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The Utilization of Agricultural Mechanization and Its Impact on Integrated Rice Farming and Cattle Farming in Merauke Regency

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ABSTRACT

Agricultural mechanization is an important strategy for increasing the efficiency and productivity of integrated rice farming with cattle farming in Merauke Regency. Agricultural mechanization can improve labor efficiency and accelerate the cultivation process, from land preparation to post-harvest. This research was conducted from October to December 2025 in three districts: Tanah Miring, Kurik, and Semangga. The research locations were selected based on the highest rice production centers in Merauke Regency. Data in this study were obtained from primary and secondary data. The results showed that all rice farmers who are members of farmer groups have utilized agricultural machinery in their farming processes, including cultivation, harvesting, and post-harvest. Rice farming using mechanization is feasible with a R/C ratio of 2.38. The amount of farmer income is Rp 32,590,000 and profit is Rp 21,907,000 per planting season.

Keywords:, ***Mechanization, Farming, Rice, Cattle***

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INTRODUCTION

Merauke Regency is a strategic area for national food agriculture development, particularly rice, with extensive agricultural land potential and government policy support as a food barn in eastern Indonesia (Rusdin et al. 2025). Integrated rice farming with cattle farming in Merauke Regency still faces various structural challenges, such as labor constraints, low production efficiency, and high operational costs (Redu and Pane 2025). This situation demands innovation and transformation of the agricultural production system so that rice farming can run more effectively, efficiently, and sustainably (Mohring et al. 2025).

One of the strategic efforts the government continues to promote is the implementation of agricultural mechanization, from land preparation, planting, maintenance, to harvesting and post-harvest (Han et al. 2024). Agricultural mechanization is believed to increase productivity, accelerate work processes, and reduce crop losses (Ndirangu and Zoltan 2025); (Mabhaudhi et al. 2025). Given the vast land area and relatively flat topography, agricultural mechanization is a highly relevant option to support the intensification and modernization of rice farming

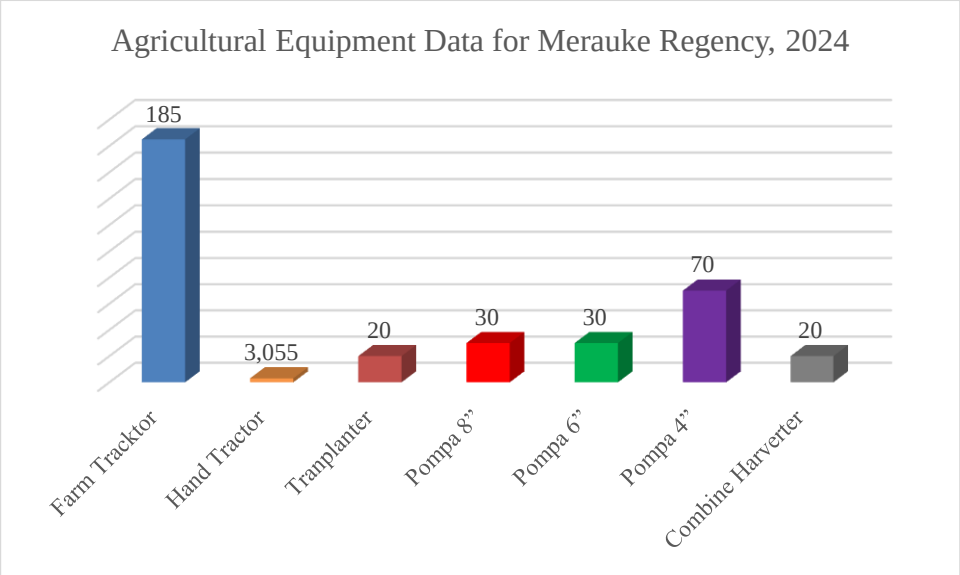

Figure 1. Agricultural Equipment Data For Merauke Regency 2024

The use of agricultural tools and machinery (alsintan) in rice farming in Merauke Regency shows that mechanization has been implemented in almost all stages of cultivation, from land preparation, planting, irrigation, and harvesting. The availability of 185 farm tractors and 3,055 hand tractors illustrates that mechanization at the land preparation stage is the most dominant form of technology adoption. Hand tractors are widely used by small- to medium-

scale farmers because they are relatively easy to operate and suited to the conditions of their rice fields (Hernández and Granados 2023). Farm tractors are more focused on large-scale land cultivation, which is generally managed through farmer groups, agricultural machinery brigades, or with local government support, thus accelerating land preparation and reducing labor costs (Latipov et al. 2022).

