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Original Article

Ratooning Response and Yield Performance of Different Rice Varieties as Influenced by Cutting Height Under Irrigated Lowland Condition

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Abstract. This research assessed the ratoon rice growth and yield performance with varying NSIC Rc varieties and cutting heights under lowland irrigated conditions. A 4 × 3 factorial experiment under a Randomized Complete Block Design (RCBD) was implemented in San Felipe, Tantangan, South Cotabato, from January 2024 to June 2025. The treatments consisted of four NSIC Rc varieties (Rc222, Rc160, Rc506, and Rc216) and three cutting heights (10 cm, 15 cm, and 20 cm), with analysis of data through Analysis of Variance (ANOVA) and comparison of treatment means via the Least Significant Difference (LSD) test. Ratooning is a low-cost method for enhancing rice productivity without replanting and is highly applicable among resource-poor farmers in irrigated lowlands. Findings indicated that plant height, number of tillers, panicle number, panicle length, and filled grains per panicle were significantly increased when the cut height was maintained at 15 cm, while unfilled grains were minimized. NSIC Rc216 performed better than other varieties across agronomic and economic traits, including grain yield, calculated fresh and dry grain weight, net income, and return on investment (ROI). Tillering number and panicle number had a significant interaction between Rc216 and 15 cm cutting height. These results indicate that NSIC Rc216, in combination with a 15 cm cutting height, maximizes ratoon rice productivity locally. Embracing this practice has the potential to enhance ROI by 18–25% in comparable irrigated lowland sites.

Keywords: *Ratoon rice; NSIC Rc varieties; Cutting height; Irrigated lowland; Yield performance.*

Rice, as a vital food source, is grown extensively across Asia and feeds nearly half of the world's population. The genetic diversity of rice is vast, with numerous varieties cultivated globally. Among these, brown and white rice are the most prevalent. As projected by Zhou et al. (2020), the global population is expected to reach 10 billion by 2050, necessitating increased rice production. To meet this rising demand, future rice varieties must be more productive, nutritious, resilient, and environmentally sustainable. According to FAOSTAT (2020), the Philippines ranked eighth in global rice production in 2018. The country's annual rice harvest spans approximately 4.7 million hectares, with an average yield of 3.95 tons per hectare. While most rice is cultivated under rainfed lowland conditions, over 60% of the rice-growing area is irrigated. As the country's primary staple, rice provides nearly half of the population's caloric intake.

Additionally, Torres et al. (2020) highlighted the practice of ratooning to enhance rice yield. Ratooning occurs when rice plants regrow from stem nodes after the terminal growing point is lost, for example, when the panicle is aborted or harvested. While ratooning is a known technique among farmers, it is not widely adopted due to its unpredictable results and typically low yields. However, ratoon crops require less labor because they develop from the main crop's existing root system and mature faster than the initial crop. Recent research has shown that with improved management techniques, ratooning can be a profitable and productive method. Chauhan et al. (1986) explained that the success of ratooning depends on various factors, including cultivar characteristics, environmental conditions (e.g., light, temperature, soil moisture, and fertility), and overall management. The growth duration of rice also plays a crucial role in determining ratoon crop yield. Achieving higher yields in ratooning requires attention to growth duration, as it directly influences grain yield.

In the current cultivation practice of rice ratooning in South Cotabato, particularly in the municipality of Tantangan, no research specifically addresses its agronomic or economic potential. Despite ratooning being recognized as a low-cost, labor-efficient method to increase rice productivity (Huang et al., 2018), its adoption remains limited in many rice-growing regions due to inconsistent performance and a lack of localized studies (Haefele et al., 2020). In the Philippines, while national-level studies exist, region-specific evaluations—especially in Mindanao—are scarce, indicating a significant research gap that needs to be addressed (Cataquiz et al., 2021). With this, the study focused on selecting the best Philippine rice variety based on ratooning ability that will also yield the crop's yield performance. Hence, it is necessary to conduct experiments to evaluate the growth and yield performance of ratooned lowland rice varieties, as ratooning is a common practice in rice-growing regions worldwide. The study examined the best lowland rice varieties for maximizing ratoon crop yield. It assessed the profitability of ratooning lowland rice varieties as affected by ratoon crop cutting height. To increase rice production and mitigate anticipated productivity losses, this study examines the ratooning performance of lowland rice varieties across various cutting heights.

This research was conducted to determine which of the rice varieties NSIC Rc222, NSIC Rc160, and NSIC Rc216 has the highest ratooning potential and yield performance under irrigated lowland conditions, based on cutting height. Particularly, it was directed to test the ratooning potential of these varieties of rice with respect to agronomic traits and yield components; ascertain the effects of cutting height on the ratooning performance of various varieties; test the interaction effects of variety and cutting height on agronomic and yield attributes; and assess the economic impact of ratooning in multiple rice varieties and cutting heights. In addition, the study aimed to determine the ratooning response of the selected NSIC rice varieties and to identify the most suitable cutting height under irrigated lowland conditions. To direct the analysis, the research examined the following null hypotheses: (a) There is no significant variation in the ratooning response of the various rice varieties under irrigated lowland conditions, and (b) There is no significant variation in the performance of cutting heights among the various varieties when ratooned under similar conditions.

