ANALYSIS OF THE ADOPTION LEVEL OF INTEGRATED CROP MANAGEMENT FOR RICE COMMODITIES IN THE SESAYAP DISTRICT

Paolus Donatus Haka[1*], Abdul Rahim[1], Nia Kurniasih Suryana[1]
[1]Magister Ilmu Pertanian Universitas Borneo Tarakan
kevinkarangora@gmail.com

ABSTRACT

Over the last three years, Paddy rice production in Tana Tidung Regency has been approximately 500-700 tons. This production is considered low, even when compared to rice production in other regencies located in North Kalimantan Province. One of the factors supporting high production is the crop management system used by farmers. This research aims to analyse the level of adoption of Integrated Crop Management (ICM) in the paddy rice commodity in the Sesayap District. ICM is an innovative approach in agriculture aimed at reducing the use of chemical pesticides and promoting sustainable pest and disease control. This study was conducted to understand the extent to which farmers in Sesayap District have adopted ICM technology in paddy rice cultivation and the factors influencing this adoption. The research method was a structured questionnaire survey from a sample of paddy rice farmers in the Sesayap District. The sample was selected using the purposive sampling method, with the criteria that they are part of farmer groups and actively cultivate paddy rice. The total number of respondents obtained was 57 individuals. The primary data collected were then described to illustrate the level of ICM adoption and the influencing factors. The results of this research indicate that the level of ICM adoption in the paddy rice commodity in Sesayap District is at 105, categorising it as moderate. Significant factors influencing the adoption level include farmers' level of education, knowledge about ICM, accessibility to information sources and training on ICM, the availability of institutional support, and farmers' perception of the benefits and effectiveness of ICM in increasing productivity and reducing production costs.

Keywords: Technology adoption, paddy rice, integrated crop management.

INTRODUCTION

The agricultural resource potential in Tana Tidung Regency (KTT) is considerable. It can be observed from the available agricultural land, which covers an area of 39,716 hectares. In 2020 and 2021, the managed land area was 567.1 hectares and 499.1 hectares, respectively [1]. The land area used for upland rice cultivation is 363 hectares, producing 1,066 tons. Over the past four years, namely 2018, 2019, 2020, and 2021, lowland rice production reached 3.00 tons per hectare, 2.59 tons per hectare, 2.55 tons per hectare, and 2.80 tons per hectare, respectively. This information indicates that lowland rice production has been experiencing a stagnant or even decreasing trend. In contrast, the demand for rice in KTT continues to increase from year to year. The rice demand in 2020 reached 2,507.23 tons and increased to 2,636.86 tons in 2021. Meanwhile, the rice production from KTT itself only reached 432.33 tons in 2020 and 321.18 tons in 2021. One of the measures that can be taken to catch up with production deficits is to implement the innovation of Integrated Crop Management (ICM) technology [2]. However, to implement this, an analysis of the level of ICM adoption in KTT, especially in the Sesayap District, must be conducted first.

Lowland rice is one of the primary staple commodities in Indonesia, playing a strategically vital role in meeting the food requirements of the population [3]. However, lowland rice production

faces numerous challenges, such as climate change, pest infestations, and plant diseases. To address these challenges, it is imperative to implement effective and sustainable crop management practices. One approach developed for this purpose is Integrated Crop Management (ICM), which integrates various cultivation techniques and methods to optimise the productivity of lowland rice while preserving the environment.

Integrated crop management is an approach that amalgamates various techniques and strategies in crop cultivation intending to optimise agricultural yields economically, socially, and environmentally [4]. This approach integrates multiple aspects such as superior crop varieties, pest and disease management, water and soil resource management, organic and biofertilizers, and soil and water conservation practices. Integrated crop management strives to balance high agricultural production, environmental health, and the social well-being of farming communities [5]. It primarily focuses on reducing excessive chemical pesticide usage by implementing biological control techniques and integrated pest and disease management. Moreover, integrated crop management promotes the use of organic fertilizers and other organic materials to maintain soil fertility and reduce negative impacts from excessive chemical fertilizer application [6]. The key principles of integrated crop management involve maintaining the balance of agricultural ecosystems, maximizing the use of existing natural resources, and reducing dependence on synthetic chemicals [7]. Through this approach, it is expected that a sustainable and environmentally friendly agricultural system can be established, providing long-term benefits to farmers, consumers, and the environment. Based on these considerations, this research aims to analyze the level of adoption of Integrated Crop Management (ICM) in the lowland rice commodity in the Sesayap District. In this context, the adoption level refers to the extent to which lowland rice farmers in the Sesayap District implement ICM practices in their farming activities.