At the planting stage, the availability of 20 rice transplanters indicates that mechanization of rice planting is still relatively limited. The low number of transplanters indicates that most farmers still use manual planting systems, which require significant labor and relatively long planting times (Denton et al. 2025). The use of transplanters has the potential to increase planting efficiency, uniformity of plant spacing, and crop productivity. These limitations are caused by several factors, such as operational skills, nursery readiness, and technological adaptation to land conditions. Therefore, technical assistance and strengthening of agricultural machinery management institutions are needed to optimize the use of planting equipment (Jain et al. 2025).

In terms of irrigation, the availability of 30 8-inch, 30 6-inch, and 70 4-inch water pumps is a crucial component in supporting water availability, particularly during the dry season or in areas not yet optimally served by technical irrigation networks (Balamurali et al., 2024). Large-capacity pumps are generally used in large-scale rice fields, while smaller-capacity pumps are used by individual farmers or farmer groups in limited areas. The use of water pumps plays a significant role in maintaining stable rice plant growth and reducing the risk of crop failure due to water shortages (Yasmin et al., 2025).

Mechanization during the harvesting phase is supported by the presence of 20 combine harvesters that function to harvest, thresh, and clean rice in an integrated manner. The use of combine harvesters can accelerate the harvesting process, reduce yield losses, and reduce harvest labor costs, which tend to increase (Qiong Wang, et al, 2022). The limited number of combine harvesters means that their utilization has not yet reached all rice farmers in Merauke Regency. Therefore, schedule-based management, institutionalization, and a rental system are still needed to ensure the benefits of harvest mechanization are more evenly distributed.

This situation demonstrates that the implementation of agricultural mechanization not only impacts the technical aspects of production but also the economic and social aspects of farmers (Ndirangu and Zoltan 2025). Mechanization can change the cost structure of farming,

increase farmer incomes, and reduce dependence on manual labor (Eileen Nchanji, et al., 2024). Mechanization also has the potential to create new challenges, such as shifts in work patterns, dependence on agricultural machinery service providers, and the need for better farm institutions and management (Kumareswaran and Jayasinghe 2022)

METHODS

This research was conducted from October to December 2025 in three districts: Tanah Miring, Kurik, and Semangga. The locations were selected based on rice production centers and the highest cattle populations in Merauke Regency. Data for this study were obtained from primary and secondary sources. This study involved 30 respondents evenly distributed across the three districts, with each district represented by 10 respondents. Data analysis included total costs, revenue, income, and R/C.

a. Total Farming Costs, calculated according to the Soekartawi formula (2002): TC = FC + VC

   Information :

   TC = Total Cost (Biaya Total)

   FC = Fixed Cost (Biaya Tetap Total)

   VC = Variabel Cost (Biaya Variabel Total)

b. Analysis of Farm Business Income, calculated according to the Kasim formula (2004): TR = Y x Py

   Information :

   TR = Total Revenue

   Y = Output

   Py = Price

c. Income Analisis: I = TR – TC

   Information :

   I = Income

   TR = Total Revenue

   TC = Total Cost

d. R/C Analysis and Business Profit, according to Rahim and Hastuti (2007) yaitu:

   RC ratio = TR/TC

   Information :

RC ratio = Return Cost Ratio

TR = Total Revenue

TC = Total cost

RESULTS AND DISCUSSION

Respondent Characteristics

The characteristics of rice farming businesses in Merauke Regency are reviewed from the perspective of business resources and socio-economic aspects, which include the respondent's age, education level, business experience, and family dependents (Mehrabi and Giagnocavo 2024).

1. Respondent's Age

Farmers' age is related to their ability to make business decisions. As individuals age, they tend to have more mature considerations in decision-making. Research results indicate that the majority of farmers are in the productive age group. According to the Ministry of Health (2009), the productive age range is 15–64 years. Respondents were predominantly aged 26–50 years (93 percent), while respondents aged 50 and over (7 percent) were. This indicates that the majority of farmers have sufficient experience in managing rice farming businesses. However, this experience is not fully supported by an optimal level of formal education (De Beer et al. 2025).