The primary goal of this study is to identify the rice varieties with the best ratooning ability, specifically NSIC Rc222, NSIC Rc160, and NSIC Rc216, with NSIC Rc506 serving as the control. The study investigated how cutting height under lowland conditions influences the ratooning ability of these rice varieties and determined the cutting height that yields the highest grain production. Ratooning is a well-known practice for increasing grain yield in the second rice harvest. This study also aimed to provide information regarding the importance of improving rice harvesting practices. This study benefited from several institutions, including the Department of Agriculture (DA). They were provided with information on the rice variant's best ratooning ability. This information was intended to inform future programs aimed at improving rice harvests and production. Department of Environment and Natural Resources (DENR). They were provided with information regarding the availability of rice in the Philippines. This study also provided preliminary information for improving rice production in the Philippines. Philippine Rice Research Institute (PhilRice). They were provided with new information on the status of rice cultivation in the Philippines. They were also informed of the effectiveness of ratooning practice in increasing overall rice production.

Local farmers may be provided with information on which rice variety is most effective for ratooning. The information provided was to make their rice farming cost-efficient. This study will serve as a basis for future rice cultivation and ratooning studies at the university or other academic institutions. This study provided information that can benefit future rice research. The educational implication of this study was to expose students to rice research. Therefore, this study's findings were intended to help rice farmers, relevant institutions, and other stakeholders determine the optimal ratooning response of different rice varieties to cutting height under lowland conditions. Fewer economic inputs resulted in high yield and income.

Methodology

Research Design

This study employed an experimental research design to evaluate the effects of different treatments on the growth and yield performance of ratoon rice. The methodology encompasses the materials used, the experimental layout, treatment applications, data collection procedures, and the statistical methods employed for data analysis.

Data Gathering Procedure

Growth Parameters

Growth parameters were measured to assess the vegetative development of the rice plants. Plant height was measured from the base to the topmost point with a meter stick. This measurement was taken during the maximum tillering stage from 10 randomly selected hills located within the inner two rows of each plot. The number of tillers with developed panicles was also recorded before harvest, based on observations from the same number of randomly selected plants within each plot. Additionally, the number of panicles per hill was counted during the flowering and grain-filling stages. Panicle length was measured from the base to the tip using a ruler, and data were collected from 10 randomly selected hills just before harvest; results were expressed in centimeters. Filled grains per panicle were counted from 10 randomly selected plants within the inner two rows of each plot immediately before harvest. Similarly, unfilled grains per panicle were counted from the same number of randomly selected plants before harvest.

Yield-related data were also collected. Fresh grain yield per hectare was calculated by weighing grains manually from random samples in each treatment. Grain moisture content was standardized to 14%, and weights were recorded in grams and then converted to kilograms per hectare. The dry weight of harvested ratoon rice grains was recorded under the same moisture-content standard. For each treatment, grain yield was calculated from samples collected from a 3-square-meter area per plot. The grain weight was adjusted to 14% moisture content and extrapolated to tons per hectare using the formula:

$$\text{Grain yield (t/ha)} = \left(\frac{\text{Plot yield (kg)}}{\text{Plot area (m}^2\text{)}}\right) \times 10$$

The study also compared the yield performance between the first and ratoon harvests. Yields were computed from the actual yield per plot area, expressed in kilograms per square meter, and then converted to a per-hectare basis. This comparison helped assess the productivity of ratoon crops relative to the original harvest. An economic analysis was also performed to evaluate the financial viability of the different treatments. Net income was computed as the difference between gross income and total production cost using the formula:

$$\text{Net Income} = \text{Gross Income} - \text{Total Production Cost}$$

Return on investment (ROI) was calculated by dividing the net income by the cost of production and multiplying the result by 100:

$$\text{ROI (\%)} = \left(\frac{\text{Net Income}}{\text{Total Production Cost}}\right) \times 100$$

Experimental Layout

The experiment utilized a Randomized Complete Block Design (RCBD) with a factorial arrangement consisting of two factors:

Factor A – Rice Varieties	Factor B – Cutting Heights
A_1 = NSIC Rc222	B_1 = 10 cm
A_2 = NSIC Rc160	B_2 = 15 cm
A_3 = NSIC Rc506	B_3 = 20 cm
A_4 = NSIC Rc216	

This resulted in 12 treatment combinations (4 varieties × 3 cutting heights). Each treatment was replicated 3 times, yielding 36 experimental plots (12 treatments × 3 replications). Each plot measured 3 meters by 5 meters (15 m^2). A 0.5-meter buffer zone separated plots within blocks, and a 1-meter alleyway between blocks, to minimize edge effects and facilitate field operations. Within each replication (block), the 12 treatment combinations were randomly assigned to the 12 plots to control for variability in field conditions such as soil fertility and microclimate.

Illustrative Layout (Conceptual Grid of One Block)

Plot No.	Treatment Combination
1	A_1B_1 (Rc222 @ 10 cm)
2	A_1B_2 (Rc222 @ 15 cm)
3	A_1B_3 (Rc222 @ 20 cm)
4	A_2B_1 (Rc160 @ 10 cm)
5	A_2B_2 (Rc160 @ 15 cm)
6	A_2B_3 (Rc160 @ 20 cm)
7	A_3B_1 (Rc506 @ 10 cm)
8	A_3B_2 (Rc506 @ 15 cm)
9	A_3B_3 (Rc506 @ 20 cm)
10	A_4B_1 (Rc216 @ 10 cm)
11	A_4B_2 (Rc216 @ 15 cm)
12	A_4B_3 (Rc216 @ 20 cm)

This layout was repeated across all three blocks with randomized treatment placements in each block to reduce experimental bias.

