



Agronomic Productivity of Lowland Rice: Impacts of Tillage and Nutrient Management in Barili, Cebu

Clea Anne V. Corsiga^{1*}, and Marciano D. Tangpos¹

¹ College of Agriculture, Food Science, Agribusiness, and Development Communitation, Cebu Technological University-Barili, Cagay, Barili, Cebu 6036, Philippines

* Correspondence: cleanne.corsiga@ctu.edu.ph

Citation:

Corsiga, C.A.V; Tangpos, M.D. Agronomic productivity of lowland rice: Impacts of tillage and nutrient management in Barili, Cebu. *ASEAN J. Sci. Tech. Report.* 2026, 29(8), e265026. <https://doi.org/10.55164/ajstr.v29i8.265026>

Article history:

Received: April 17, 2026

Revised: May 31, 2026

Accepted: June 21, 2026

Available online: July 11, 2026

Publisher's Note:

This article is published and distributed under the terms of the Thaksin University.

Abstract: Lowland rice (*Oryza sativa* var. NSIC RC222) under conventional (M1) and minimum (M2) tillage systems utilizing various fertilizer treatments (T₁-control (no fertilizer application); T₂ - Organic fertilizer at 2 t ha⁻¹ (combination of rice straw compost, chicken manure dried, and carbonized rice hull at 1:1:1 ratio); T₃ - Organic fertilizer (same as T₂) + inorganic fertilizer at a rate of 60-30-30 kg/ha N-P₂O₅-K₂O; and T₄ - Inorganic fertilizer at the rate of 120-60-60 kg N-P₂O₅-K₂O) was the subject of a split-plot study to evaluate the agronomic and yield performance of lowland rice under different tillage systems and nutrient management schemes. Results showed that Conventional Tillage and Minimum Tillage showed comparable effects on the growth and yield of lowland rice. Further, the application of integrated inorganic and organic fertilizers yielded significant results compared with treatments with no fertilizer application or organic fertilizer alone. However, comparable values were observed for T₄ (inorganic application). Thus, the study offers rice producers a workable plan by recommending the use of combined inorganic and organic fertilizers with Minimum Tillage for rice production to preserve soil health and quality.

Keywords: Rice; minimum tillage; integrated inorganic; organic fertilizers

1. Introduction

Oryza sativa Linn. is the most important food crop of the developing world and the staple food of more than half of the world's population [1]. Its central role has prompted wide-ranging research spanning grain and aroma quality [2, 3], post-harvest drying and processing [4], value-added utilization of rice byproducts [5], and the adoption of information and communication technologies among rice growers [6]. For this reason, land preparation is crucial to ensure the rice field is ready for planting [7]. To prepare the land, there are two types of tillage: conventional and minimum tillage. Conventional tillage is an effective way to incorporate manure and break up sod fields [8, 9], thereby increasing porosity and loosening soil, allowing better root growth and nutrient uptake [10]. However, conventional tillage on smallholdings in some parts of Asia can be very labor-intensive and slow [7] because it is expensive, with high fuel consumption and labor requirements [11]. On the other hand, minimum tillage demonstrated apparent advantages over traditional methods. Minimum tillage can control soil erosion, reduce fuel, increase flexibility in planting and harvest, reduce labor requirements, improve water retention, reduce evaporation, and lower equipment requirements.

Furthermore, the availability of sufficient nutrients to meet the plant's needs is another factor that influences a crop's performance. Providing the soil with the nutrients that plants need for healthy growth and development is the primary objective of fertilizer application. These substances might be either organic or inorganic. Compared to natural organic fertilizers, inorganic fertilizers are more soluble in soil and have a higher nutrient content [12]. However, inorganic fertilizers are too expensive for small-scale farmers to buy [13]. Moreover, continuous and excessive application of inorganic fertilizer can cause detrimental effects to the soil [12, 13]. An organic approach, on the other hand, can maintain a healthy, biologically active soil with large reservoirs of plant nutrients [14]. Applying organic fertilizer to plants can increase organic matter content of the soil, thus improving and stabilizing soil structure, resulting in easy cultivation and improving water holding capacity, soil pH, bulk density, soil texture, soil aeration, porosity, as well as soil aggregation, especially when it is applied at the proper time [15, 16].

Achieving higher yields with a suitable quantity of affordable fertilizers at a low production cost is one of the ideal solutions small-scale farmers envision. Hence, this study evaluated the agronomic and yield performance of rice grown under conventional and minimum tillage, with different fertilizers (organic, inorganic, and a combination of organic and inorganic). Figure 1 shows the conceptual framework of the study.

