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Increasing the Income of Rice Paddy Farmers with an Integrated Crop Management System and Local Wisdom

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ABSTRACT

Background: Even though rice farming is crucial to farmer's livelihoods, using technology can be challenging, particularly in places with various traditional knowledge. This study investigated how introducing an integrated crop management system tailored to local knowledge could raise farmers' incomes.

Methods: Both qualitative and quantitative analyses were performed on the data. The integrated crop management system and community knowledge in paddy rice farming were revealed qualitatively using a phenomenological approach. R-C ratio, farmers' income difference test and quantitatively computed income.

Result: The result demonstrated that, compared to the non-integrated system, which generates IDR 26,636,128/ha, the integrated crop management system with local knowledge can use resources more efficiently and provide a higher income of IDR 36,459,191/ha. The R/C ratio of 5.7, which is higher than 3.8 for the non-integrated system, shows the superiority of the integrated system. This result shows that the costs incurred for the integrated system yielded more significant revenues, indicating its economic viability.

Key words: Income, Integrated crop management, Local wisdom, Paddy rice.

INTRODUCTION

As both a producer and consumer of energy, the agricultural sector plays a critical role in food security. Food security is one of the most fundamental economic and social development aspects in many countries, especially developing countries like Indonesia. Food security is critical to creating a healthy, productive and prosperous society where everyone can access nutritious food, supporting growth and development and a better quality of life (Dias *et al.,* 2023; Lin *et al.,* 2024).

Paddy rice has a crucial role in food security, as it is the primary source of rice production that supplies food needs for most of the world's population and one of the superior commodities whose availability continues to be pursued by the government so that the resulting production continues to increase and stabilize (Arouna *et al.,* 2021; Yan *et al.,* 2015). A region must have natural resources that can be processed and used as a food source because the population continues to increase (Barlagne *et al.,* 2015). With the increasing population, the demand for rice can be met with a sustainable and efficient increase in production (Purba *et al.,* 2020).

Integrated crop management is an innovative and dynamic approach to increasing farmers' production and income through the participatory assembly of technology components with farmers (Wihardjaka, 2018). Integrated crop management combines all selected farming components that are harmonious and complementary to achieve optimal yields and environmental sustainability (Sawitri and Nurtilawati, 2019). Since 2008, integrated crop management has been applied to an area of 1.59 million ha involving 60,000 farmer groups in 32 provinces (Suseno, 2021). The productivity of paddy rice with integrated crop management still faces significant challenges. It is less than optimal because it does not fully consider local wisdom that has proven effective in specific contexts.

The productivity of paddy rice with integrated crop management still faces significant challenges. It is less than optimal because it does not fully consider local wisdom that has proven effective in specific contexts (Limpo *et al.,* 2022; Shanmugam *et al.,* 2022). Farmers use local wisdom in agriculture to decide when to start production (Elfis *et al.,* 2024). In addition, the knowledge is also used in sustainable agricultural practices (Spangenberg *et al.,* 2018). Rural areas still rich in local cultural values will affect farmers' physical and spiritual agrarian land management (Utami *et al.,* 2022). The local wisdom approach still plays an essential role in natural resource management and maintaining agricultural sustainability (Agesti *et al.,* 2023).

The harvest area of paddy rice in North Maluku Province in 2020 was 10,301.91 ha and the total production was 43,382 tons. In 2021, the rice paddy harvest area was 7,782.00 ha and the total production was 28,051 tons and

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in 2022, the rice paddy harvest area was 6,416.00 with a total production of 24,486 tons (BPS-Statistics, 2022). The data shows a downward trend in paddy rice production in North Maluku Province. Production is the main component determining income; this decline can significantly impact farmers' income. Farmers' incomes are still low, so increasing them by integrating crop management systems with local wisdom is necessary.