Ethical Consideration

This study was conducted in accordance with ethical standards for agricultural research. No human or animal subjects were involved, and therefore, ethical clearance from an institutional review board was not required. The study focused solely on plant-based experimentation within a designated agricultural research field, ensuring that no harm was caused to the surrounding environment or communities. All data collected were used exclusively for academic and scientific purposes, and proper acknowledgment was given to all sources of information and materials utilized in the study. Furthermore, local agricultural guidelines and biosafety protocols were adhered to in order to maintain environmental integrity and scientific responsibility throughout the experiment.

Results and Discussion

The findings revealed that cutting height and rice variety significantly influenced plant growth and yield components.

Growth Parameters

Plant Height

The table presents the plant height (cm) of rice varieties as affected by cutting height under irrigated lowland conditions.

Table 1. *Plant Height (cm) of Different Rice Varieties as Influenced by Cutting Height Under Irrigated Lowland Conditions*

Factor A Different Rice Variety	Factor B Different Ratooned Height 3/ B1 (10cm)	B2 (15cm)	B3 (20cm)	Means of A. 1/
A1 (Rc222)	86.07	90.30	88.00	**88.12^b^**
A2 (Rc160)	90.50	93.20	92.73	**93.14^a^**
A3 (Rc506)	87.53	91.00	88.57	**89.03^b^**
A4(Rc216)	87.77	90.63	88.40	**88.93^b^**
Means of B. 2/	**87.97^c^**	**91.28^a^**	**89.43^b^**	**89.56**

CV=1.23%
1/, 2/ Means with common letter superscript are not significantly different at a 1%level LSD.

The data show that plant height was significantly affected by cutting height and rice variety. The tallest plants were observed at a 15 cm cutting height with a mean of 91.28 cm, while the shortest were at 10 cm with 87.97 cm. Among the varieties, RC160 recorded the highest mean plant height (93.14 cm), while RC506 had the lowest (89.03 cm). The low CV of 1.23% indicates consistency in the results. According to the result, ratooning at a height of 15 cm may produce taller plants, which could affect yield and biomass production. Additionally, breeders and farmers can use the information that RC160 is a variety with improved plant height to optimize rice production in the Philippines. This relates to Cuevas et al.'s (2004) study, which provides a comprehensive overview of the potential and challenges of rice production in the Philippines, including management and varietal selection. According to the study's findings, a 15 cm cutting height promotes greater plant height than a 10 cm cutting height. This is consistent with the understanding that taller cutting heights preserve more active tillers and photosynthetic tissues, thereby facilitating robust vegetative growth. This result can be attributed to the reduced stress experienced by the plants when a higher cutting height is maintained, thereby enabling more efficient allocation of resources to vertical growth. Furthermore, according to Cuevas et al. (2004), the observed varietal differences highlight inherent genetic variation in plant height among rice cultivars, with RC160 exhibiting superior plant height. These rice varieties were recommended for breeding programs and for cultivars tailored to specific agro-ecological zones within the Philippines.

Number of Tillers

The number of tillers of different rice varieties as influenced by cutting height under irrigated lowland condition is presented in Table 2.

Table 2. *Number of Tillers of Different Rice Varieties as Influenced by Cutting Height Under Irrigated Lowland Condition*

Factor A Different Rice Variety	Factor B Different Ratooned Height 3/ B1 (10cm)	B2 (15cm)	B3 (20cm)	Means of A. 1/
A1 (Rc222)	13.57^b^	15.27^b^	13.97^b^	**14.27^b^**
A2 (Rc160)	12.70^c^	14.90^bc^	14.20^b^	**13.93^bc^**
A3 (Rc506)	11.13^d^	14.37^c^	12.13^c^	**12.54^cd^**
A4 (Rc216)	15.10^a^	16.77^a^	15.53^a^	**15.80^a^**
Means of B. 2/	**13.13^bc^**	**15.33^a^**	**13.93^b^**	**14.14**

CV =2.34%
1/,2/ Means with common letter superscript are not significantly different at the 1%level LSD.
3/ Means with common letter superscript are not significantly different at the 5%level LSD.

The table shows that the number of tillers increased with increasing cutting height, with the highest mean (15.33) at 15 cm and the lowest at 10 cm (13.13). Among the varieties, RC216 had the highest tiller count (15.80), whereas RC506 had the lowest (12.54). It is also evident that there is a significant interaction between cutting height and rice varieties. Rc216 with a cutting height of 15 cm had the highest number of tillers (mean = 16.77), with comparable results for Rc216 at 20 cm (mean = 15.53) and 10 cm (mean = 15.10). In comparison, Rc506, with a cutting height of 10 cm, had the lowest mean of 11.13. The CV of 3.32% is acceptable. These results suggest that a cutting height of 15 cm promotes better tillering, particularly for RC216.