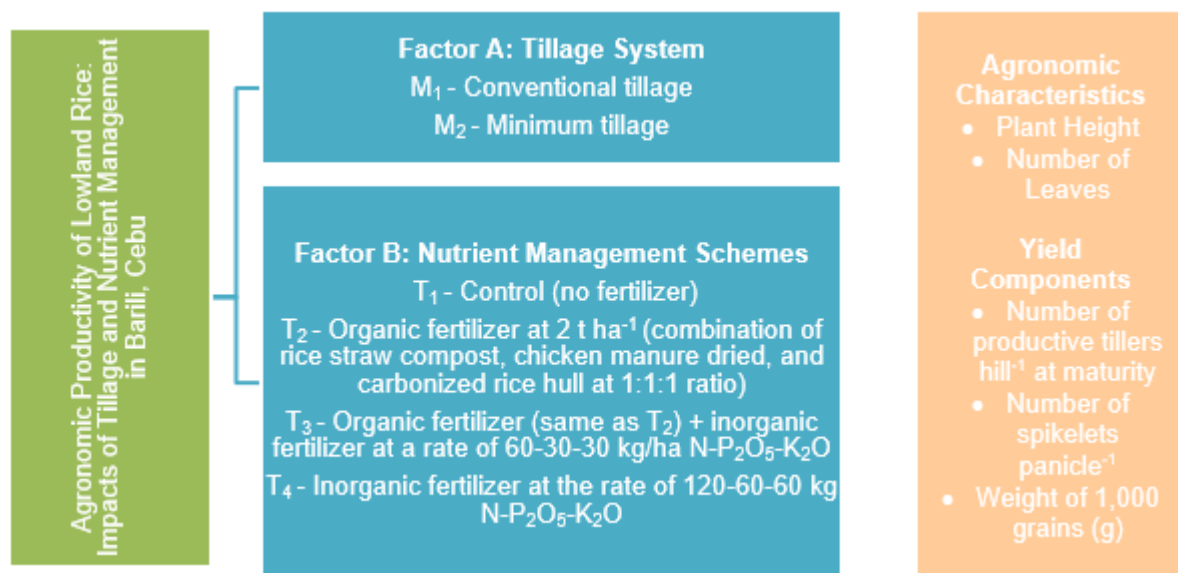


Figure 1. Conceptual framework of the study

2. Materials and Methods

2.1 Land Preparation

A 530 m² space was set up using conventional and minimum-tillage systems. In M₁ (Conventional Tillage), plowing and harrowing were performed twice at weekly intervals. Right after harrowing, the field soils were manually leveled before transplanting. On the other hand, for M₂ (Minimum Tillage), plowing was done upon soaking the field for one (1) week. After plowing, the field was soaked with water for one (1) month and immediately harrowed thereafter. One week after the harrowing, the field was leveled before transplanting.

2.2 Experimental Design

The experimental area was arranged in a split-plot using a randomized complete block design (RCBD) with three (3) replications. The fertilizer treatments were the subplot (Factor B), while the tillage system was the main plot (Factor A). To make farm operations, management, and data collection easier, each treatment plot was measured at 4 x 5 meters, with 1m alleyways for replication and treatment plots. Each plot contained 25 rows of rice plants. A dike and irrigation/drainage canals encircled each treatment plot to prevent fertilizer contamination between plots. The different treatments were designated as follows:

Factor A - Main Plot (Tillage System)

M₁ - Conventional tillageM₂ - Minimum tillage

Factor B - Subplot (Nutrient Management Schemes)

T₁ - Control (no fertilizer application)T₂ - Organic fertilizer at 2 t ha⁻¹ (combination of rice straw compost, chicken manure dried, and carbonized rice hull at a 1:1:1 ratio)T₃ - Organic fertilizer (same as T₂) + inorganic fertilizer at a rate of 60-30-30 kg/ha N-P₂O₅-K₂OT₄ - Inorganic fertilizer at the rate of 120-60-60 kg N-P₂O₅-K₂O**2.3 Preparation and Application of Fertilizer**

A locally produced organic fertilizer was used, following the formulation of different mixtures of decomposed materials: rice straw, dried chicken manure, and carbonized rice hull, mixed in equal proportions (1:1:1 by weight). One week before transplanting, T₂ and T₃ received an application of organic fertilizers. T₃ and T₄ received half of the N and all of the P and K 12 days after transplantation. 35 days after transplanting, the second half of N in T₃ was administered. One-half (30 kg/ha N) of the remaining N in T₄ (60 kg/ha N) was administered 35 days after the transplant, and the other half (30 kg/ha N) was applied 55–60 days into the transplant (Table 1).

