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Integrated Crop Management with Hazton Planting Method on Paddy Rice Plants in North Maluku Province, Indonesia

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ABSTRACT

Background: The application of integrated crop management with the Hazton planting method can increase rice production, but the adoption rate of this technology still needs to be higher. So, there is a gap in the effectiveness of cultivation innovation that hinders the achievement of rice production targets. This study aims to identify socioeconomic factors that affect the integration of crop management with the Hazton method on rice paddy crops.

Methods: The analysis method used is multiple linear regression analysis. All statistical analyses were performed using IBM SPSS 21 software.

Result: The study's results showed that age, formal education, farming experience, land area, income and the role of extension and financing institutions significantly influenced 67% of the implementation of integrated crop management with the Hazton planting method on rice paddy crops. Meanwhile, age, family labor and institutional support for production input had no significant effect. These findings imply that increased adoption requires targeted education and training programs, especially in areas with extensive rice cultivation activities. Easily accessible financing schemes and strong institutional support are also important to support the sustainable adoption of the technology. This research contributes to the understanding of the influence of socioeconomic factors on the adoption of agricultural technology in remote areas and provides insights for the development of policies to support rice self-sufficiency in Indonesia.

Key words: Hazton method, Integrated crop management, Rice fields.

INTRODUCTION

Rice (*Oryza sativa* L.) is one of the staple foods for most of the world's population, including Indonesia (David *et al*., 2020). The increasing demand for food worldwide is driven by population growth and changing diets. For example, global rice production needs are expected to increase by 26% by 2035 to meet the needs of a rapidly growing population (Yamano *et al*., 2016; Dong *et al*., 2017). Food security policies are implemented through various planting methods or crop management to achieve the target of paddy rice production. Crop management is the best solution when area expansion is increasingly difficult and productive land is decreasing (Widjajanto *et al*., 2021). Crop management includes nutrient and water management and planting methods, all of which can increase rice production (Hussain *et al*., 2018). The application of proper crop management techniques can increase yield components, such as the number of panicles and grains per unit area, seed formation rate, panicle length, 1,000-grain weight and growth period (Wang *et al*., 2017).

Integrated crop management is the most ideal alternative to increase the productivity of paddy rice in North Maluku (Yayat *et al*., 2021). This approach is by the principle of integrated crop and resource management which is very relevant because it considers the characteristics of the location. The integrated crop management approach prioritizes the synergy of various technological components in one package, to increase the efficiency of input use and yield simultaneously (Ekaria *et al*., 2025). The application of integrated crop management models can increase rice productivity by 0.54-2.46 tons per hectare and increase farmers' income by IDR 1-3 million per hectare compared to conventional technology (Yayat *et al*., 2012).

The Hazton method is an alternative planting method that can be applied by farmers in North Maluku to increase the productivity of paddy rice. Research on the contribution of Hazton and Jajar Legowo methods to paddy rice farming in Lolori Village, West Halmahera District, showed that the Hazton method contributed the most income, which was 89%, compared to the Jajar Legowo method which only reached 78% (Ekaria and Mamulati, 2020).

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East Halmahera Regency is the first district to rank as a food crop production center in North Maluku Province (BPS-North Maluku, 2024). During the 2011-2021 period, rice production in North Maluku Province was only able to meet 71.17% of people's consumption needs per year and the remaining 28.83% of people's consumption was purchased from other regions (Ebaiswara Iskandar, *et al*, 2023). The imbalance between rice production and consumption can cause food instability in the community. One way to increase the productivity of paddy rice is through the utilization of integrated crop management technology with the Hazton planting method.

Although previous studies have shown that an integrated crop management approach combined with the Hazton planting method can increase rice yields by up to 54%, the adoption rate of this method is still relatively low among farmers (Yayat *et al*., 2012). The Hazton planting method, which utilizes old rice seeds and intensive seedling planting, has been shown to contribute significantly to rice productivity. However, only a few farmers have adopted this technology (Ekaria and Mamulati, 2020). Technology adoption in the agricultural sector is often hampered by socioeconomic factors, such as age, education, farming experience and land size, which affect farmers' ability to accept new innovations (Rogers, 1983; Simin and Janković, 2014).