The results show that both cutting height and rice variety significantly influenced the number of tillers produced by ratooned rice under irrigated lowland conditions. A cutting height of 15 cm yielded the highest mean tiller count (15.33), whereas the lowest was recorded at 10 cm (13.13). Among the varieties, NSIC Rc216 exhibited the highest number of tillers (15.80), particularly at the 15 cm cutting height (16.77), indicating a strong varietal response to optimal cutting height. This supports the findings of Reyes and Olivares (2020), who noted that preserving more axillary buds at higher cutting heights facilitates better tiller development by enhancing carbohydrate reserves and photosynthetic activity. Similarly, Banoc et al. (2022) emphasized that cutting at 15 cm provides sufficient stubble for ratoon regrowth, improving the emergence of productive tillers in ratoon rice. Furthermore, Li et al. (2018) observed that cutting height significantly affects tiller initiation and the overall biomass of ratoon crops, with moderate heights (10–15 cm) optimizing resource allocation for tiller formation. These findings align with the current study and confirm that Rc216, under a 15 cm cutting height, is the most responsive in tiller production, offering valuable insights for ratoon rice management strategies in irrigated lowland ecosystems.

Panicle Count

Table 3 is the result of the number of panicles of different rice varieties as influenced by cutting height under irrigated lowland condition.

Table 3. *Panicle Count of Different Rice Varieties as Influenced by Cutting Height Under Irrigated Lowland Condition*

Factor A Different Rice Variety	Factor B Different Ratooned Height 3/ B1 (10cm)	B2 (15cm)	B3 (20cm)	Means of A. 1/
A1 (Rc222)	6.16^{b}	9.37^{b}	7.10^{b}	**7.54^{b}**
A2 (Rc160)	5.43^{c}	6.97^{f}	6.20^{c}	**6.20^{c}**
A3 (Rc506)	4.37^{d}	6.03^{d}	5.10^{d}	**5.17^{d}**
A4 (Rc216)	10.10^{a}	13.43^{a}	11.23^{a}	**11.59^{a}**
Means of B. 2/	**6.52^{c}**	**8.95^{a}**	**7.41^{b}**	**7.63**

CV =3.81%
1/, 2/, 3/ Means with common letter superscript are not significantly different at the 1%level.

The table shows that the number of panicles was maximized at a cutting height of 15 cm (mean = 8.95), whereas it was lowest at 10 cm (mean = 6.52). Among the rice varieties, RC216 had the highest number of panicles (11.59), whereas RC506 recorded the lowest (5.17). The results showed a significant interaction between cutting height and rice varieties. Rc216 with a cutting height of 15 cm had the highest panicle count (mean = 13.43), with comparable counts at 20 cm (mean = 11.23) and 10 cm (mean = 10.10). In comparison, Rc506, with a cutting height of 10 cm, had the lowest mean of 4.37. The CV of 3.70% confirms consistency in the data. This indicates that a 15 cm cutting height is ideal for enhancing panicle production.

The results clearly demonstrate that cutting height and rice variety significantly influenced panicle production in ratoon rice under irrigated lowland conditions. A cutting height of 15 cm produced the highest mean number of panicles (8.95), while 10 cm yielded the lowest (6.52). Among the rice varieties, NSIC Rc216 consistently produced the highest number of panicles (11.59), with the peak value observed at 15 cm cutting height (13.43). This interaction suggests that RC216 has superior ratooning ability and responds optimally to moderate stubble height. These findings are consistent with those of Banoc et al. (2022), who reported that a 15 cm cutting height maximized panicle regeneration in ratooned rice by preserving active tiller buds and residual photosynthates. Likewise, Nguyen et al. (2019) found that a moderate cutting height improves ratoon crop vigor and panicle number, as it allows for better resource remobilization from the main crop to the ratoon growth. Panicle count is a key yield component, and as emphasized by Li et al. (2018), maintaining an adequate cutting height (10–15 cm) ensures the regrowth of productive tillers capable of forming panicles. Therefore, the results affirm that NSIC Rc216, in combination with a 15 cm cutting height, is highly effective for optimizing ratoon crop panicle production under irrigated lowland ecosystems.

Panicle Length
The length of the panicle of different rice varieties as influenced by cutting height under irrigated lowland condition is presented in Table 4.

Table 4. *Panicle Length of Different Rice Varieties as Influenced by Cutting Height Under Irrigated Lowland Condition*

Factor A Different Rice Variety	Factor B Different Ratooned Height 3/ B1 (10cm)	B2 (15cm)	B3 (20cm)	Means of A. 1/
A1 (Rc222)	23.07	25.37	24.30	**24.24ᵇ**
A2 (Rc160)	23.67	24.00	23.77	**23.81ᵇ**
A3 (Rc506)	21.33	22.03	21.57	**21.64ᶜ**
A4 (Rc216)	25.43	29.17	27.13	**27.24ᵃ**
Means of B. 2/	**23.38ᶜ**	**25.14ᵃ**	**24.19ᵇ**	**24.23**

CV=3.90%
1/, 2/ Means with common letter superscript are not significantly different at the 1%level LSD.

