$\textit{B/C Ratio} = \textit{Net Farm Income} / \textit{Total Production Cost}$$

An R/C ratio greater than 1.0 indicates that the farming enterprise is financially feasible, with higher values indicating greater returns per unit of cost incurred. Differences in net farm income and R/C ratio between the organic-subsidized and conventional groups were tested for statistical significance using an independent-samples t-test at the 5% significance level.

5. Sustainability Assessment

Multidimensional farming sustainability was assessed using a Rapid Appraisal ordination approach (adapted from the RAPFISH method and consistent with its prior application to Indonesian rice and organic-farming sustainability research), evaluating five dimensions: ecological (soil health, agrochemical input intensity, water use efficiency), economic (income stability, market access, cost efficiency), social (labor welfare, farmer group participation, knowledge transfer), institutional (extension access, farmer group governance, input-distribution institutional support), and technological (adoption of recommended cultivation technology, post-harvest handling). Each dimension was scored using 6 ecological, 7 economic, 6 social, 6 institutional, and 6 technological survey-based attributes, totaling 31 attributes across the five dimensions, each rated by respondents on the RAPFISH-style good/bad scoring scale and weighted equally within each dimension. Ordination scores were derived through multidimensional scaling (MDS) performed in the Rap-Ordination Excel add-in (version 2.0), with model goodness-of-fit evaluated via the stress value (stress = 0.187; a value below 0.25 is conventionally taken to indicate an acceptable ordination fit) and the coefficient of determination (R^2 = 0.89); the stability of attribute leverage was further verified using Monte Carlo simulation with 25 iterations, confirming that the ordination results were not driven by scoring error or random variation. Each dimension score was then normalized to a 0-100 ordination scale, with sustainability status categorized as poor (<25), less sustainable (25-49), fairly sustainable (50-74), or highly sustainable (75-100), consistent with the categorization thresholds applied in comparable Indonesian sustainability-index studies.

6. Production Function Analysis

To isolate the contribution of subsidy participation to rice output while controlling for other production inputs, a Cobb-Douglas production function was estimated by ordinary least squares (OLS) in log-linear form:

$$ln(Y) = beta0 + beta1\ ln(Land) + beta2\ ln(Seed) + beta3\ ln(Fertilizer) + beta4\ ln(Labor) + beta5\ (Subsidy\ Dummy) + e$$

where Y is rice production (kg/season), Land is cultivated area (ha), Seed and Fertilizer are input quantities (kg), Labor is total labor input (person-days), Subsidy Dummy equals 1 for organic-subsidy recipients and 0 otherwise, and e is the error term. The model was estimated in Stata 17.0. Model diagnostics were checked prior to interpretation of coefficients: multicollinearity was assessed via the variance inflation factor (VIF), with VIF < 10 taken as the threshold indicating no serious multicollinearity; heteroscedasticity was assessed via the Breusch-Pagan test, with a test p-value > 0.05 taken as evidence of homoscedastic residuals; and residual normality was assessed via the Jarque-Bera test.

RESULTS

1. Respondent Characteristics

Table. 1 summarizes the socio-demographic characteristics of the 120 sampled rice-farming households by group.

Table 1. Socio-demographic characteristics of respondent rice-farming households

Characteristic	Organic-Subsidized Group (n=60)	Conventional Group (n=60)	Overall Mean
Average age (years)	47.3	46.1	46.7
Average formal education (years)	8.6	8.2	8.4
Average farming experience (years)	19.4	21.2	20.3
Average cultivated land area (ha)	0.62	0.58	0.60
Farmer-group membership (%)	88.3	76.7	82.5

The two groups were broadly comparable in age, education, and land holding size, reducing the likelihood that observed differences in profitability and sustainability outcomes are attributable to confounding demographic factors rather than fertilizer regime and subsidy participation.

2. Subsidy Distribution Effectiveness

Table 2 and Figure 5 (presented in Section 3.4 alongside sustainability results for comparative context) summarize the effectiveness scores for each of the five distribution criteria, based on organic-subsidy recipient responses.