Table 1. Amount of fertilizer treatments applied per plot (kg plot⁻¹).

Treatments	Amount of fertilizers (kg plot ⁻¹)
T ₁ - (No fertilizer)	0
T ₂ - (2 t ha ⁻¹ of organic fertilizer)	4 kgs of organic fertilizer plot ⁻¹
T ₃ - (2 t ha ⁻¹ of organic fertilizer + inorganic at a rate of 60-30-30 kg ha ⁻¹ N, P ₂ O ₅ , K ₂ O)	4 kgs. of organic fertilizer plot ⁻¹ 1 st application of inorganic fertilizer (12 DAT): 429 g of complete fertilizer plot ⁻¹ 2 nd application (35 DAT): 130 g of urea plot ⁻¹
T ₄ - (120-60-60 kg ha ⁻¹ N, P ₂ O ₅ , K ₂ O inorganic fertilizer)	1 st application (12 DAT): 857 g of complete fertilizer plot ⁻¹ 2 nd application (35 DAT): 130 g of urea plot ⁻¹ 3 rd application (55-60 DAT): 130 g of urea plot ⁻¹

2.4 Seedbed Preparation and Transplanting

One to two days before sowing, the seedbed was prepared. A typical wet bed measuring 2 × 5 m, with a drainage canal surrounding it, was constructed on separate sites to avoid obstacles during construction of the experimental plot. Rice seeds (NSIC Rc222) of approximately 2 kg were used. The seeds were incubated for 43 hours after being immersed in fresh water for 24 hours. The seedbed was planted with pre-germinated seeds. Until the seedlings were prepared for transplantation, proper care and weed control were used. One 14-day-old seedling was moved to each hill, spaced 20 cm apart. Five (5) days following seed emergence, missing hills were replanted.

2.5 Pest Control

Each treatment plot received the same hand weeding or rotary weeding treatment. The first weeding operation was done ten (10) days after transplanting. Twenty (20) days after the second weeding, a selective hand weeding was carried out. The succeeding weeding operations were done at two-week intervals or whenever necessary. From the tillering stage to two weeks before maturity, panyawan (*Tinospora rumphii* Boerl) was sprayed as a botanical insecticide to control insect infestation.

2.6 Water Management

During transplantation, the area was drained. Irrigation was applied three (3) days after transplanting at a depth of five (5) cm. Three (3) weeks after transplanting, no flooding of water was done. The irrigation water was kept at a level sufficient to maintain a wet or muddy soil condition until 50 days after transplanting.

Then flooding was repeated at a depth of 5 cm. Around the experimental area and in between replications, irrigation and drainage canals were constructed to supply water during dry spells and remove excess water as needed. A week before crop harvesting, the area was drained to make harvesting easier.

2.7 Harvesting and Processing

When 85% of the grains in the top portion of each treatment had ripened and turned yellow, and the panicle base had reached the hard dough stage, harvesting was done. The panicle bases from the harvestable area (13.44m²) were chopped with a sickle. Every sample plant was taken from the harvestable area, except for the two boundary rows on each side and the two hills at either end of each row. It was then winnowed, dried to around 14% moisture content, and threshed before all the necessary information was gathered.

2.8 Data Gathered

2.8.1 Agronomic Characteristics

1. Plant height (cm) - the height of the ten (10) sample plants in each treatment plot was measured from ground level to the tip of the tallest plant part before harvest.
2. Number of Leaves - this was obtained by counting the leaves of the tallest tiller per hill, which represent the whole-plant samples.

2.8.2 Yield Components

1. Number of productive tillers hill⁻¹ at maturity - ten (10) sample hills in each treatment plot were used to calculate the number of tillers hill⁻¹ that formed panicles at maturity.
2. Number of spikelets panicle⁻¹ - in each treatment plot, ten (10) sample panicles were counted to determine the number of filled and unfilled spikelets (panicle⁻¹).
3. Weight of 1,000 grains (g) - 1,000 grains from the same sample plants used for the filled and unfilled spikelet count were weighed to determine this parameter.

2.9. Statistical Analysis

The Statistical Analysis System (SAS version 9.4 or later; SAS Institute Inc., Cary, NC, USA) was used to analyze the data statistically. Tukey's test was used to compare means.