MATERIALS AND METHODS

Research sites

The research was conducted in the Sesayap District, specifically in the rice-producing central villages of Tideng Pale Village, Limbu Sedulun Village, Sedulun Village, and Gunawan Village.

Data Collection Method

According to (21), purposive sampling is a sampling technique employed when the researcher already has specific individuals in mind with characteristics that align with the research objectives. The sample selection method was determined using purposive sampling, with the following sample criteria:

- Those who are members of farmer groups and registered in the Agricultural Extension Information System (Simluhtan) of the Ministry of Agriculture.
- Farmers from farmer groups engaged in lowland rice cultivation in the Sesayap District over the past two years.

The number of samples meeting these criteria in this study amounted to 57 respondents out of a total population of 105.

Data Type

The data collected in this study are primary data. Primary data were obtained through direct interviews with farmers using questionnaires. The primary data consists of respondent

characteristics, including data on the level of agricultural technology innovation adoption, factors influencing farmers' adoption of agricultural technology, barriers to adopting agricultural technology, farm production data, and components of Integrated Crop Management (ICM) introduced to farmers. The data used in this research were gathered through observation, face-to-face interviews, telephone interviews, and Focus Discussion Group (FGD) sessions.

Descriptive Analysis with Likert Scale

The analysis of adoption levels utilizes a descriptive analysis employing the Likert scale. The Likert Scale is a measurement scale used to gauge an individual's level of belief, attitude, or perception towards a specific topic. Typically, this scale consists of statements or items, where respondents are asked to indicate their level of agreement with these statements, ranging from the most positive to the most negative scale. The Likert Scale in this research is uprovidesuable information regarding respondents' adoption of the Integrated Crop Management (ICM) technology innovation for lowland rice.

In the Likert scaling, quantification is carried out by recording the level of response from negative to positive regarding the nature of the object. The scores for each variable in this study are categorized into five scales: 1. Very Low, 2. Low, 3. Moderate, 4. High, 5. Very High. Measurement is done using the class interval formula [8], which is:

$$I = \frac{J}{K}$$

I = Class Interval

J = Class Score (Σ maximum score - Minimum score)

Maximum Value = Total items / questionnaire x 5 (highest score)

Minimum Value = Total questionnaires x 1 (lowest score)

K = Number of classes / categories

$$I = \frac{maximum\ score - Minimum\ score}{5} + Class\ Interval\ Score$$

The categories for overall adoption levels are as follows:

The range/class with the formula: $\frac{(36 \times 5)-(36-1)}{5} = \frac{180-36}{5} = \frac{144}{5} = 28{,}8 \rightarrow (29)$

Therefore, the categories for the adoption level of Integrated Crop Management technology innovation are as follows:

No	Score	Category
1	36 - 64	Very low
2	63 - 93	Low
3	94 - 122	Moderate
4	123 – 151	High
5	152 - 180	Very high

RESULT AND DISCUSSION

The farmers' adoption rates of Integrated Crop Management (ICM) innovation can be observed in the following table:
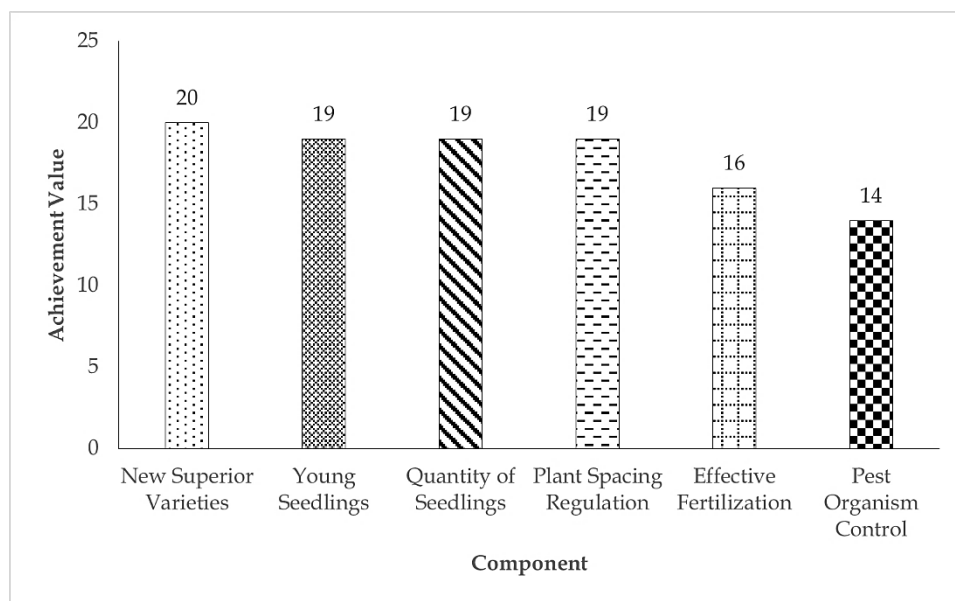
Figure 1. Overall Adoption Achievement