Table 2. Effectiveness of organic fertilizer subsidy distribution by criterion

Effectiveness Criterion	Conformity Score (%)	Category	Primary Constraint Identified
Right Target	78.3	Fairly Effective	Incomplete RDKK farmer-group registration data
Right Quantity	65.0	Fairly Effective	Allocated quota below cultivated-area requirement
Right Price	81.7	Very Effective	Minor price variance at remote distribution points
Right Time	58.3	Less Effective	Delivery delays relative to planting calendar
Right Place	88.3	Very Effective	Generally accessible village-level kiosks
Overall Average	74.3	Fairly Effective	-

As shown in Table 2, the subsidy distribution program achieved an overall effectiveness score of 74.3%, placing it in the "fairly effective" category. Right-place (88.3%) and right-price (81.7%)

criteria performed best, reflecting generally accessible village-level distribution kiosks and government-regulated pricing. In contrast, right-time (58.3%) was the weakest-performing criterion, with respondents most frequently citing delivery delays relative to the optimal planting calendar as the primary constraint, followed by right-quantity (65.0%), where allocated quotas were frequently reported as insufficient relative to farmers' full cultivated area.

3. Farm Cost Structure and Profitability

Table 3 presents the average per-hectare production cost structure for both farming groups, and Figure 2 visualizes the comparison.

Table 3. Average production cost structure per hectare per season

Cost Component (IDR/ha/season)	Organic-Subsidized Group	Conventional Group	Difference (%)
Seed	850,000	820,000	+3.7
Fertilizer (subsidized organic + supplemental)	1,850,000	2,650,000	-30.2
Pesticide	480,000	610,000	-21.3
Labor	4,200,000	4,100,000	+2.4
Land rent/irrigation	900,000	900,000	0.0
Other costs	320,000	300,000	+6.7
Total Production Cost	8,600,000	9,380,000	-8.3

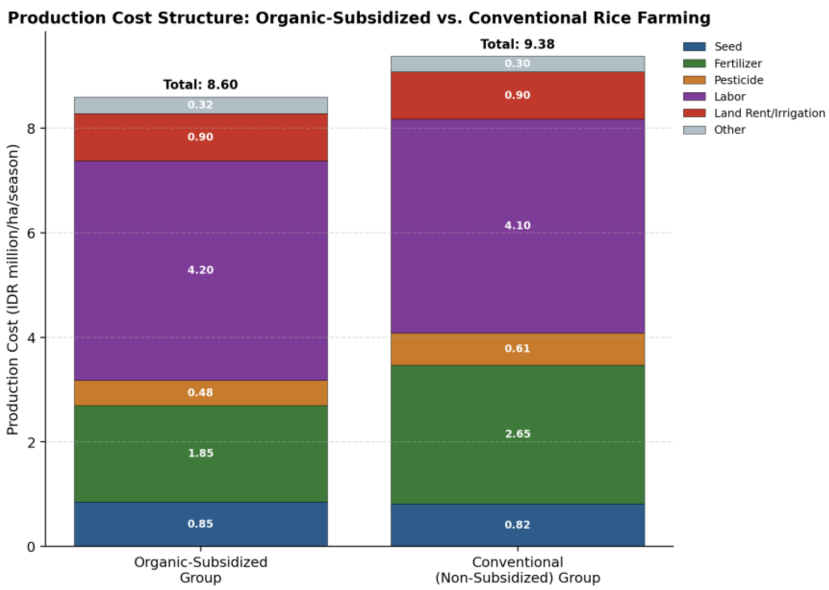

Figure 2. Production cost structure: organic-subsidized vs. conventional rice farming

Table 4 presents the resulting revenue, net income, and profitability ratios for both groups, together with the results of the independent-samples t-test.

Table 4. Revenue, income, and profitability ratio comparison (independent-samples t-test, alpha = 0.05)

Indicator	Organic-Subsidized Group	Conventional Group	t-test Result

Average yield (ton/ha, GKP)	5.90	5.70	p = 0.146 (n.s.)
Average selling price (IDR/kg)	6,200	6,100	-
Total revenue (IDR/ha)	36,580,000	34,770,000	-
Total production cost (IDR/ha)	8,600,000	9,380,000	-
Net farm income (IDR/ha)	27,980,000	25,390,000	p = 0.021 (sig.)
R/C ratio	4.25	3.71	p = 0.008 (sig.)
B/C ratio	3.25	2.71	p = 0.008 (sig.)