3. Results and Discussion

3.1 Agronomic Characteristics

3.1.1 Plant Height

Plant growth can be observed by an increase in length or height, stem diameter, tissue volume, cell count, fresh and dried weight, leaf area, leaf weight, and other features [17]. Plant height is a significant morphological parameter that is widely predictive of ultimate grain production and biomass [18] and may be used as an indicator of overall plant growth vigor and as a parameter to estimate characteristics [19]. As shown in Table 2, a significant difference in plant height was observed among rice plants treated with different fertilizer rates and types, regardless of the tillage system adopted. Results for T₁ and T₂ were comparable, while T₃ and T₄ showed no significant difference. Thus, applying both organic and inorganic fertilizers will likely yield the same crop yield as using only inorganic fertilizer. Accordingly, research has indicated that applying inorganic fertilizer in combination with organic fertilizer, known as Integrated Plant Nutrient Management, maintains soil fertility and balances nutrient supply, thereby increasing crop yield per unit area [20, 21]. Certain studies also suggest that careful use of both organic and inorganic resources can address soil fertility restrictions [22] and sustain agronomic productivity [23]. Furthermore, a study by Demissie et al. [10] in the Wolmera district of Central Ethiopia found that the combined application of organic and inorganic fertilizers significantly increased barley plant height. Similarly, in Adiyo and Ghimbo, Southwestern Ethiopia, Woldesenbet et al. [24] found that the combined application of organic and inorganic fertilizers significantly affected barley plant height.

Table 2. Analysis of Variance on the Average Plant Height of Rice grown under different Tillage Management Systems applied with different Fertilizers

Treatment	Average Plant Height (cm)		
	30 DAP	50 DAP	70 DAP
Factor A – Tillage System			
M ₁ – Conventional Tillage	34.92 a	57.50 a	76.29 a
M ₂ – Minimum Tillage	33.64 a	56.17 a	73.69 b
Factor B – Fertilizer Application			
T ₁ - control	29.17 c	47.56 b	64.67 b
T ₂ - Organic fertilizer at 2 t ha ⁻¹ (combination of rice straw compost, chicken manure dried, and carbonized rice hull at a 1:1:1 ratio)	32.50 b	51.61 b	67.91 b
T ₃ - Organic fertilizer (same as T ₂) + inorganic fertilizer at a rate of 60-30-30 kg/ha N-P ₂ O ₅ -K ₂ O	37.61 a	65.17 a	84.56 a
T ₄ - Inorganic fertilizer at the rate of 120-60-60 kg N-P ₂ O ₅ -K ₂ O	37.83 a	63.00 a	82.83 a
CV (%) (A)	13.14	15.40	3.64
CV (%) (B)	6.76	6.27	4.14

Means with the same letter were not significantly different at 5 % level of the HSD test.

3.1.2 Number of Leaves

One of the visual essential phenotypic characteristics that characterizes a plant's growth and development is the quantity of leaves it possesses [25, 26]. It is connected to the plant's health and prospective yield and allows growth rate estimation [26, 27, 28]. This study showed that the average number of leaves was highest for the treatment applied with inorganic fertilizer (T₄), though, statistically, it obtained a comparable result with the treatment applied with combined inorganic and organic fertilizers (T₃) (Table 3). Additionally, the results showed no discernible difference in leaf number on rice plants grown under minimum (M₂) or normal (M₁) tillage systems.

Table 3. Analysis of Variance on the Average Number of Leaves of Rice grown under different Tillage Management Systems applied with different Fertilizers

Treatment	Average Number of Leaves		
	30 DAP	50 DAP	70 DAP
Factor A – Tillage System			
M ₁ – Conventional Tillage	27.61 a	82.17 a	101.89 a
M ₂ – Minimum Tillage	27.17 a	82.92 a	96.22 a
Factor B – Fertilizer Application			
T ₁ - control	16.55 c	49.78 b	54.11 b
T ₂ - Organic fertilizer at 2 t ha ⁻¹ (combination of rice straw compost, chicken manure dried, and carbonized rice hull at a 1:1:1 ratio)	26.00 b	60.05 b	67.16 b
T ₃ - Organic fertilizer (same as T ₂) + inorganic fertilizer at a rate of 60-30-30 kg/ha N-P ₂ O ₅ -K ₂ O	33.61 a	109.67 a	131.89 a
T ₄ - Inorganic fertilizer at the rate of 120-60-60 kg N-P ₂ O ₅ -K ₂ O	33.39 a	110.67 a	143.06 a
CV (%) (A)	29.23	38.53	15.11
CV (%) (B)	10.59	12.87	14.89

Means with the same letter were not significantly different at 5 % level of the HSD test.