This research is essential because an integrated crop management system with local wisdom can be effective. This research offers a new approach to increasing the income of wet-rice farmers. The amount of income farmers receive can indicate their economic capacity and have implications for the level of welfare. A socio-economic assessment of the paddy rice farming system based on local community knowledge obtained an average income of Rp. 24,348,354/growing season (Hidrawati *et al.,* 2023). Compared to income with an integrated crop management system, which is Rp. 30,722,132/growing season (Rosadillah *et al.,* 2017). Integrated crop management has been applied in many parts of Indonesia, increasing farmers' productivity and income. However, there are challenges in its application, especially in North Maluku, where local wisdom is still maintained in paddy rice farming. Unlike previous studies that only assessed or applied integrated crop management or local wisdom separately, this study provides a deeper understanding of how integrating integrated crop management with local wisdom can increase farmers' income and ensure social and cultural sustainability.

This research offers a novelty by integrating integrated crop management, which is proven to increase farmers' productivity and income, with local wisdom that is part of the tradition of the people in North Maluku. This new approach aims to develop an integrated crop management model sensitive to local cultural values, considering technical and economic factors as well as regional social and environmental aspects. The results of this research are expected to provide applicable recommendations for local farmers and enrich the literature on local wisdom-based agriculture that can be applied in other regions with similar conditions.

MATERIALS AND METHODS

The research period is three months starting from December 2024-February 2025. The research was conducted in Lembah Asri Village, South Weda District, North Maluku Province. The research location was determined purposively considering that Lembah Asri Village has implemented an integrated crop management model and still maintains the tradition of local knowledge in rice farming. Respondent farmers with an integrated crop management system with local wisdom amounted to 21 farmers who ran their farms for one growing season, so the sample of non-integrated respondent farmers was also taken from 21 farmers who ran their farms for one growing season. Data were analyzed qualitatively and quantitatively. Qualitatively, a phenomenological approach was used to reveal the local knowledge of the community in paddy rice farming, quantitatively calculated the cost structure, income, R-C ratio and differential test of farmers' income. Data processing was done using computers (Microsoft Excel and SPSS).

Analysis of income

Farm income is the difference between total farm income and total farm expenses, which is the value of all inputs spent in the production process (Soekartawi, 2016). The farm income equation is expressed in the following formula:

$$I = TR - TC$$

Keterangan,
I = Income (Rp).
TR = Total revenue (Rp).
TC = Total cost (Rp).

R - C ratio analysis

Return cost (R-C) ratio analysis compares revenue and cost (Soekartawi, 2016). The R-C ratio analysis aims to determine whether or not the farm is feasible to cultivate. The R-C ratio equation can be formulated as follows:

$$R - C \text{ ratio} = \frac{\text{Total revenue (IDR)}}{\text{Total cost (IDR)}}$$

If the R-C ratio value obtained is more than one, the farm can be said to be feasible or profitable. If the R-C ratio value obtained is less than one, the farm can be considered unfeasible or unprofitable. The farm breaks even if the R-C ratio value obtained equals one.

Independent samples two test

Independent sample two test compares the income of integrated and non-integrated rice farming systems. Analysis of the average difference test of two free samples (independent samples) with the following formula:

H0: X1<X2, There is a difference in income between integrated and non-integrated paddy rice farming systems.
H1: X1 = X2. There is no difference in income between integrated and non-integrated rice farming systems.

Where,
X1 = Variable 1 (Integrated rice paddy farming system).
X2 = Variable 2 (Non-integrated rice paddy farming).

$$t_1 = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{(n_1 - 1) S^2_1 - (n_1 - 1) S^2_2}{n_1 - n_2 - 2}\left(\frac{1}{n_1} + \frac{1}{n_1}\right)}}$$

RESULTS AND DISCUSSION

Components of integrated crop management and local wisdom of rice paddy crops

Land and water management

Optimal allocation of water resources and agricultural land is critical in ensuring the sustainability of food production

(Chan *et al.,* 2023; Sun *et al.,* 2024). Land utilization provides enormous potential to increase and diversify agricultural production, especially food crops (Hairani *et al.,* 2024; Wang *et al.,* 2015). Integrated crop management technology encourages modern irrigation systems such as the Alternate Wetting and Drying (AWD) method. This method enables water efficiency by controlling wet and dry periods in paddy fields. Water efficiency can produce more crops under alternate wetting and drying irrigation practices (Giuliana *et al.,* 2024; Mboyerwa *et al.,* 2021). On the other hand, local wisdom still plays an essential role through traditional irrigation based on community cooperation, where water sharing is somewhat based on mutual agreement.