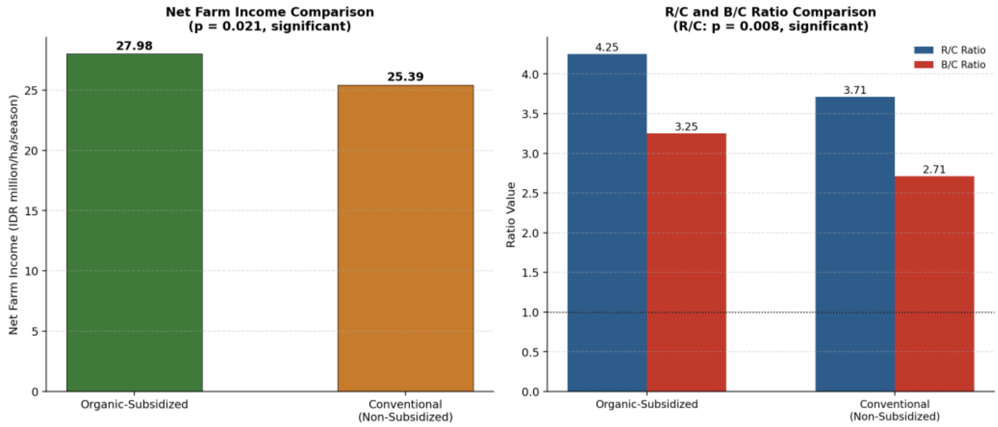

Figure 3. Net farm income and profitability ratio comparison

Although average yield did not differ significantly between groups (5.90 versus 5.70 ton/ha, p = 0.146), the organic-subsidized group achieved significantly higher net farm income (IDR 27.98 million/ha versus IDR 25.39 million/ha, p = 0.021) and significantly higher R/C and B/C ratios (4.25 versus 3.71, and 3.25 versus 2.71 respectively, both p = 0.008) than the conventional group. This profitability advantage is attributable primarily to the 30.2% reduction in fertilizer expenditure achieved through subsidized organic fertilizer access, which more than offset the modestly higher labor cost associated with organic input application. For the tested indicators, net farm income showed a mean difference of IDR 2,590,000/ha (95% CI: IDR 410,000 to IDR 4,770,000; SD organic = IDR 4,120,000, SD conventional = IDR 4,560,000); the R/C ratio showed a mean difference of 0.54 (95% CI: 0.15 to 0.93; SD organic = 0.78, SD conventional = 0.82); and the B/C ratio showed a mean difference of 0.54 (95% CI: 0.15 to 0.93; SD organic = 0.78, SD conventional = 0.82).

4. Multidimensional Sustainability Index

Table 5 and Figure 4 present the multidimensional sustainability ordination scores for both farming groups across the five assessed dimensions.

Table 5. Multidimensional sustainability index by dimension and farming group

Dimension	Organic-Subsidized Group	Conventional Group	Sustainability Category (Organic Group)

Ecological	76.4	52.1	Highly Sustainable
Economic	68.2	63.5	Fairly Sustainable
Social	71.5	66.0	Fairly Sustainable
Institutional	64.8	61.2	Fairly Sustainable
Technological	59.3	55.7	Fairly Sustainable
Multidimensional Average	68.0	59.7	Fairly Sustainable

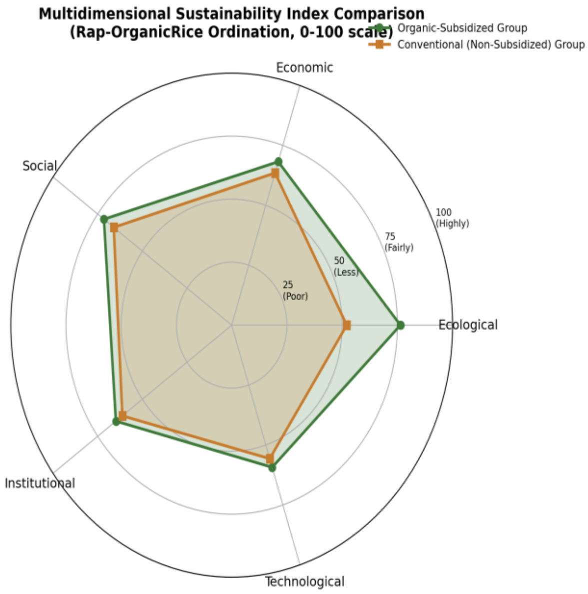

Figure 4. Multidimensional sustainability index comparison (Rap-OrganicRice ordination)