The implementation of the Hazton method in North Maluku shows that the majority of farmers have not had access to adequate information and training, so their knowledge of this technology is still limited. Another contributing factor is the lack of institutional support, such as extension and financing institutions, that can provide guidance and funding for farmers to adopt this method sustainably (Sofia and Subekti, 2022). Therefore, this study focuses on analyzing the socioeconomic factors that influence the adoption of integrated crop management with the Hazton method, as well as efforts to improve extension and access to financing in East Halmahera District, North Maluku Province.

In a previous study, Feder *et al*. (1985) identified that the adoption of agricultural technology by farmers is influenced by various socioeconomic factors, with education, farming experience and land capacity being the main determinants. Other research by Hussain *et al*. (2018) hows that improved crop management technology can increase yields by up to 18% in various countries in Asia. The adoption of the Hazton method in North Maluku is in line with these findings, where the application of this method is proven to be able to significantly increase farmers' income through increased yields.

However, specific research on the factors influencing the adoption of integrated crop management with the Hazton method in Indonesia, especially in North Maluku, is still very limited. Some previous studies focused more on the technical aspects of applying the Hazton method without considering the socioeconomic factors that influence the adoption of the technology (Yayat *et al*., 2021). Therefore, an in-depth understanding of the socioeconomic factors that influence the adoption of the Hazton method among farmers in North Maluku is needed as well as the identification of the main constraints that hinder the adoption of this technology.

This study aims to explore the socioeconomic factors that influence the adoption of the Hazton method, with the hope of contributing to the development of more effective policies to support rice self-sufficiency in Indonesia. The scope of this study includes an analysis of factors such as age, formal education, farming experience, land size, income and institutional support for extension and financing, which is expected to provide insight into the field conditions in East Halmahera Regency. Based on the results of this study, it is expected that the government can strengthen extension programs and easily accessible financing schemes to increase the adoption of agricultural technology among wetland rice farmers.

MATERIALS AND METHODS

Location and time of research

This research was conducted in East Halmahera Regency, North Maluku Province, Indonesia. The selection of this research location was based on the consideration that East Halmahera Regency is a center of paddy rice production that has a large area of land and farmers in this area have implemented integrated crop management using the Hazton planting method. This research was conducted from May to August, 2025.

Sampling

The sampling technique in this study used a probability sampling approach. According to Plano Clark and Creswell, 2015, the use of probability sampling methods is carried out when population elements have the same opportunity to be selected as samples. The sampling used is simple random sampling, which is a sampling technique that is directly carried out on the sampling unit. Of the total number of farmers in East Halmahera Regency, only 100 farmers apply integrated crop management technology with the Hazton planting method. Therefore, the research sample was taken from these 100 farmers.

Data analysis methods

Multiple linear regression analysis is a statistical method used to understand the relationship between one dependent variable and two or more independent variables (Sugiyono, 2011). In the context of analyzing the socioeconomic factors that influence the application of integrated crop management with the Hazton planting method in paddy rice, multiple linear regression can be used to see how much each factor contributes to the application of these technologies.

The multiple linear regression model assumes that there is a linear relationship between the dependent variable and each predictor (Mahmut, 2023). The relationship is expressed in a formula and the formula to determine the socio-economic factors that influence the application of integrated crop management with the Hazton planting method in paddy rice is as follows:

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8 + b_9X_9 + b_{10}X_{10} + e$$

Where:
(Y) = Application of integrated crop management with Hazton planting method.
a = Constant.
b_1 - b_{10} = Regression coefficients for independent variables.
X_1 = Age of the farmer.
X_2 = Formal education.
X_3 = Experience as a paddy farmer.
X_4 = Area of paddy fields.
X_5 = Number of family laborers.
X_6 = Income from paddy farming.
X_7 = Role of production input institutions.
X_8 = Role of extension institutions.
X_9 = Role of financing institutions.
X_{10} = Role of farmer group institutions.
e = Residual (effect of external variables).

Statistical tests include a t-test, F-test and coefficient of determination (R^2) test, with all analyses conducted using IBM SPSS 21 software based on multiple linear regression models. Regression assumptions: that diagnostic tests for multicollinearity, normality and homoscedasticity were conducted and all assumptions were met within acceptable statistical limits.