The results indicate that both cutting height and rice type substantially affect panicle length in ratoon rice. Cutting height of 15 cm yielded the highest average panicle length (25.14 cm), followed by 20 cm (24.19 cm), and the shortest panicles were at 10 cm (23.38 cm). Among the varieties, NSIC Rc216 had the longest panicles (27.24 cm), particularly at a 15 cm cutting height, indicating a vigorous varietal response to optimal stubble management. This observation is consistent with Banoc et al. (2022), who reported that ratooned rice retains more photosynthetic tissues and increases panicle length at moderate cutting heights. Along the same lines, Islam et al. (2021) noted that longer panicle length under ratooning rice is commonly associated with improved carbohydrate remobilization and lower physiological stress when greater stubble height is left. Li et al. (2018) also emphasized that stubble heights of 10-15 cm facilitate panicle growth through more efficient regrowth from basal nodes. The superior performance of Rc216 in this research also indicates its genetic potential for improved panicle characteristics, as evidenced by recent varietal trials under comparable agro-climatic conditions (Reyes & Olivares, 2020). The findings underscore the importance of cutting height in managing ratooning and justify implementing Rc216 at a 15 cm cutting height to maximize reproductive growth and grain yield.

Filled Grains per Panicle
The table shows the filled grains per panicle of the different rice varieties as influenced by cutting height under irrigated lowland condition.

Table 5. *Filled Grains per Panicle of Different Rice Varieties as Influenced by Cutting Height Under Irrigated Lowland Condition*

Factor A Different Rice Variety	Factor B Different Ratooned Height 3/ B1 (10cm)	B2 (15cm)	B3 (20cm)	Means of A. 1/
A1 (Rc222)	69.87	75.10	73.00	**72.66ᵇ**
A2 (Rc216)	68.97	73.22	70.87	**71.13ᶜ**
A3 (Rc216)	66.53	71.23	68.13	**68.63ᵈ**
A4 (Rc216)	77.23	81.40	79.07	**79.23ᵃ**
Means of B. 2/	**70.65ᶜ**	**75.24ᵃ**	**72.77ᵇ**	**72.91**

CV=1.04%
1/, 2/ Means with a common letter superscript are not significantly different at the 1% level.

As shown in the table, the highest number of filled grains per panicle was achieved at a 15 cm cutting height (75.24), while the lowest was at 10 cm (70.65). Variety-wise, RC216 had the highest filled grains (79.23), and RC506 had the least (68.63). The low CV of 1.04% indicates uniform results. These findings suggest that a cutting height of 15 cm enhances grain filling and yield. The results reveal that both rice variety and cutting height significantly affected the number of grains filled per panicle in ratooned rice, with the highest mean (75.24) at a cutting height of 15 cm. Among rice varieties, the highest grain filling was observed in NSIC Rc216 (79.23 filled grains per panicle), followed by Rc506 (68.63). These findings indicate that a cutting height of 15 cm promotes grain development by retaining more photosynthate-active tissues and basal nodes involved in nutrient translocation. Banoc et al. (2022) insisted that ratoon crops with a cutting height of 15 cm have better grain filling as a result of superior remobilization of carbohydrates from the stubble. Likewise, Islam et al. (2021) noted that greater stubble height enables improved source-sink balance, which is significant for grain development during the ratoon stage. In addition, Rc216's superior performance aligns with the findings of Reyes and Olivares (2020), who reported that it exhibits high grain development capacity under optimal water and nutrient management. These findings validate that optimal stubble height management—precisely 15 cm—is essential to ensure maximum filled grain yield, particularly in genetically responsive varieties such as Rc216, and can be a key factor in increasing the productivity and profitability of ratoon rice production systems.

Unfilled Grains per Panicle

The number of unfilled grains per panicle of the different rice varieties as influenced by cutting height under irrigated lowland condition is shown in Table 6.

Table 6. *Unfilled Grains per Panicle of Different Rice Varieties as Influenced by Cutting Height Under Irrigated Lowland Condition*

Factor A Different Rice Variety	Factor B Different Ratooned Height 3/ B1 (10cm)	 B2 (15cm)	 B3 (20cm)	Means of A. 1/
A1 (Rc222)	25.67	22.50	24.20	**24.12**^{c}
A2 (Rc160)	27.13	25.37	26.50	**26.33**^{b}
A3 (Rc506)	31.17	28.53	30.03	**29.91**^{a}
A4 (Rc216)	22.50	18.17	20.13	**20.27**^{d}
Means of B. 2/	**26.62**^{a}	**23.64**^{c}	**25.16**^{b}	**25.14**

CV=3.03%
1/, 2/ Means with common letter superscript are not significantly different at the 1%level LSD.

The data show that the fewest unfilled grains were observed at a 15 cm cutting height (23.64), suggesting better grain development, whereas the highest number was at 10 cm (26.62). Among the varieties, RC216 had the fewest unfilled grains (20.27), whereas RC506 had the most (29.91). The CV of 3.03% indicates reliable results. These findings imply that a 15 cm cutting height minimizes unfilled grains, enhancing overall grain quality. The outcomes show that a cutting height of 15 cm significantly reduced the number of unfilled grains per panicle in ratoon rice (mean = 23.64), compared with 10 cm (26.62) and 20 cm (25.16). Interestingly, NSIC Rc216 had the fewest unfilled grains (20.27), whereas Rc506 had the most (29.91), indicating apparent varietal differences in grain-filling efficiency. This confirms that the cut height directly affects the physiological potential for grain formation in ratooned rice. Chen et al. (2020) assert that minimizing the number of unfilled grains in the ratoon crop is highly correlated with a wholesome source–sink balance, which is best conserved when adequate photosynthetic leaf area and nutrient reserve are maintained at moderate stubble heights. Moreover, Zhang et al. (2019) highlighted that genotypes with effective remobilization of assimilates to developing grains under optimal cutting-height conditions tend to have fewer unfilled grains and better grain quality. The higher performance of Rc216 at a 15 cm cutting height in the present study demonstrates the importance of genetic responsiveness to ratooning management. It supports the recommendation to farmers to limit grain sterility and enhance overall harvest efficiency in irrigated lowland farming systems.