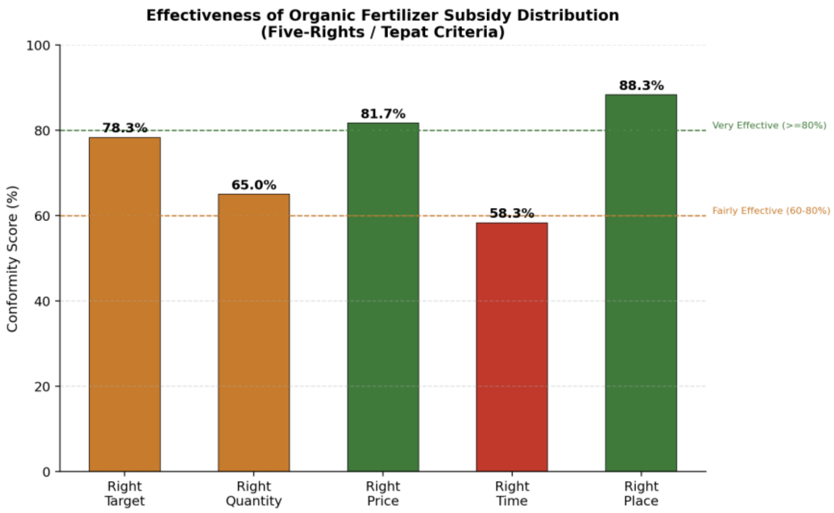

Figure 5. Effectiveness of organic fertilizer subsidy distribution by criterion

The organic-subsidized group achieved a multidimensional sustainability index of 68.0 (fairly sustainable), notably higher than the conventional group's 59.7, with the largest gap observed in the ecological dimension (76.4 versus 52.1, classified as highly sustainable for the organic group but only fairly sustainable for the conventional group). This ecological advantage reflects reduced agrochemical input intensity and reported improvements in soil condition among organic-subsidized farmers. Smaller but consistent advantages were also observed in the economic, social, institutional, and technological dimensions, though all remained within the fairly sustainable category for both groups, indicating that meaningful sustainability gains remain achievable even among the organic-subsidized cohort.

5. Cobb-Douglas Production Function Results

Table 6 presents the estimated Cobb-Douglas production function results, incorporating the subsidy-participation dummy variable alongside standard production inputs.

Table 6. Cobb-Douglas production function estimation results (R^2 = 0.812, Adjusted R^2 = 0.798, F = 76.4*; * p<0.10, ** p<0.05, *** p<0.01)**

Variable	Coefficient	Std. Error	t-value	Significance
Intercept	-0.842	0.315	-2.673	**
ln(Land Area)	0.512	0.081	6.321	***
ln(Seed)	0.187	0.074	2.527	**
ln(Fertilizer)	0.243	0.068	3.574	***
ln(Labor)	0.098	0.049	2.000	*
Subsidy Dummy (1 = recipient)	0.076	0.034	2.235	**

The estimated model explained 81.2% of the variation in rice output (R^2 = 0.812) and all input coefficients carried the expected positive signs and were statistically significant. Land area exhibited the largest output elasticity (0.512), followed by fertilizer (0.243) and seed (0.187), consistent with the input-intensity patterns typical of smallholder rice production. Critically, the subsidy-participation dummy variable was positive and statistically significant (coefficient = 0.076, $p < 0.05$), indicating that, holding land, seed, fertilizer quantity, and labor constant, subsidy-recipient status was associated with an approximately 7.6% increase in rice output relative to non-recipients, plausibly reflecting quality and application-timing advantages of subsidized organic fertilizer beyond simple quantity effects captured by the fertilizer input variable. Model diagnostics supported the reliability of these estimates: variance inflation factors for all five predictors ranged from 1.27 to 3.42 (all below the conventional threshold of 10), indicating that multicollinearity was not a serious concern; the Breusch-Pagan test for heteroscedasticity returned a chi-square statistic of 4.13 (p = 0.127), indicating homoscedastic residuals and confirming that no correction (e.g., robust standard errors) was required; and a normality test on the regression residuals (Jarque-Bera statistic = 1.85, p = 0.396) indicated no serious departure from normality.