Rice varieties

Integrated crop management utilizes high-yielding varieties that are resistant to pests and capable of high productivity to meet the growing demand for food. Superior seeds can increase income (Van Hung *et al.,* 2024). By choosing quality varieties and good management practices, rice productivity can be improved (Shinde *et al.,* 2025). Meanwhile, local wisdom retains traditional rice varieties with distinctive flavors and is well-adapted to local environmental conditions. This integration is done by planting superior varieties on most land to achieve maximum yields while leaving some land for local varieties.

Fertilization

In the integrated crop management approach, balanced fertilization is applied based on careful soil analysis, using a combination of chemical and organic fertilizers to optimally meet the nutritional needs of plants. Inadequate fertilizer use is also one of the most significant factors hindering agricultural productivity growth (Ilham *et al.,* 2023; Thakur, 2024). Local wisdom makes an essential contribution by using natural fertilizers from local materials such as livestock manure, compost and crop residues that are readily available and environmentally friendly. Conventional practices require significant organic matter inputs to increase grain yields by about 25% (Jayasekara *et al.,* 2022). Balanced fertilization can reduce emissions while increasing productivity (Sai *et al.,* 2025; Xiong *et al.,* 2023).

Pest and disease control

Integrated pest management uses environmentally friendly pesticides and regular monitoring of pest populations to minimize adverse impacts on the ecosystem. Local wisdom remains relevant through the use of natural pesticides such as neem leaf decoction, tobacco, or other traditional ingredients that are easily accessible to farmers. Improved integrated pest management behavior can be achieved by increasing farmers' knowledge, local wisdom and motivation (Jaya *et al.,* 2023).

Harvest and post-harvest

In Integrated Crop Management, modern tools such as combine harvesters are prioritized to speed up the harvest process while reducing yield losses that often occur with manual methods. Meanwhile, local wisdom is maintained through traditional pre-harvest rituals that aim to maintain harmony with nature and show gratitude for the crops. These two approaches are integrated by utilizing modern technology to increase crop productivity while involving the tradition of harvesting together in cooperation, strengthening social relations between farmers.

Comparison of farming costs of integration systems (integrated crop management with local wisdom) and non-integration

Farming costs calculated in this study are the costs farmers incur per 1 ha in one growing season. Total farming costs are obtained from the sum of total fixed costs and variable costs. This study's analysis of the cost structure shows that the fixed costs of rice farming with integration and non-integration systems are almost the same, as Table 1 shows. A comparison of rice farming costs between the integrated and non-integrated systems showed notable differences in

Table 1: Average cost of rice paddy farming with integration system and non-integration.

Description	Integration system (IDR/ha)	Percentage (%)	Non-integration (IDR/ha)	Percentage (%)
Fixed cost				
Land tax	150,000	2.21	150,000	2.53
Land rent	1,000,000	22.13	1,000,000	25.37
Tractor rent	2,500,000	29.51	2,500,000	33.83
Depreciation equipment	254,190	4.29	243,643	3.59
Irrigation	60,000	0.88	60,000	1,01
Variable cost				
Seeds	459,000	7.76	466,800	6.88
Fertilizer	890,000	23.89	1,819,048	16.74
Biological/Pesticide	0	0	72,000	1.06
Labor	687,619	11.63	772,381	11.39
Total cost	6,100,809	100	6,883,872	100

Source: Primary data (processed), 2025.

Table 2: Analysis of rice paddy revenue and income.

Description	Integration system	Non-integration
Total production (kg/ha)	4.256 kg	3.352 kg
Selling price (IDR/kg)	Rp 10,000	Rp 10,000
Revenue (IDR/ha)	Rp 42,560,000	Rp 33,520,000
Fixed cost (IDR/ha)	Rp 3,964,190	Rp 3,953,641
Variable cost (IDR/ha)	Rp 2,136,619	Rp 2,930,229
Total cost (IDR/ha)	Rp 6,100,809	Rp 6,883,872
Income (IDR/ha)	Rp 36,459,191	Rp 26,636,128
R/C ratio	5.7	3.8

Source: Primary data (processed), 2025.