3.2 Yield Components

3.2.1 Number of Tillers

Initially appearing as a single culm seedling, rice rapidly produces primary, secondary, and tertiary tillers. Panicle and tiller numbers are the two main factors that determine rice plant design and thus affect grain yield [29]. Rice's tillering capacity is a varietal trait that mostly depends on shape and duration [30, 31]. To maximize rice yield [32] and achieve higher yields [18], tillering optimization is crucial. Additionally, optimal tillering enables synchronized flowering, maturity, and uniform panicle size [33]. In this study, the average number of tillers was highest in Conventional Tillage (M₁) with the application of inorganic fertilizers (T₄). The statistical analysis presented in Table 4 showed that the Minimum Tillage (M₂) result was comparable to that for Conventional Tillage (M₁). Likewise, the combined application of inorganic and organic fertilizers (T₃) also showed no significant difference with the application of inorganic fertilizer alone (T₄). To corroborate the results, Demissie et al. [10] noted that the combination of organic and inorganic fertilizers may have a synergistic effect on the number of effective tillers. Additionally, according to Arif et al. [34] and Silguera and Dollison [35], the increased nutrient availability and uptake due to the combined use of organic manure and inorganic fertilizers resulted in a higher number of fertile tillers, grains per panicle, panicles per hill, filled grains per panicle, 1000 grain weight, biological yield, grain yield, and harvest index.

Table 4. Analysis of Variance on the Average Number of Tillers of Rice grown under different Tillage Management Systems applied with different Fertilizers

Treatment	Average Number of Tillers		
	30 DAP	50 DAP	70 DAP
Factor A – Tillage System			
M ₁ – Conventional Tillage	7.28 a	20.25 a	24.36 a
M ₂ – Minimum Tillage	7.00 a	21.25 a	23.92 a
Factor B – Fertilizer Application			
T ₁ - control	3.83 c	11.83 b	13.28 b
T ₂ - Organic fertilizer at 2 t ha ⁻¹ (combination of rice straw compost, chicken manure dried, and carbonized rice hull at a 1:1:1 ratio)	6.72 b	14.00 b	15.95 b
T ₃ - Organic fertilizer (same as T ₂) + inorganic fertilizer at a rate of 60-30-30 kg/ha N-P ₂ O ₅ -K ₂ O	9.11 a	28.95 a	31.00 a
T ₄ - Inorganic fertilizer at the rate of 120-60-60 kg N-P ₂ O ₅ -K ₂ O	8.89 a	28.22 a	36.00 a
CV (%) (A)	34.23	43.47	16.85
CV (%) (B)	11.57	14.81	17.98

Means with the same letter were not significantly different at 5 % level of the HSD test.

3.2.2 Number of Filled and Unfilled Grains

The final step in cereal growth, known as grain filling, occurs when fertilized ovaries mature into caryopses. Canopy photosynthesis, assimilate conversion to biomass, and assimilate partitioning to grains are all interrelated processes that contribute to rice yield [29, 36]. The quantity of filled grains per panicle is closely correlated with crop output, and matured rice panicles contain both filled and unfilled grains [37]. Panicles with a high percentage of complete grains compared to unfilled grains are fundamentally indicative of a crop's high productivity or yield [38]. This study found that, regardless of tillage system and fertilizer application, the average number of filled grains was greater than the average number of unfilled grains (Table 5). However, significant differences were detected between tillage systems (Factor A) and fertilizer applications (Factor B). Conventional Tillage (M₁) obtained higher values for the total number of filled and unfilled grains compared to Minimum Tillage (M₂). Consequently, the highest values were also observed in the treatment that received both organic and inorganic fertilizers (T₃), although the results were comparable to those of inorganic fertilizer alone (T₄). This suggests that combining inorganic and organic fertilizers with Minimum Tillage could increase crop yield, particularly in rice, as shown by the grain yield (filled/unfilled) results of this study. This finding

was further supported by research conducted by Adane et al. [20] and Tadesse et al. [39], which found that the combined application of organic and mineral amendments led to improved barley yields by improving the soil's pH, available Phosphorus (P), total Nitrogen (N), and potentially other macronutrients and micronutrients.

Table 5. Analysis of Variance on the Average Number of Filled and Unfilled Grains of Rice grown under different Tillage Management Systems applied with different Fertilizers

Treatment	Number of Filled Grains	Number of Unfilled Grains	Total Number of Filled and Unfilled Grains
Factor A – Tillage System			
M1 – Conventional Tillage	389.92 a	179.08 a	569.00 a
M2 – Minimum Tillage	371.92 b	100.33 b	472.25 b
Factor B – Fertilizer Application			
T1 - control	277.50 b	107.33 b	384.83 b
T2 - Organic fertilizer at 2 t ha ⁻¹ (combination of rice straw compost, chicken manure dried, and carbonized rice hull at a 1:1:1 ratio)	361.50 ab	97.33 b	458.83 b
T3 - Organic fertilizer (same as T ₂) + inorganic fertilizer at a rate of 60-30-30 kg/ha N-P ₂ O ₅ -K ₂ O	447.00 a	204.00 a	651.00 a
T4 - Inorganic fertilizer at the rate of 120-60-60 kg N-P ₂ O ₅ -K ₂ O	437.67 a	150.17 ab	587.84 a
CV (%) (A)	20.60	37.88	16.63
CV (%) (B)			

Means with the same letter were not significantly different at 5 % level of the HSD test.