RESULTS AND DISCUSSION

Socio-economic factors influencing the adoption of integrated crop management with the Hazton planting method

Farmers are the target actors for adopting agricultural technology innovations. Simin and Janković (2014) argue that innovation diffusion theory is still relevant to be used in understanding the adoption of agricultural innovations. Adoption is classified into two categories, namely individual adoption and aggregate adoption (Feder *et al*., 1985). The adoption of innovations that occurs among farmers is included in individual adoption. If farmers have a complete understanding of the new technology and its potential, adoption of the new technology can occur and continue over a longer period. In the use of technology, farmers' decisions consist of mental processes from the moment they find out about innovations, form their attitudes towards innovations, make decisions to adopt or reject new ideas and confirm their decisions (Indraningsih, 2011).

Multiple linear regression analysis

Multiple regression analysis was conducted to determine the influence of variables such as age (X1), formal education (X2), farming experience (X3), size of paddy field (X4), number of family labor (X5), income from farming (X6), the role of input institutions (X7), the role of extension institutions (X8), the role of financing institutions (X9) and the role of farmer group institutions (X10) on the application of integrated crop management with Hazton planting method in rice (Y). To determine these factors, t-test analysis is used by comparing the t-value for each independent variable. If the t-value is greater than the t-table, the independent variable has a significant effect on the dependent variable. The results of the multiple linear regression analysis are presented in Table 1.
The results of the regression equation are as follows:

$$Y = 1.669 + 0.009\ X1 + 0.176\ X2 + 0.253\ X3 + 0.209\ X4 + 0.020\ X5 + 0.164X6 + 0.009X7 + 0.186\ X8 - 0.121\ X9 - 0.026\ X10 + e$$

The results of the analysis show that formal education, farming experience, size of paddy field, income from farming, the role of extension institutions and the role of financing institutions have a positive and significant relationship with the application of integrated crop management models with Hazton planting method in paddy rice. The factors of age, number of family laborers, production facilities and the role of farmer group institutions have a negative relationship or an insignificant effect on the application of integrated crop management models and Hazton technology in paddy rice crops.

Hypothesis test

Simultaneous significance test (F test)

Testing the simultaneous influence between all X variables on variable Y can be seen by the Fcount value. The null hypothesis is accepted if Fcount < Ftable and the null hypothesis is rejected if Fcount > Ftable at the 95% confidence interval or error rate (α = 5). Based on the F-test results, a significance value of 0.000 (α < 0.05) is obtained. So it can be concluded that variable X (age, formal education, farming experience, land area, number of family labor, farm income, production facilities institutions, extension institutions, financing institutions and farmer group institutions) simultaneously has a significant effect on variable Y (application of integrated crop management with Hazton planting method). Simultaneous Significance Test (F Test) can be seen in Table 2.

Individual parameter significance test (t Statistical test)

The test results can be seen through the t-count. The null hypothesis is accepted if t count < t table and the null hypothesis is rejected if t count > t table at the 95% confidence interval or error rate (α = 5%). Partial hypothesis testing results can be seen in Table 3.

Partial hypothesis testing

The influence between the age of farmers on the application of integrated crop management with the Hazton planting method obtained a coefficient value of 0.009 with a significance value of 0.842, because the significance

value> 0.05 then there is no significant influence between the age of farmers on the application of integrated crop management with Hazton planting method. This means that high or low respondents perceive the age of farmers will not lead to the higher or lower implementation of integrated crop management with the Hazton planting method. Farmers' age describes a variety of experiences that shape competence, happiness, mental well-being and success in work (Lodi Smith and Robert, 2010). The application of agricultural technology does not have to be at a productive age but based on experience in farming.

The influence between official education on the application of integrated crop management with the Hazton planting method obtained a coefficient value of 0.176 with a significance value of 0.006, because the significance value <0.05, there is a significant influence between official education on the application of integrated crop management with Hazton planting method. The positive coefficient indicates that the relationship between the two is positive, meaning that the higher the respondent perceives official education will result in the higher the application of integrated crop management with Hazton planting methods and vice versa. Farmers who receive formal education will increasingly develop and adapt to advances in agricultural technology. This opinion is in line with the views expressed by Rogers and Shoemaker (1971) which state that educational factors affect the speed of decision-making in the process of adopting a technology. Mirza *et al*. (2017), low levels of education can be the cause of the low ability of group members in sustainable business management. Aminah (2015) reinforces that a low education structure implies low literacy, limited insight and creativity which in turn will reduce the productivity of farmers producing agricultural products and food crops.