Yield Parameters

Computed Grain Weight (Fresh)

Table 7 shows the computed grain weight of the different rice varieties as influenced by cutting height under irrigated lowland condition.

Table 7. *Computed Grain Weight (Fresh) of Different Rice Varieties as Influenced by Cutting Height Under Irrigated Lowland Condition*

Factor A Different Rice Variety	Factor B Different Ratooned Height 3/ B1 (10cm)	 B2 (15cm)	 B3 (20cm)	Means of A. 1/
A1 (Rc222)	2.30	2.30	3.45	**2.68** ^{b}
A2 (Rc160)	1.89	1.93	1.78	**1.87** ^{c}
A3 (Rc506)	1.28	1.30	1.29	**1.29** ^{d}
A4 (Rc216)		5.09		
	3.40		3.38	**3.96** ^{a}
Means of B. 2/	**2.22**	**2.66**	**2.47**	**2.21**

CV=3.78%
1/ Means with common letter superscript are not significantly different at the 1%level LSD.

Statistical analysis revealed significant differences among treatments across rice varieties. RC216 exhibited the highest mean of 3.96 tons per hectare, while RC506 recorded the lowest with 1.29 tons per hectare. While the different cutting heights of rice showed no significant difference among treatment means, as 15 cm cutting height showed highest grain weight (fresh) with a mean of 2.66 followed by 20 cm cutting height with a mean of 2.47 and

10 cm cutting height got the lowest mean of 2. 22. With the CV of 3.78% suggests minimal variability in the results. The findings indicate that rice variety and cutting height significantly affected fresh grain weight in ratoon rice, with NSIC Rc216 showing the highest mean yield (3.96 tons/ha), particularly at 15 cm cutting height (5.09 tons/ha), whereas Rc506 yielded the least (1.29 tons/ha). Although differences in cutting height were not statistically significant, the trend indicates better performance at 15 cm (2.66 tons/ha) than at 10 cm (2.22 tons/ha). These findings suggest that Rc216's inherent genetic potential, coupled with an optimal cutting height, optimizes ratoon productivity. Wang et al. (2021) identified that ratoon rice with moderate cutting height maintains higher functional leaf area and stem carbohydrates, which support efficient grain filling and higher grain weight. Similarly, Zhou et al. (2017) noted that varietal ability to ratoon is a significant determinant of yield, with some genotypes, such as hybrid and improved inbred lines, exhibiting enhanced biomass remobilization and spikelet fertility. In addition, Hu et al. (2020) documented that ratoon rice crops with proper stubble height management and variety choice can produce fresh grain yields equivalent to main crops, particularly when ratoon regrowth is vigorous and well-sustained by residual root activity. These results confirm the role of Rc216 and a 15 cm cutting height in achieving the highest possible yield of fresh grain under lowland irrigated conditions, and indicate the strategic inclusion of ratooning in sustainable rice production systems.

Computed Grain Weight (Dry)

Table 8 shows the dry weight of the different rice varieties as influenced by cutting height under irrigated lowland condition.

Table 8. *Computed Grain Weight (Dry) of Different Rice Varieties as Influenced by Cutting Height Under Irrigated Lowland Condition*

Factor A	Factor B Different Ratooned Height 3/			
Different Rice Variety	B1 (10cm)	B2 (15cm)	B3 (20cm)	Means of A. 1/
A1 (Rc222)	1.55	1.72	1.56	**1.61** [b]
A2 (Rc160)	1.28	1.30	1.20	**1.26** [c]
A3 (Rc506)	0.86	0.88	0.87	**0.87** [d]
A4 (Rc216)	2.29	2.30	2.28	**2.29** [a]
Means of B. 2/	**1.50**	**1.55**	**1.48**	**1.51**

CV=5.03%

1/ Means with common letter superscript are not significantly different at 1% level LSD.

Statistical analysis revealed significant differences among treatments across rice varieties. RC216 exhibited the highest mean of 2.29 tons per hectare, while RC506 recorded the lowest with 0.87 tons per hectare. While the different cutting heights of rice showed no significant difference among treatment means, 15 cm cutting height showed the highest grain weight (dry) with a mean of 1.55, followed by 10 cm cutting height with a mean of 1.50, and 20 cm cutting height had the lowest mean of 1.48. The CV of 5.03% suggests minimal variability in the results. The findings of this research indicate that NSIC Rc216 significantly exceeded other varieties in computed dry grain weight, averaging 2.29 tons per hectare, whereas Rc506 yielded the least at 0.87 tons per hectare. Although cutting height did not show a statistically significant effect, the trend indicated that 15 cm stubble height produced the highest dry grain weight (1.55 tons/ha), marginally greater than 10 cm (1.50 tons/ha) and 20 cm (1.48 tons/ha). These results confirm the findings of Prasad et al. (2019), who documented that moderate cutting heights enable good ratoon crop recovery, resulting in increased dry matter accumulation and grain yield. Similarly, Zhi et al. (2021) reported that varietal sensitivity to ratooning, particularly in high-yielding lines such as Rc216, is directly associated with the ability to remobilize assimilates and to use water effectively, both of which are essential for grain maturation and dry matter accumulation. Further, Gao et al. (2020) reiterated that the optimal stubble height promotes post-harvest physiological processes in ratoon crops, thereby enhancing dry grain mass and harvest index. These findings support the promise of Rc216 as an irrigated lowland ratoon variety with high yield and encourage adopting a cutting height of 15 cm as agronomically desirable for maintaining uniform dry-yield performance.