3.2.3 Thousand Grain Weight (TGW)

One of the primary determinants of rice and other cereal crop yield production on a single plant is grain weight (thousand-grain weight) [40]. A vital component of agriculture, Thousand Grain Weight (TGW) significantly affects grain quality and crop productivity [41]. Farmers and researchers alike must understand TGW, as it provides important insights into crop productivity and performance. The findings of this study showed that all treatments did not differ significantly in Thousand Grain Weight (Table 6). However, a significant difference was observed between Conventional (M₁) and Minimum (M₂) tillage systems. A higher average value (24.83 g) was indicated in Conventional Tillage as compared to Minimum Tillage (22.67 g). The study by Khan et al. [42], which found a maximum mean value of 1000-grain weight, produced similar findings: conventional tillage yielded (363.7g); deep tillage yielded (362.56g); and minimal tillage yielded the lowest value (322.6g) with non-hybrid maize. Additionally, tillage was the most popular and effective technique for improving soil physical conditions, accounting for up to 20% of crop yields [43]. As soil fertility, tillage type, and climate can all influence crop development and yield, tillage can also alter soil structure and remove moisture.

Table 6. Analysis of Variance on the Average Weight of 1000 Grains (g) of rice under different Tillage Management Systems applied with different Fertilizers

Treatment	Average Weight of 1000 Grains (g)
Factor A – Tillage System	
M ₁ – Conventional Tillage	24.83 a
M ₂ – Minimum Tillage	22.67 b
Factor B – Fertilizers	
T ₁ – control	23.83 a
T ₂ - Organic fertilizer at 2 t ha ⁻¹ (combination of rice straw compost, chicken manure dried, and carbonized rice hull at a 1:1:1 ratio)	22.50 a
T ₃ - Organic fertilizer (same as T ₂) + inorganic fertilizer at a rate of 60-30-30 kg/ha N-P ₂ O ₅ -K ₂ O	24.50 a
T ₄ - Inorganic fertilizer at the rate of 120-60-60 kg N-P ₂ O ₅ -K ₂ O	24.17 a
CV (%) (A)	6.94
CV (%) (B)	8.73

Means with the same letter were not significantly different at 5 % level of the HSD test.

4. Conclusions

The results of the study lead to several conclusions. Conventional Tillage and Minimum Tillage showed comparable effects on the growth and yield of lowland rice. The application of integrated inorganic and organic fertilizers yielded significant results compared with treatments that received no fertilizer or organic fertilizer alone, although comparable values were observed for T₄ (inorganic application). Accordingly, the study recommends applying integrated inorganic and organic fertilizers with Minimum Tillage for rice production to maintain soil health and quality. Because these findings are derived from a single location (Barili, Cebu) and a single cropping season, multi-season and multi-location validation is strongly recommended before broader application. Future studies should also include pre-trial baseline soil characterization and report actual grain yield (t ha⁻¹) to substantiate the agronomic recommendations fully.

5. Acknowledgments

The authors would like to acknowledge the support of Cebu Technological University in conducting this study.

Author Contributions: CAV Corsiga facilitated and supervised the conduct of the study, interpreted the obtained results, and wrote the report. MD Tangpos conceptualized and led the study and conducted the statistical analyses.

Funding: This study was an approved 2023 General Appropriations Act (GAA)-Funded Research of Cebu Technological University.

Conflicts of Interest: The author states that there are no conflicts of interest regarding this research. The creation and content of this article are entirely the responsibility of the author.

References

- [1] International Rice Research Institute (IRRI). Rice Basics. 2012. http://www.irri.org/index.php?option=com_k2&view=item&layout=item&id=981&lang=en (accessed 2026).
- [2] Dangmanee, N. Germinated Sang Yod Brown Rice as a Novel Prebiotic for Synbiotic Dietary Supplement Development. *ASEAN J. Sci. Tech. Rep.* 2024, 27(1). <https://doi.org/10.55164/ajstr.v27i1.249850>
- [3] Hanphan, R.; Jansord, J.; Suwanmanee, P.; Wongchoosuk, C.; Udomvech, A. The Aroma Properties Measurements of the Sang Yod Rice of Phatthalung by the Machine Olfaction. *ASEAN J. Sci. Tech. Rep.* 2017, 20(3), 114-123.