DISCUSSION

The overall subsidy effectiveness score of 74.3% obtained in this study falls within the same "fairly effective" range reported in comparable Indonesian district-level subsidy-effectiveness studies applying the same five-rights framework, and specifically echoes the pattern identified in South Sulawesi's rice production centers, where implementation gaps between subsidy policy design and field-level practice were similarly attributed primarily to distribution-timing and quota-adequacy constraints rather than pricing or accessibility failures. The persistently weak right-time performance identified in this study (58.3%) reinforces a recurring finding across the Indonesian subsidy literature: that logistical and administrative delays in fertilizer distribution relative to the cropping calendar remain the most persistent operational weakness of the subsidy program, a finding also highlighted in studies examining infrastructure effects on subsidized-fertilizer distribution effectiveness in other

Indonesian regencies. From an agricultural-logistics perspective, right-time is structurally the hardest of the five criteria to satisfy because, unlike price or place, it depends on synchronizing a multi-tier distribution chain (central allocation, provincial and district redistribution, kiosk-level stocking) with a fixed agronomic window rather than on distributing fixed information (a price) or fixed infrastructure (a kiosk) that, once established, remains adequate across seasons; any single upstream delay in this chain propagates directly into a missed application window, whereas price and place failures are typically local and correctable without cascading effects. This structural asymmetry explains why right-time underperforms even in a program that scores "very effective" on price and place, and implies that improving right-time requires supply-chain and scheduling interventions distinct from the price-setting and kiosk-accessibility mechanisms that already function well.

The finding that organic-subsidized farmers achieved significantly higher net income and R/C ratio than conventional farmers, despite statistically indistinguishable yields, is broadly consistent with, though more moderate in magnitude than, prior Indonesian comparative studies of organic versus conventional rice farming. Comparative income studies in East Java reported an income advantage for organic rice farming of approximately 44% over conventional farming, while the present study found an income advantage of approximately 10.2%; feasibility studies among food-policy-program beneficiary farmers in Jember similarly reported R/C ratios in the 2.5-1.4 range depending on cost-accounting method, generally lower than the 3.71-4.25 range obtained in this study, likely reflecting differences in regional cost structures, land productivity, and the specific accounting treatment of family labor. The comparatively modest income advantage observed here, relative to some prior organic-versus-conventional comparisons, is consistent with the more moderate framing found in studies cautioning that subsidy payments alone may be insufficient to generate large-scale profitability transformation in the presence of persistent adoption and cost-structure constraints, even though the direction and statistical significance of the advantage in this study confirm that the subsidy mechanism does deliver a measurable economic benefit. That the profitability gain arises without a corresponding yield gain is consistent with a cost-side rather than a production-frontier explanation: standard farm-household theory attributes net income to the gap between revenue and cost, and because organic subsidy access lowers the price farmers pay per unit of fertilizer nutrient without necessarily raising the physical output elasticity of that nutrient (as the statistically indistinguishable yields and the comparatively modest fertilizer output elasticity in Table 6 suggest), the subsidy operates primarily as an input-cost transfer rather than a technology-driven productivity shock. In other words, organic subsidization in this setting behaves less like a yield-augmenting technical-change intervention and more like a targeted subsidy that shifts the cost structure in farmers' favor, a distinction with direct implications for how policymakers should evaluate the program's success: profitability and yield are not interchangeable performance metrics, and a program can be economically successful (as this one is) while leaving the production frontier largely unchanged.