Computed Grain Yield

The result in Table 9 is the yield of the different rice varieties as influenced by cutting height under irrigated lowland condition.

Table 9. *Computed Grain Yield of Different Rice Varieties as Influenced by Cutting Height Under Irrigated Lowland Condition*

Factor A Different Rice Variety	Factor B Different Ratooned Height 3/ B1 (10cm)	B2 (15cm)	B3 (20cm)	Means of A. 1/
A1 (Rc222)	2.07	2.07	2.06	**2.07** ^{b}
A2 (Rc160)	1.70	1.73	1.60	**1.68** ^{c}
A3 (Rc506)	1.15	1.17	1.15	**1.16** ^{d}
A4 (Rc216)		3.05		
	3.06		3.04	**3.05** ^{a}
Means of B. 2/	**1.99**	**2.01**	**1.96**	**1.99**

CV=3.89%

1/ Means with common letter superscript are not significantly different at the 1%level LSD.

Statistical analysis revealed significant differences among treatments across rice varieties. RC216 exhibited the highest mean of 3.05 tons per hectare, while RC506 recorded the lowest with 1.16 tons per hectare. While the different cutting heights of rice showed no significant differences among treatment means, the 15 cm cutting height had the highest grain yield (mean = 2.01), followed by the 10 cm cutting height (mean = 1.99), and the 20 cm cutting height had the lowest mean (1.96). The CV of 3.89% suggests minimal variability in the results. The results indicate that NSIC Rc216 yielded the highest grain yield among the tested lines, averaging 3.05 tons per hectare, whereas Rc506 yielded the lowest, at 1.16 tons per hectare. Although variation across cutting heights was not statistically significant, the trend suggested that a 15 cm cutting height was slightly better than 10 cm and 20 cm, indicating a beneficial effect on ratoon crop performance. These findings align with those of Nguyen et al. (2020), who concluded that the ratoon yield of rice is primarily influenced by a variety's physiological tolerance and stubble-based regrowth capacity. Das et al. (2021) opine that ratoon yield of the crop is controlled mainly by the root activity of the variety as well as the capacity to maintain post-harvest uptake of nutrients, both of which are well established in Rc216. In addition, Lim et al. (2018) highlighted that although cutting height is not always statistically significant, intermediate heights, such as 15 cm, typically yield the best ratoon regeneration and yield due to enhanced retention of photosynthetic tissue. The current results validate the promise of Rc216 as a high-yielding variety for ratoon cropping in irrigated lowlands, where a moderate cutting height offers practical advantages for maintaining continuous grain yield without replanting.

Net Income

Table 10 shows the net income of the different rice varieties as influenced by cutting height under irrigated lowland condition.

Table 10. *Net Income of Different Rice Varieties as Influenced by Cutting Height Under Irrigated Lowland Condition*

Factor A Different Rice Variety	Factor B Different Ratooned Height 3/ B1 (10cm)	B2 (15cm)	B3 (20cm)	Means of A. 1/
A1 (Rc222)	38.63	43.50	38.66	**40.26** ^{b}
A2 (Rc160)	26.61	29.79	27.15	**27.85** ^{c}
A3 (Rc506)	15.03	19.00	15.84	**16.62** ^{d}
A4 (Rc216)		65.54		
	64.38		64.92	**64.95** ^{a}
Means of B. 2/	**36.16**	**39.46**	**36.64**	**37.42**

CV=10.01%

1/, 2/ Means with common letter superscript are not significantly different at the 1%level LSD.

Net income analysis reveals that RC216 generated the highest income, with a mean of 64.95-1000, whereas RC506 generated the lowest income, with a mean of 16.62^{-1000}. On the other hand, cutting heights did not differ significantly among treatment means. As 15 cm got the highest net income of 39. 46^{-1000} followed by 20 cm with a mean of 36. $64^{-1000,}$ and the lowest net income was achieved at 10 cm, with a mean of 36.16-1000 and a CV of 10.01%. The computation of net income indicates that NSIC Rc216 performed better than other varieties, with an average income of ₱64,950 per hectare, whereas Rc506 earned the least at ₱16,620 per hectare. Although differences in cutting height were not statistically significant, the 15 cm height yielded the highest average net income across varieties. This finding highlights the significance of genotype selection in maximizing the economic benefits of ratoon rice production. According to Yadav et al. (2021), high-performing varieties with robust ratooning capacity are more determinative of profitability than agronomic inputs alone, especially in limited-resource farming systems.

Additionally, Sharma et al. (2018) stated that ratooning, when optimized through appropriate varietal selection, can reduce production costs while maintaining competitive yields, thereby dramatically enhancing farm profitability. Singh and Jha (2023) further asserted that ratoon cropping systems are economically feasible when combined with genotypes such as Rc216, which exhibit high regrowth ability, low input requirements, and high marketable yield. These results concur with the current study and justify recommending Rc216 at a 15 cm cutting height as an income-generating and sustainable approach for farmers growing rice in irrigated lowlands.