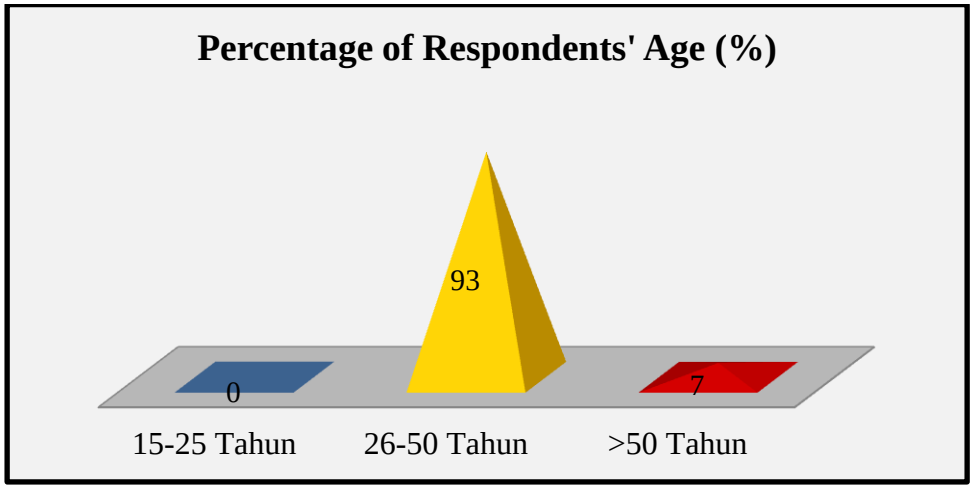

Figure 2. Respondent's Age

2. Level

Education level is a crucial factor influencing a farmer's ability to manage and develop their business (Mayele and Sakurai 2025). Farmers with a better educational background tend

to have an easier time choosing business options and adopting innovations to improve their business performance. Furthermore, adequate education plays a role in expanding networks, thus providing broader and more effective marketing opportunities for their products (Musman et al. 2025).

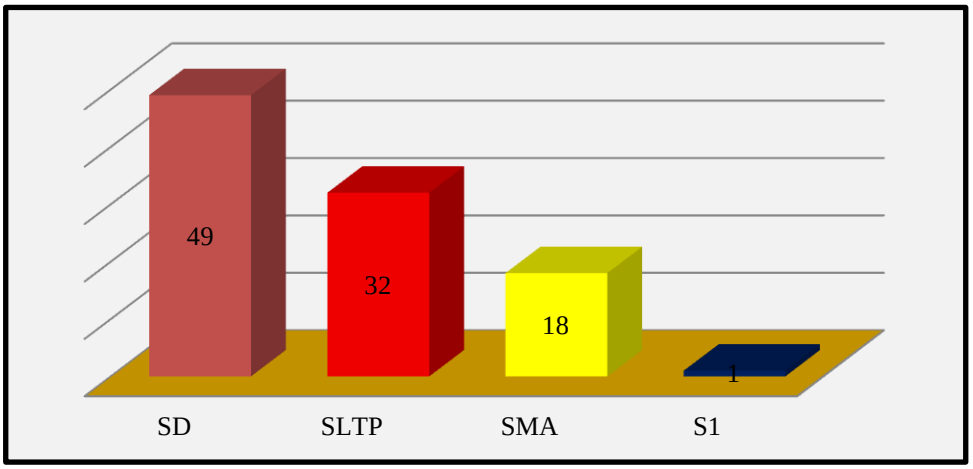

Figure 3. Level

Based on the illustration in the figure, it can be seen that farmers at the research location have diverse educational backgrounds, ranging from elementary school to university level. The composition of respondents was dominated by elementary school graduates (49 percent), followed by junior high school graduates (32 percent), high school graduates (18 percent), and university graduates (1 percent). This variation in education levels has implications for differences in business management skills, which ultimately affect the level of income earned by farmers (Malik and Terzidis 2025).

3. Length of Business

Length of service reflects the duration of farmer and livestock farmer involvement in their current business activities (Robson and Otteson 2025). The longer a farmer's business experience, the greater the chance of success in managing that business. In the research area, most farmers have long implemented integrated business patterns over their tenure at the location. These business activities are carried out sustainably and serve as a primary source of income for meeting daily needs.