- [4] Khomkaew, S.; Suksabai, N.; Srirugsa, T.; Chuchit, T.; Su-hren, W.; Kaewpoung, S. Optimizing Brown Rice Drying with Modified LSU Systems for Energy Efficiency, Carbon Reduction, and 2AP Preservation. *ASEAN J. Sci. Tech. Rep.* **2026**, 29(4). <https://doi.org/10.55164/ajstr.v29i4.260421>
- [5] Jirawattanasomkul, N.; Roschat, W.; Leelatam, T.; Phanphli, S.; Chaipikun, W.; Thammayod, A. Evaluation of the Nutritional, Mineral, and Estimated Metabolizable Energy Values of Agricultural Biomass Raw Materials for Fermented Concentrated Feed for Beef Cattle. *ASEAN J. Sci. Tech. Rep.* **2026**, 29(4). <https://doi.org/10.55164/ajstr.v29i4.262452>
- [6] Dollison, M. D.; Basulgan, E. B.; Cornal, N. R.; Dollison, B. B. Utilization of Information and Communication Technology (ICT) Tools among Masbate Rice Seed Growers. *ASEAN J. Sci. Tech. Rep.* **2026**, 29(1). <https://doi.org/10.55164/ajstr.v29i1.257993>
- [7] International Rice Research Institute (IRRI). Rice Knowledge Bank: Your Information Source of Rice Farming. **2015**. <http://www.knowledgebank.irri.org/training/fact-sheets/nutrient-management/item/composting-rice-residue-fact-sheet> (accessed 2026)
- [8] Bordt, M.; Wang, J. *EnviroStats. Minister of Industry, Canada* **2008**, 2(3).
- [9] Kumar, S.; Sharma, P. K.; Anderson, S. H.; Saroch, K. Tillage and Rice-Wheat Cropping Sequence Influences on Some Soil Physical Properties and Wheat Yield under Water Deficit Conditions. *Open J. Soil Sci.* **2012**, 2, 71–81. <https://doi.org/10.4236/ojss.2012.22011>
- [10] Demissie, W.; Selamyihun, K.; Raghavaiah, C. V. Effect of Integrated Use of Lime, Blended Fertilizer and Compost on Productivity, Nutrient Removal and Economics of Barley (*Hordeum vulgare* L.) on Acid Soils of High Lands in West Showa Zone of Ethiopia. *Int. J. Life Sci.* **2017**, 5(3), 311–322.
- [11] Žugec, I.; Stipešević, B.; Kelava, I. Rational Soil Tillage for Cereals (Winter Wheat – *Triticum aestivum* L. and Spring Barley – *Hordeum vulgare* L.) in Eastern Croatia. In *Proceedings of the 15th ISTRO Conference*; Fort Worth, USA, **2000** [CD-ROM].
- [12] Bernal, F. C. Growth and Yield Performance of Corn Applied with Various Sources of Organic Fertilizer Combined with Inorganic Fertilizer. Undergraduate Thesis, Visayas State University, Visca, Baybay City, Leyte, **2013**; 66 pp.
- [13] Ibañez, R.; Velza, J. F.; Gaylan, R.; Catimpuhan, J. M. Income and Expenditure Analysis of Selected Lowland Rainfed Rice Farmers in Tubog, Cawayan, Masbate. *ASEAN J. Sci. Tech. Rep.* **2024**, 27(2). <https://doi.org/10.55164/ajstr.v27i2.249926>
- [14] Sideman, E. *Maine Organic Farmers and Gardeners Association*; MOFGA Fact Sheet #1; United States of America, **2007**; pp 1–2.
- [15] Luces, H. Effects of Different Levels of Vermicompost on Black Rice (*Oryza sativa* L.) Cultivation. *ASEAN J. Sci. Tech. Rep.* **2025**, 28(5). <https://doi.org/10.55164/ajstr.v28i5.257803>
- [16] Reoma, V. I. Growth and Yield Response of Sweetpotato to Depth of Fertilizer Placement. Undergraduate Thesis, Visayas State College of Agriculture, Baybay, Leyte, **1986**; 41 pp.
- [17] Pandey, R.; Paul, V.; Das, M.; Meena, M.; Meena, R. C. Plant Growth Analysis. In *Manual of ICAR Sponsored Training Programme on “Physiological Techniques to Analyze the Impact of Climate Change on Crop Plants”*; Division of Plant Physiology, IARI: New Delhi, **2017**; pp 16–25.
- [18] Wang, Y.; Zhang, T.; Wang, R.; Zhao, Y. Recent Advances in Auxin Research in Rice and Their Implications for Crop Improvement. *J. Exp. Bot.* **2018**, 69, 255–263. <https://doi.org/10.1093/jxb/erx228>
- [19] Wang, Y.; Chen, Y. Non-Destructive Measurement of Three-Dimensional Plants Based on Point Cloud. *Plants* **2020**, 9, 571.
- [20] Adane, M.; Misganaw, A.; Alamnie, G. Effect of Combined Organic and Inorganic Fertilizer on Yield and Yield Components of Food Barley (*Hordeum vulgare* L.). *Food Sci. Qual. Manag.* **2020**, 95.
- [21] Roberts, T. L. Nutrient Best Management Practices: Western Perspectives on Global Nutrient Stewardship. In *19th World Congress of Soil Science, Soil Solutions for a Changing World*; Brisbane, Australia, **2010**; pp 172–175. <https://doi.org/10.3390/plants9050571>
- [22] Abedi, T.; Alemzadeh, A.; Kazemeini, S. A. Effect of Organic and Inorganic Fertilizers on Grain Yield and Protein Banding Pattern of Wheat. *Aust. J. Crop Sci.* **2010**, 4(6), 384–389.