Explanation: Standard values range from 6 to 36 per component. The total achievement score is 105, categorized as "Moderate."

Source: Processed primary data for the year 2023.

In Integrated Crop Management (ICM), there are three main components often referred to as "VUB," namely superior varieties, cultivation practices, and pest management. Superior varieties pertain to the selection of plant varieties that are outstanding and adaptable to local conditions [9]. Superior varieties can yield higher results, resist pests and diseases, and possess other desirable characteristics for farmers and the market. The cultivation practices component encompasses the principles of good and sustainable farming. Through sound cultivation practices, farmers can optimize the use of resources such as water, fertilizers, and pesticides, thereby enhancing agricultural productivity and efficiency. Sustainable cultivation practices also contribute to environmental conservation and mitigate negative impacts on ecosystems. Meanwhile, the cultivation component itself involves integrated pest, disease, and weed management. This approach combines various control methods, such as using resistant varieties, biological control, botanical insecticides, crop rotation, orchard sanitation, and the utilization of other technologies to minimize losses caused by pests,diseasese, and weed infestations. These three VUB components are interconnected and mutually supportive within Integrated Crop Management. By employing superior varieties, implementing good cultivation practices, and integrated pest, disease, and weed management, it is anticipated that productivity, crop quality, and agricultural sustainability can be improved [10]. The ICM approach with VUB components has proven effective in enhancing agricultural yields while reducing the use of potentially environmentally and human health-damaging synthetic chemicals.

In Integrated Crop Management (ICM), the component of young seedlings also plays a crucial role. The element of young seedlings in ICM, which involves selecting plant varieties that are suitable for environmental conditions, market demands, and other relevant factors, is an essential initial step in ICM [11]. The chosen varieties should ideally possess outstanding traits such as high productivity, resistance to pests and diseases, good adaptability, and the desired quality of produce. Seedling production in ICM involves producing high-quality seedlings free from diseases and pests.

This entails selecting quality seeds or cuttings from healthy parent plants. Also, good sanitation practices must be applied during the young seedling production process to prevent the spreading of disease. In ICM, monitoring and selecting young seedlings are essential to ensure that only seedlings meeting the standards used in planting are utilized. Seedlings with healthy growth, no signs of disease or pest infestations, and the expected quality should be prioritized. During the introduction of ICM technology to farmers, education on the selection and use of quality young seedlings should also be conducted [12]. Farmers must understand the importance of using quality seedlings that meet ICM requirements to enhance crop yields and reduce losses due to pests and diseases. In ICM, monitoring and certifying young seedlings can be implemented to ensure that the produced and traded seedlings meet established standards. This monitoring and certification process may involve inspection, laboratory testing, and the issuance of labels or certificates indicating compliance with ICM requirements. By paying attention to the young seedling component in ICM, farmers can ensure they use high-quality seedlings in line with ICM principles. This will help enhance agricultural productivity, reduce the risk of pest and disease infestations, and maintain overall agricultural sustainability.