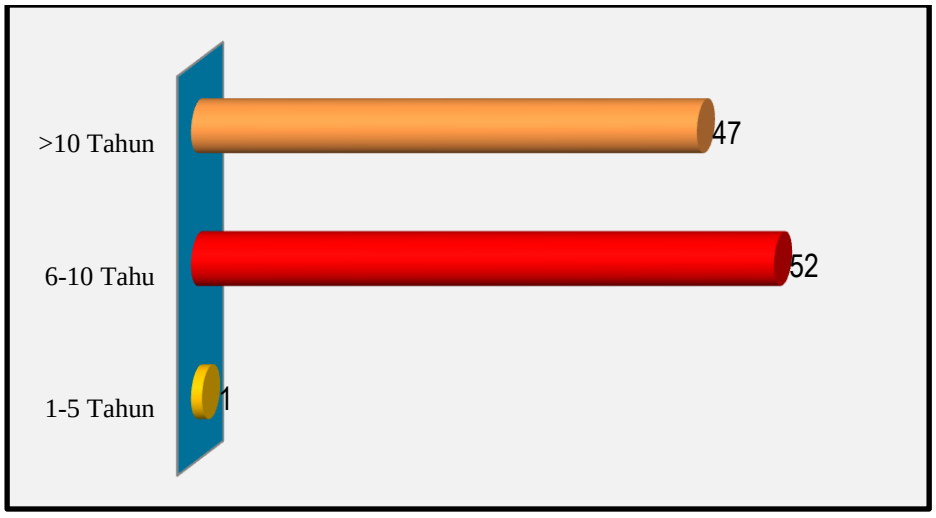

Figure 4. Length of Business

The predominance of respondents with 6–10 years of business experience, reaching 52 percent, indicates that these businesses have developed into a relatively stable source of income. This range of experience also contributes to entrepreneurs' increased understanding of market dynamics and consumer preferences. Accumulated experience in running a business encourages adaptive behavior, including innovation efforts to support business sustainability and development (Mehdiyev, Majlatow, and Fettke 2025).

4. Family Dependencies

The number of family members supported by farmers influences the level of household expenditure financed from business income (Nchanji et al. 2024). The greater the number of dependents, the higher the allocation of costs required to meet family consumption needs (Syakirotin et al. 2025). Research findings indicate that the average farming household consists of four people, some of whom are involved as laborers in the agricultural business

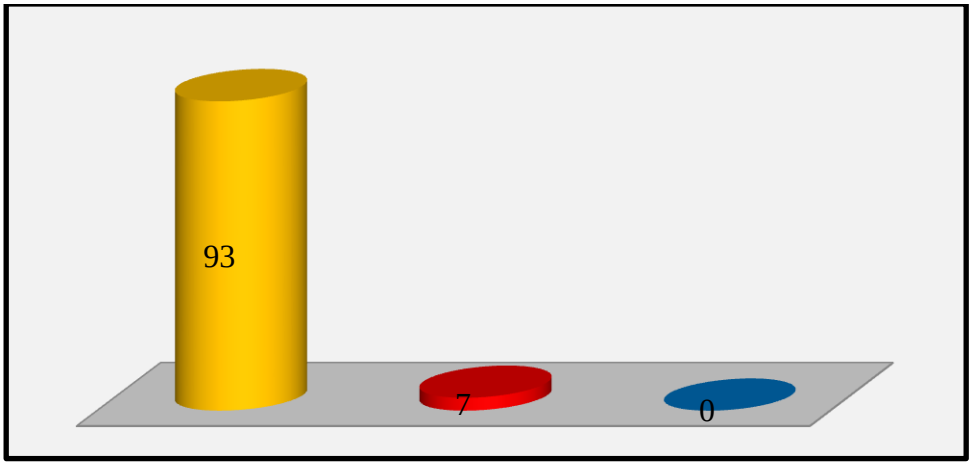

Figure 5. Family Dependencies

Farmer and livestock households operating integrated cattle and rice farming businesses in Semangga District generally have a relatively small number of dependents, ranging from one to four people. This is reflected in the predominance of respondents with 1–4 dependents (93 percent), while households with 5–10 dependents accounted for only 7 percent. No respondents were found with more than 10 dependents, thus the household structure in the study area is dominated by small families.

Analysis of Integrated Rice Farming and Cattle Farming

Table 1. Total Costs of Rice Farming Using Agricultural Machinery

Type of Fee	Cost (Rp/ha)	Percentage (%)
Cost of production facilities	6.552.000,-	32,68
Labor	5.970.000,-	29,78
Sack cost	561.000,-	2,79
Feed costs and others	6.960.000,-	34,72
Total cost	20.043.000,-	100

Source: Processed data, 2025

Table 1 above shows that the farm cost structure indicates that the total production cost incurred is Rp20,043,000, consisting of several main components, namely the cost of production facilities, labor, sacks, feed, and other components. This cost composition reflects the characteristics of a farming business that combines rice cultivation with livestock raising, resulting in relatively diverse production input requirements.

The cost of production inputs (saprodi) is one of the largest cost components, amounting to Rp6,552,000, or 32.68 percent of the total cost. This large cost allocation indicates the high dependence of farming businesses on production inputs such as seeds, fertilizers, and pesticides to support rice productivity. The use of adequate production inputs is a crucial factor in maintaining the quality and quantity of yields, especially in farming systems that demand efficiency and continuity of production.