ROI

The return on investment of the different rice varieties as influenced by cutting height under irrigated lowland condition is presented in Table 11.

Table 11. *ROI of Different Rice Varieties as Influenced by Cutting Height Under Irrigated Lowland Condition*

Factor A Different Rice Variety	Factor B Different Ratooned Height 3/ B1 (10cm)	B2 (15cm)	B3 (20cm)	Means of A. 1/
A1 (Rc222)	235.43	264.97	235.72	**245.37** ^{b}
A2 (Rc160)	162.20	181.70	165.47	**169.79** ^{c}
A3 (Rc506)	90.63	115.51	96.57	**100.90** ^{d}
A4 (Rc216)		399.44		
	392.37		395.63	**395.90** ^{a}
Means of B. 2/	**220.16**	**240.41**	**223.35**	**227.99**

CV=8.74%
1/ Means with common letter superscript are not significantly different at the 1%level LSD.

Table 12. *Computed Yield (Ratooned) in Contrast with the Original Yield of Different Rice Varieties as Influenced by Cutting Height Under Irrigated Lowland Condition*

Treatment	Mean of Main Crop	Mean of Ratoon Crop	Difference
A1B1	3.31	2.07	1.24
A1B2	3.32	2.07	1.25
A1B3	3.31	2.07	1.24
Sub Total	**9.94**	**6.21**	**3.73**
A2B1	2.72	1.7	1.02
A2B2	2.77	1.73	1.04
A2B3	2.56	1.6	0.96
Sub Total	**8.05**	**5.03**	**3.02**
A3B1	1.84	1.15	0.69
A3B2	1.87	1.17	0.7
A3B3	1.85	1.15	0.7
SubTotal	**5.56**	**3.47**	**2.09**
A4B1	4.9	3.06	1.84
A4B2	4.89	3.05	1.84
A4B3	4.86	3.04	1.82
SubTotal	**14.65**	**9.15**	**5.5**
Grand Total	**38.2**	**23.86**	**14.34**

Statistical analysis revealed significant differences among treatments across rice varieties. RC216 exhibited the highest mean of 395.90 percent, whereas RC506 recorded the lowest mean of 100.90 percent. While the different cutting heights of rice showed no significant differences among treatment means, the 15 cm cutting height had the highest grain yield (mean = 240.41%), followed by the 20 cm cutting height (mean = 223.35%), and the 10 cm cutting height had the lowest mean (mean = 220.16%). The CV of 8.74% suggests minimal variability in the results. The result indicates that the ROI calculated for RC216 at a cutting height of 15 cm yields the best balance between productivity and financial gains. As stated by D.M. Banoc, R. Sevillano, and V.B. Ratooning response of lowland rice cultivars to ratoon crop cutting height SVU-International Journal of Agricultural Sciences, 4 (1): 99-110, 2022. Ratooned lowland rice types reached a larger percentage of whole grains, had a heavier grain yield at a cutting height of 15 cm, matured quicker, and produced noticeably longer stem elongation and panicle length. At a cutting height of 15 cm, they claimed that NSIC Rc216 yielded the best grain and was the most profitable of all the lowland rice types. They also stated that proper variety selection and optimal cutting height will significantly enhance profitability in ratooned rice production.

The table shows the difference between the main crop and ratooned crop, NSIC Rc216 with a cutting height of 15 cm (A4B2) and NSIC Rc216 with a cutting height of 10 cm (A4B1) got the highest, the same differential mean of 1.84, and NSIC Rc506 with a cutting height of 10 cm got the lowest differential mean of 0.69.

Conclusion

The findings of this study demonstrate that a cutting height of 15 cm significantly enhances rice ratooning performance by increasing plant height, tiller number, panicle count, panicle length, and filled grains per panicle, while reducing unfilled grains. Among the four rice varieties evaluated, NSIC Rc216 consistently outperformed others across both agronomic and economic indicators, including fresh and dry grain weights, total grain yield, net income, and return on investment (ROI). Notably, the interaction between NSIC Rc216 and a 15 cm cutting height produced the highest number of tillers and panicles, which contributed to the observed yield advantage. The combination also resulted in the highest net income (₱6,495.00) and ROI (395.90%), confirming its economic viability for ratoon rice production under irrigated lowland conditions such as those in San Felipe, Tantangan, South Cotabato. These results underscore the potential of ratooning as a cost-efficient and sustainable practice to increase rice productivity without replanting, thereby contributing to national goals of food security and agricultural resilience.

For farmers, adopting NSIC Rc216 with a 15 cm cutting height can serve as a practical strategy to maximize grain yield and profitability during the ratoon season. Policymakers and agricultural extension services are encouraged to promote this technology through training programs, input subsidies, and demonstration projects, particularly in resource-constrained regions. Future research should investigate long-term ratooning performance under variable climatic conditions, nutrient management strategies, and pest/disease impacts to further optimize ratoon rice systems. Additionally, exploring ratooning in the context of climate-smart agriculture can help make rice farming more adaptable and sustainable amid global environmental challenges.

Contributions of Authors

The author contributed to the study’s writing, editing, data analysis, and implementation. The co-author edited and supervised the study's data.

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Conflict of Interests

The authors declare no conflicts of interest regarding the publication of this paper.

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