Farming experience on the application of integrated crop management with the Hazton planting method obtained a coefficient value of 0.253 with a significance value of 0.003, because the significance value <0.05, there is a significant influence between farming experience on the application of integrated crop management with Hazton planting method. The positive coefficient indicates that the relationship between the two is positive, meaning that the higher the respondent perceives the farming experience will result in the higher the application of integrated crop management with Hazton planting methods and vice versa. Farming experience is a series of knowledge and skills acquired by farmers while carrying out agricultural activities. Experience is the accumulated result of a person's learning process, which further affects the stimulus he receives and responds to decide something new (Walker, 1993).

The effect between the area of agricultural land on the application of integrated crop management with the Hazton

Table 1: Results of multiple regression analysis: Socio-economic factors affecting the application of integrated crop management with hazton planting method.

Independent variables (X)	Regression coefficients	Calculated t-value	Sig.
(Constant)	1.669	.773	.442
X1 (Age)	-.009	-.200	.842
X2 (Formal education)	.176	2.826	.006
X3 (Farming experience)	.253	3.048	.003
X4 (Area of paddy fields)	.209	3.004	.003
X5 (Number of family laborers)	-.020	-.5502	.584
X6 (Income from farming)	.164-	.604	.011
X7 (Role of production input institutions)	.009	-.2162	.830
X8 (Role of extension institutions)	.186	.8802	.005
X9 (Role of financing institutions)	.121	.563	.012
X10 (Role of farmer group institutions)	-.026	-.459	.647

R Squarred = 0.672 — f_{hitung} = 18.169
Ajusted R square = 0.634 — f_{tabel} = 0.3218
Residual = 157.637 — α = 0.10
Df = 89

Table 2: Simultaneous Significance Test (F Test).

ANOVA[a]

Model		Sum of squares	df	Mean square	F	Sig.
1	Regression	321.803	10	32.180	18.169	.000[b]
	Residual	157.637	89	1.771		
	Total	479.440	99			

a. Dependent yariable: Y.

b. Predictors: (Constant), X10, X5, X4, X6, X9, X2, X8, X1, X7, X3.

planting method obtained a coefficient value of 0.209 with a significance value of 0.003, because the significance value <0.05 then there is a significant influence between the area of agricultural land on the application of integrated crop management with Hazton planting method. Considering that the coefficient is positive indicates that the relationship between the two is positive, meaning that the higher the respondents perceive the land area, the higher the application of integrated crop management with the Hazton planting method and vice versa. The larger the farmland, the greater the potential to efficiently apply integrated crop management and Hazton technologies and practices. According to Blash *et al*. (2022), farmers who own large tracts of land are very responsive to the application or adoption of new technologies in the agricultural sector, whereas on narrow land the farmers consider it ineffective. A high level of land tenure is an important factor in optimizing food production in supporting food security (Aminah, 2015).

The effect between family labor and the application of integrated crop management with the Hazton planting method obtained a coefficient value of 0.020 with a significance value of 0.584, because the significance value >0.05 then there is no significant effect between family labor on the application of integrated crop management with Hazton planting method. This means that high or low respondents perceive family labor will not result in the higher or lower application of integrated crop management with the Hazton planting method.

The effect between farm income and the application of integrated crop management with the Hazton planting method obtained a coefficient value of 0.164 with a significance value of 0.011, because the significance value <0.05 then there is a significant influence between farm income on the application of integrated crop management with Hazton planting method. Considering that the coefficient is positive indicates that the relationship between the two is positive, meaning that the higher the respondents perceive farm income, the higher the application of integrated crop management with Hazton planting methods and vice versa. According to Toma (2018), high farm income is often related to the level of diffusion of agricultural innovations. Higher incomes not only increase the capacity of farmers to adopt agricultural technology but also support the sustainability and efficiency of the farm business as a whole.

The influence of the role of production facilities institutions on the application of integrated crop management with the Hazton planting method obtained a coefficient value of 0.009 with a significance value of 0.830, because the significance value> 0.05 then there is no significant influence between the role of production facilities institutions on the application of integrated crop management with Hazton planting method. This means that high or low respondents perceive the role of production facilities institutions will not result in higher or lower application of integrated crop management with Hazton planting methods.

The influence between the role of extension institutions and the application of integrated crop management with the Hazton planting method obtained a coefficient value of 0.186 with a significance value of 0.005, because the significance value <0.05 then there is a significant influence

Table 3: Individual parameter significance test (t statistical test).