Sound planning regarding the required quantity of seedlings constitutes the initial step in Integrated Crop Management [13]. This entails determining the land area to be cultivated, the seedling requirements per hectare or unit area, and selecting suitable varieties per the environmental and operational requisites. The production of an adequate and high-quality seedling inventory stands as a pivotal component within Integrated Crop Management. The seedling production process encompasses precise plant propagation techniques, selecting high-quality seeds or cuttings, and effective management practices to facilitate robust seedling growth, free from diseases and pests [14]. A practical and timely seedling distribution also holds paramount importance within Integrated Crop Management. The distribution of seedlings to farmers must align with their specific needs and planting schedules. This ensures that farmers possess sufficient access to the requisite seedlings for the successful implementation of Integrated Crop Management. Monitoring the available seedling stock and exercising quality and quantity control measures is an essential aspect of Integrated Crop Management. Routine monitoring of seedling stock is indispensable to ensure an adequate supply, and quality control measures must be enforced to mitigate the risks associated with disease transmission or seedling damage. Providing farmers with guidance on the importance of utilizing the appropriate quantity of seedlings is also a requisite component of Integrated Crop Management. Farmers must be imparted with a comprehensive understanding of aspects such as planting spacing, plant density, and seedling requirements per unit of land, enabling them to optimize seedling utilization efficiently. Farmers can optimize seedling use, ensure adequate availability, and uphold the quality of utilized seedlings by considering the seedling quantity component within Integrated Crop Management. This will bolster the successful implementation of Integrated Crop Management by ensuring that farmers have sufficient access to high-quality seedlings aligned with their specific needs.

Appropriate plant spacing regulation can significantly influence plant growth, productivity, pest and disease control, as well as the efficient utilization of resources [15]. The selection of plant varieties for cultivation should consider these plants' growth characteristics. Some varieties may require wider spacing, while others may necessitate closer spacing. Consider information from

relevant agricultural institutions or technical recommendations to obtain guidelines for appropriate plant spacing based on the selected varieties. Plant spacing should also be adapted to soil moisture conditions and the irrigation system. If soil moisture is low or the irrigation system is uneven, wider plant spacing may be required to accommodate the plant's water needs. Conversely, if soil moisture is high or the irrigation system is uniform, closer plant spacing can be applied. Consider the size of the plants and their vegetative growth when deciding on plant spacing. Larger plants or those with robust vegetative growth may require wider spacing to provide adequate room for root, leaf, and branch development. Meanwhile, smaller plants or those with more controlled vegetative growth may be suitable for closer plant spacing. Plant spacing regulation can also influence pest and disease control. Wider plant spacing can help reduce the spread of diseases and pests among plants due to the increased distance between them. This can reduce the risk of pathogen transmission and facilitate farmers' access to carry out control measures in case of an infestation. Proper plant spacing regulation can also contribute to efficiently using resources such as water, fertilizers, and pesticides [16]. Appropriate plant spacing can optimize the distribution of these resources, minimizing waste and reducing negative environmental impacts. It is essential to consider carefully determining plant spacing in Integrated Crop Management. It should be noted that optimal plant spacing may vary depending on the type of crop, environmental conditions, and cultivation practices employed.

Adequate fertilization within Integrated Crop Management (ICM) is a crucial step toward enhancing crop productivity, harvest quality, and environmental sustainability. Soil analysis represents a vital initial step in adequate fertilization [17]. By analyzing soil composition, farmers can ascertain the existing nutrient content and determine the precise fertilization requirements. Soil analysis yields information regarding soil acidity (pH), the content of macronutrients (nitrogen, phosphorus, and potassium), as well as micronutrients (such as iron, zinc, and copper). ICM encourages using organic fertilizers as a source of plant nutrients. Organic fertilizers like manure, compost, and other organic materials can enhance soil fertility, improve soil structure, and enhance the soil's water and nutrient-holding capacity. Fertilizing with organic materials can help minimize the use of chemical fertilizers and promote agricultural sustainability. Adequate fertilization entails the balanced application of fertilizers in accordance with the plant's requirements. ICM advocates the principle of balanced fertilization, which involves the application of nitrogen (N), phosphorus (P), and potassium (K) in appropriate ratios based on the plant's needs and soil conditions [18]. Balanced fertilizer application assists plants in thriving, optimizing root growth, flowering, and fruit formation. Adequate fertilization also involves providing fertilizers according to the plant's growth stages. Plants have varying nutritional needs during each growth stage. For example, plants require nitrogen fertilisers during the early growth stage to promote vegetative growth. During the flowering and fruiting stage, plants require phosphorus-rich fertilizers to facilitate fruit formation. ICM promotes the use of controlled and precision fertilization methods, such as site-specific fertilization or the use of sensor technology to measure plant nutrient status. These methods help minimize fertilizer wastage, reduce the risk of environmental contamination, and optimize fertilization efficiency. Additionally, it is essential to consider fertilization schedules, the correct fertilizer dosage, and environmental sustainability principles.