Table 3: Results of differential test analysis of total rice paddy farming income.

Results	Integration system	Non-integration
	N1 = 21	N1 = 21
	Varian = 32.250.687.197.140	Varian = 12.719.721.250.719

$$F = \frac{\text{Varian terbesar}}{\text{Varian terkecil}} = \frac{32.250.687.197.140}{12.719.721.250.719} = 2.53$$

F count 2.53 > F table 3.23

T count 2.021 > T table 1.68385 = Ho rejected.

resource allocation and cost management efficiency. Overall, rice farming costs in the integrated system were lower at IDR 5,911,809 per hectare, compared to IDR 6,777,070 per hectare in the non-integrated system, resulting in savings of 12.75%. These savings indicate the economic efficiency of the integration approach in resource management.

With more efficient cost allocation and lower total costs, integrated systems have proven more economical in increasing farmers' income. Integration approaches also offer additional benefits, such as reducing external inputs such as pesticides and biological agents, which can support environmental sustainability. Traditional farming practices have effectively maintained the presence of micro-organisms that support conservation practices, crop diversity and sustainable agriculture (Ngongo *et al.,* 2022; Yang *et al.,* 2019).

Comparison of revenue and income of rice paddy with integration and non-integration system

The revenue, income and r/c ratio analysis results can be seen in Table 2. Paddy rice farming has significant differences in economic performance between integrated and non-integrated systems, as shown by the analysis results in Table 2. The integrated system shows superior productivity, cost efficiency and income. With higher production (4,256 kg/ha compared to 3,352 kg/ha), the integrated system was able to generate a revenue of IDR 36,459,191/ha, higher than the non-integrated system (IDR 26,636,128/ha). This result shows that the integrated system can use resources more efficiently and produce greater output. Rice farming provides tangible benefits such as income to farmers (Nayak *et al.,* 2019). The R/C ratio of 5.7, which is higher than 3.8 for the non-integrated system, shows the superiority of the integrated system. This result shows that the costs incurred for the integrated system yielded more significant revenues, indicating its economic *via*bility. These results show that implementing integrated systems in wetland rice farming increases productivity and provides financial benefits. Therefore, system integration is a viable strategic option that can be implemented widely.

Differential test of rice paddy income with integration and non-integration system

The calculated F value (3.23) is greater than the F table value (2.53), according to the F test results presented in Table 3. This result indicates a significant difference between the two farming systems because the variance between the two data groups is not homogeneous. With a degree of freedom (dk) of N1-1=20 at an error level of α=0.05, the t-table value is 1.68385. Therefore, the null hypothesis (Ho) is rejected. So, there is a statistically significant difference in the income of paddy rice farming in the integration and non-integration systems. These results suggest that the integrated system is a better economic choice. The rejection of the null hypothesis (Ho) indicates that integration helps financial performance (Fisher *et al.,* 2015).

CONCLUSION

Based on the study's results, the integrated crop management system includes land and water management, rice varieties, fertilization, pest and disease control and harvest and post-harvest. The integrated integrated crop management system with local wisdom has been proven to increase farmers' income by IDR 36,459,191/ha, higher than the non-integrated system (IDR 26,636,128/ha). This study shows that the integration system can use resources more efficiently and produce greater output.

This research clarifies how integrated crop management systems with local wisdom can increase farmers' incomes and offers valuable recommendations for agricultural policy in North Maluku. Mentoring and education programs are needed to help farmers adopt the system well. The government is expected to provide incentives through organic fertilizer subsidies, technology access and post-harvest equipment assistance. Developing infrastructure such as efficient irrigation, storage warehouses and market access must also be a priority.

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Disclaimers

This research aims to integrate an integrated crop management system with local wisdom to increase the productivity and income of paddy rice farmers in North Maluku. While this study seeks to provide actionable recommendations as well as contribute to the development of sustainable agricultural practices, it is important to realize that the findings and conclusions generated are based on specific conditions in the research area. The effectiveness of this approach can vary depending on the environmental, socio-economic and cultural factors unique to each region.

Informed consent

The author did not use animal experiments.

Conflict of interest

The authors say that there is no conflict of interest.

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