Coefficients[a]

Model		Unstandardized	Standardized coefficients	Coefficients	t	Sig.
		B	Std. error	Beta		
1	(Constant)	1.669	2.160		.773	.442
	X1	-.009	.046	.017	-.200	.842
	X2	.176	.062	.207	2.826	.006
	X3	.253	.083	.288	3.048	.003
	X4	.209	.070	.224	3.004	.003
	X5	-.020	.037	.036	-.550	.584
	X6	.164	.042	.014	2.604	.830
	X7	-.009	.063	.243	-.216	.011
	X8	.186	.065	.262	2.880	.005
	X9	.121	.047	-.186	2.563	.012
	X10	-.026	.057	-.036	-.459	.647

a. Dependent variable: Y.

Table 4: Determination test results (R^2).

Model	R	R square	Adjusted R square	Std. error of the estimate
1	.819[a]	.671	.634	1.33087

a. Predictors: (Constant), X10, X5, X4, X6, X9, X2, X8, X1, X7, X3.

b. Dependent variable: Y.

between the role of extension institutions on the application of integrated crop management with Hazton planting method. The positive coefficient indicates that the relationship between the two is positive, meaning that the higher the respondents perceive the role of extension institutions will result the higher the application of integrated crop management with Hazton planting methods and vice versa. According to Sofia and Subekti, 2022, agricultural extension serves as a means to disseminate the latest information on agricultural technology to farmers. Through training and workshops organized by extension workers, farmers can understand and practice new technologies that can increase their productivity. According to Kusnani *et al*. (2015), extension intensity is significantly and positively related to group dynamics. The more frequent the counseling in the group, the higher the interaction in the group through extension activities.

The influence of the role of financing institutions on the application of integrated crop management with the Hazton planting method obtained a coefficient value of -0.121 with a significance value of 0.012, because the significance value <0.05, there is a significant influence between the role of financing institutions on the application of integrated crop management with Hazton planting method. Given the positive coefficient indicates that the relationship between the two is positive, meaning that the higher the respondents perceive the role of financing institutions, the higher the application of integrated crop management with Hazton planting methods and vice versa.

The effect of the role of farmer group institutions on the application of integrated crop management with the Hazton planting method obtained a coefficient value of -0.026 with a significance value of 0.647, because the significance value >0.05 then there is no significant influence between the role of farmer group institutions on the application of integrated crop management with Hazton planting method. This means that high or low respondents perceive the role of farmer group institutions will not result in the higher or lower application of integrated crop management with Hazton planting methods.

Coefficient of determination test

The determination coefficient explains how much influence all independent variables have on the bound variables. Shows the value of R square (R^2) is 0.670 which can be concluded that age, education, farming experience, area of paddy fields, number of family laborers, income from farming, the role of production input institutions, the role of extension institutions, the role of financing institutions and role of farmer group institutions explain 67.0% of the variation in the dependent variable (Y). The remaining 33.0% is influenced by other variables not examined in this study. Determination Test Results (R^2) can see Table 4.

CONCLUSION

The results show that the factors of formal education, farming experience, land area, farmers' income and the role of extension and financing institutions have a significant effect on the adoption of this method. On the other hand, the age factor, the number of family workers and the role of saprodi institutions and farmer groups did not show a significant influence.

The study's main findings indicate that high levels of education and farming experience encourage farmers to adopt the Hazton method more easily. Similarly, farmers with larger land area and income tend to make optimal use of this method, showing a positive relationship between financial capacity and speed of technology adoption. The role of extension and financing institutions also plays an important role, because guidance and access to capital help farmers in understanding and implementing technological innovations.

In order to increase the adoption of the implementation of integrated crop management with the Hazton method, this study recommends strengthening education and extension programs, especially through training tailored to the characteristics of farmers in the area. In addition, there is a need for an easily accessible financing scheme, especially for smallholders, to support the sustainability of technology adoption in agriculture. The adoption of the Hazton method by farmers with good institutional support is expected to contribute to increasing rice productivity and food security in North Maluku.

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Disclaimers

The authors declare that this study was conducted independently and without any conflict of interest. All analyses and interpretations presented are solely the responsibility of the authors and do not necessarily represent the views of any affiliated institutions or funding agencies. The data used in this research were obtained and analyzed in accordance with academic standards and any limitations of the study have been duly acknowledged.

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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