The control of Pests and Diseases (Pest Organisms), commonly called pest and disease management is an integral component of Integrated Crop Management (ICM). In ICM, the control

of Pest Organisms is carried out in an integrated manner, utilizing various environmentally friendly approaches and methods. The initial pest and disease control step within ICM involves identifying the types of pests and diseases present in the field [19]. Through regular monitoring and observation of crops, farmers can recognize signs of pest or disease infestations and identify the specific pest organisms involved. Accurate identification allows for the application of appropriate and effective control methods. Cultural control of Pest Organisms consists of implementing cultivation practices that reduce the risk of pest and disease infestations. Some cultural practices that can be employed include crop rotation, land sanitation, crop residue management, and selecting Pest Organism-resistant crop varieties. These cultural practices help create an unfavourable environment for Pest Organism attacks and reduce the need for chemical pesticides. Physical and mechanical control methods for Pest Organisms involve using specific tools or techniques to manage pests and diseases [20]. Examples include using insect traps, removing infected plant parts, using barrier nets, and clearing fields from weeds or crop residues that serve as breeding grounds for Pest Organisms. Biological control of Pest Organisms involves the utilization of naturally occurring living organisms or natural enemies of Pest Organisms to control pest or disease populations. This can be achieved by introducing predators, parasitoids, or disease-causing microorganisms that prey on or infect pest or disease organisms. Biological control is environmentally friendly and sustainable. Chemical control of Pest Organisms must be conducted selectively, meaning the selection of effective pesticides that do not negatively impact the environment and non-target organisms. The use of chemical pesticides should adhere to recommended doses and schedules, while also considering safe usage principles. Continuous monitoring of pest and disease infestations and evaluating control methods implemented are crucial for assessing the effectiveness of Pest Organism control in ICM. If the techniques used are ineffective, then adjustments to the control strategy more suitable for the situation are necessary.

In conclusion, based on the data analysis presented above, the level of adoption of Integrated Crop Management (ICM) technology innovations in wetland rice farming in the Sesayap sub-district can be characterized as moderate, with an achievement level of 105. This achievement indicates that ICM technology has not yet become a priority for farmers in managing wetland rice cultivation. Integrated Crop Management (ICM) is an agricultural approach that combines sustainable and environmentally friendly methods for controlling plant pests and diseases. ICM aims to reduce the use of chemical pesticides through integrated actions such as the use of pest-resistant varieties, biological control, crop rotation, field sanitation, and pest population monitoring and prediction. Adopting technological innovations like ICM typically depends on factors such as knowledge and understanding, resource availability, economic factors, support and access to information, social and cultural factors, experiences, observable outcomes, and institutional factors.

Farmers' levels of knowledge and understanding of Integrated Crop Management (ICM) technology play a crucial role in its adoption. The better farmers comprehend the benefits and usage of this technology, the higher the likelihood of their adoption. The availability of resources such as capital, equipment, and agricultural inputs also influences the adoption of ICM technology. If farmers do not have adequate access to these resources, they may be reluctant to adopt the technology. Economic aspects, such as initial investment costs and return on investment, also impact

the level of ICM technology adoption. If farmers believe that the use of this technology will provide significant long-term economic benefits, they are more likely to adopt it.

Support from the government, research institutions, and agricultural service providers is essential in promoting the adoption of ICM technology. Providing accurate and easily accessible information about this technology can also assist farmers in making adoption decisions. Social and cultural factors, such as community norms, traditional practices, and social structures, can also influence the adoption of ICM technology. Farmers may hesitate to change their farming methods if this technology does not align with existing cultural values or practices. Farmers' direct experiences with ICM technology and the visible outcomes of previous adoptions can also influence their decisions to adopt it. If farmers see that their neighbours or others have succeeded with this technology, they may be more motivated to follow in their footsteps. Government policies, regulations, and supportive institutional frameworks can also affect the level of adoption of ICM technology. The presence of policies that encourage agricultural innovation and institutional solid support can enhance the adoption of this technology. In conclusion, based on the research conducted in the Sesayap sub-district of Tana Tidung Regency, the level of farmers' adoption of Integrated Crop Management (ICM) technology innovations in wetland rice farming falls within the moderate category.

CONCLUSION

Based on the results of the research conducted in the Sesayap sub-district of Tana Tidung Regency, it can be concluded that the level of farmers' adoption of Integrated Crop Management (ICM) technology innovations in wetland rice farming falls within the moderate category.

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