The multidimensional sustainability results, particularly the pronounced ecological-dimension advantage for the organic-subsidized group (76.4 versus 52.1), align closely with the broader rationale underlying Indonesia's policy shift toward organic fertilizer subsidization: that reduced agrochemical input intensity yields measurable ecological benefits beyond what profitability analysis alone would capture. The overall multidimensional sustainability index obtained for the organic-subsidized group in this study (68.0) is closely comparable to the average sustainability score of 68.56 reported for organic rice farming sustainability assessment in Central Java and Yogyakarta using a similar Rapid Appraisal methodology, lending external validity to both the measurement approach and the substantive finding that organically managed rice farming in Indonesia, subsidized or otherwise, tends to cluster within the "fairly sustainable" rather than "highly sustainable" category, indicating room for further improvement even under favorable input-cost conditions.

The positive and significant subsidy-participation coefficient in the Cobb-Douglas production function (0.076, $p < 0.05$), obtained after controlling for the quantity of fertilizer applied, suggests that the productivity benefit of subsidized organic fertilizer access extends beyond the simple input-quantity channel already captured by the fertilizer variable, plausibly reflecting improved application timing, product-quality consistency, or complementary extension support often bundled with subsidy program participation. This finding is broadly consistent with production-function-based evaluations of fertilizer subsidy programs elsewhere in Indonesia, which have similarly found direct and indirect productivity effects of subsidy access even after controlling for measured input quantities.

These findings should be interpreted in light of several limitations. First, the cross-sectional, single-season design captures a snapshot of relative performance but cannot fully account for multi-season learning effects, cumulative soil-health changes, or price-volatility exposure that would more fully differentiate organic and conventional systems over the longer term. Second, self-selection into subsidy-recipient status, even after stratified sampling and demographic comparison, may reflect unobserved farmer characteristics (e.g., greater engagement with farmer-group institutions) that independently influence both subsidy access and farming outcomes; future research employing propensity-score matching or panel-data fixed-effects approaches would help further isolate the causal effect of subsidy participation. Third, this study focused on Kabupaten Solok, West Sumatra; given documented regional variation in subsidy-distribution effectiveness and cost structures across Indonesia, generalization of the specific magnitude of profitability and sustainability advantages to other regions should be made cautiously, though the directional findings are consistent with the broader national literature.

CONCLUSIONS

This study analyzed the effectiveness of organic fertilizer subsidies and their impact on the profitability and sustainability of rice farming businesses in Kabupaten Solok, West Sumatra. Subsidy distribution achieved an overall effectiveness score of 74.3%, categorized as fairly effective, with right-place and right-price criteria performing strongly while right-time distribution remained the weakest link, indicating a clear and specific area for policy improvement. Organic-subsidized rice-farming households achieved significantly higher net farm income (10.2% higher) and R/C ratio (4.25 versus 3.71) than conventional non-subsidized households, despite statistically comparable yields, driven primarily by a 30.2% reduction in fertilizer expenditure. The organic-subsidized group also achieved a meaningfully higher multidimensional sustainability index (68.0 versus 59.7), with the largest advantage in the ecological dimension, confirming that the subsidy program delivers measurable sustainability co-benefits alongside its profitability effects. The Cobb-Douglas production function further confirmed a positive, statistically significant, quantity-independent productivity contribution of subsidy participation (7.6% output increase, $p < 0.05$). Collectively, these findings indicate that Indonesia's organic fertilizer subsidy policy, while requiring improvement in distribution timeliness and quota adequacy, is delivering measurable and statistically significant benefits for both the economic profitability and the long-term sustainability of smallholder rice farming, and that continued investment in, and refinement of, the program is empirically justified. These findings point to specific, actionable policy directions rather than general calls for improvement: (1) given that right-time was the weakest criterion and that its underperformance stems from multi-tier distribution delays rather than pricing or accessibility failures, the government should prioritize logistics-scheduling reform and real-time digital monitoring of fertilizer distribution against the cropping calendar, rather than further price or kiosk-access interventions where the program already performs well; (2) because right-quantity allocation was frequently reported as insufficient relative to farmers' cultivated area, subsidy quota formulas should be revisited to better match land-area-based demand, potentially through the same electronic farmer-group data (RDKK) used for right-target verification; and (3) because the profitability gain was shown to operate through cost reduction rather than yield enhancement, complementary programs aimed at raising organic-fertilizer output elasticity (e.g., technical training on organic application timing and rates) would be needed if the policy goal shifts from cost relief toward productivity growth.

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