Labor costs ranked second, totaling Rp5,970,000, or 29.78 percent of total costs. The high proportion of labor costs indicates that farming activities still require significant human input, both in land preparation, crop maintenance, and livestock management. Despite the implementation of agricultural mechanization, labor remains essential, particularly for activities that cannot yet be fully replaced by agricultural tools and machinery.

Feed costs and other expenses constitute the largest cost component, amounting to Rp6,960,000, equivalent to 34.72 percent of total production costs. This substantial cost indicates that integrating rice farming with cattle farming requires significant allocation of funds for feed and other supporting operations. However, the integrated system offers efficiency opportunities through the use of agricultural waste as animal feed, potentially reducing these costs in the long term if managed optimally.

The cost of sacks only contributed Rp561,000, or 2.79 percent of the total cost, making it the smallest cost component. This low cost proportion indicates that packaging expenditures are relatively insignificant in the farm cost structure. Overall, this cost composition demonstrates that farm efficiency can be improved through the management of agricultural inputs, optimization of labor utilization, and the utilization of local resources within an integrated rice and cattle system.

Table 2. Average Farm Business Income

Description	Revenue (Rp/ha)
Planting Production 1	34,965,500
Planting Production 2	21,538,333
Livestock Sales	12,433,333
Total revenue	68.937.166

Source: Processed data, 2025

Table 2 shows that income from integrated rice farming and cattle farming comes from several sources, namely rice production in the first planting season, the second planting season, and livestock sales. Total income from all these business activities reached Rp68,937,166, reflecting the contribution of each component in supporting the household income of farmers and livestock breeders.

The largest revenue came from rice production during the first planting season, amounting to Rp34,965,500. The high revenue during the first planting season indicates that agro-climatic conditions and resource availability during that period were relatively supportive of rice growth, resulting in optimal production. Furthermore, the use of agricultural mechanization during land preparation and harvesting contributed to increased efficiency and yields during this planting season.

In the second planting season, revenues reached Rp21,538,333. This figure was lower than the first planting season, possibly due to several factors, such as differences in weather

conditions, water availability, and decreased land fertility due to high cropping intensity. Nevertheless, the second planting season's contribution remained significant in supporting total farm revenues, particularly in maintaining the continuity of farmers' incomes throughout the year

In addition to rice crops, business revenue also comes from cattle sales, totaling Rp12,433,333. The cattle's contribution to total revenue demonstrates that the integrated rice and livestock system provides additional economic benefits for farmers and ranchers. The livestock business serves as an alternative source of income and a buffer against fluctuations in rice production, thereby increasing household income stability.

Table 3. Average Income of Integrated Rice Farming with Cattle

Description	Amount (Rp)
Farm Business Income	68.937.166
Total cost	20.043.000
Farm Income	48.894.166,-
Efficiency (R/C)	3.34

Source: Processed data, 2025

Table 3 shows that the results of the economic feasibility analysis indicate that the total revenue from integrated rice farming with cattle is Rp68,937,166, while the total production costs incurred reached Rp20,043,000. The difference between revenue and total costs resulted in a farm income of Rp48,894,166, which reflects a fairly high level of profit for farmers and livestock breeders

The high income generated demonstrates that integrated farming systems can provide significant added economic value (Thao et al. 2023). Integrating rice and cattle farming not only increases income but also contributes to the efficient use of production inputs. The use of agricultural waste as animal feed and the use of agricultural mechanization in rice cultivation contribute to reducing production costs and increasing productivity.

A revenue-to-cost (R/C) ratio of 3.34 indicates that every rupiah of costs incurred in farming activities generates Rp3.34 in revenue. An R/C value greater than one indicates that the farming business is financially viable and profitable. The higher the R/C value, the more efficient the farming activities are.

The high R/C value in this farming business also reflects the effectiveness of business management, both in terms of the use of production facilities, labor, and integration between

crop and livestock businesses. Agricultural mechanization plays a crucial role in increasing time and labor efficiency, thereby reducing production costs without reducing yields (Tamás Mizik, et al., 2025). Furthermore, cattle farming provides additional income, strengthening the economic structure of farming households.

CONCLUSION AND IMPLICATIONS

1. Rice farmers who are members of a farmer group have utilized agricultural machinery in their farming processes, including cultivation, harvesting, and post-harvest.
2. Integrated rice farming with cattle using mechanization is feasible, with a R/C ratio of 3.34. Farmers receive Rp 68,937,166 and profit is Rp 48,894,166 per year.

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