- [23] Kaur, T.; Brar, B. S.; Dhillon, N. S. Soil Organic Matter Dynamics as Affected by Long-Term Use of Organic and Inorganic Fertilizers under Maize–Wheat Cropping System. *Nutr. Cycling Agroecosyst.* **2008**, *81*(1), 59–69. <https://doi.org/10.1007/s10705-007-9152-0>
- [24] Wollesenbet, M.; Tana, T.; Singh, T. N.; Teferi, M. Effect of Integrated Nutrient Management on Yield and Yield Components of Food Barley (*Hordeum vulgare* L.) in Kaffa Zone, Southwestern Ethiopia. *Sci. Technol. Arts Res. J.* **2014**, *3*(2), 34–42. <https://doi.org/10.4314/star.v3i2.5>
- [25] Dobrescu, A.; Giuffrida, M. V.; Tsiftaris, S. A. Leveraging Multiple Datasets for Deep Leaf Counting. In *2017 IEEE International Conference on Computer Vision Workshop (ICCVW)*; IEEE, **2017**; pp 2072–2079. <https://doi.org/10.1109/ICCVW.2017.243>
- [26] Farjon, G.; Itzhaky, Y.; Khoroshevsky, F.; Bar-Hillel, A. Leaf Counting: Fusing Network Components for Improved Accuracy. *Front. Plant Sci.* **2021**, *12*, 575751. <https://doi.org/10.3389/fpls.2021.575751>
- [27] Telfer, A.; Bollman, K.; Poethig, R. Phase Change and the Regulation of Trichome Distribution in *Arabidopsis thaliana*. *Development* **1997**, *124*, 645–654. <https://doi.org/10.1242/dev.124.3.645>
- [28] Walter, A.; Schurr, U. The Modular Character of Growth in *Nicotiana tabacum* Plants under Steady-State Nutrition. *J. Exp. Bot.* **1999**, *50*, 1169–1177. <https://doi.org/10.1093/jxb/50.336.1169>
- [29] Islam, M. T.; Akter, S. E. Tillering Dynamics, Grain Growth and Yield Performance of Four Rice Varieties. *Int. J. Sustainable Crop Prod.* **2021**, *16*(3).
- [30] Mohanan, K. V.; Mini, C. B. Relative Contribution of Rice Tillers of Different Status towards Yield. *Int. J. Plant Breed. Genet.* **2008**, *2*(1), 9–12. <https://doi.org/10.3923/ijpb.2008.9.12>
- [31] Pawar, S. Y.; Radhakrishnan, V. V.; Mohanan, K. V. The Importance of Optimum Tillering in Rice – An Overview. *South Indian J. Biol. Sci.* **2016**, *2*(1), 125–127. <https://doi.org/10.22205/sijbs/2016/v2/i1/100359>
- [32] Zhao, S.; Jang, S.; Lee, Y. K.; Kim, D. G.; Jin, Z.; Koh, H. J. Genetic Basis of Tiller Dynamics of Rice Revealed by Genome-Wide Association Studies. **2020**. <https://doi.org/10.21203/rs.3.rs-54023/v1>
- [33] Khush, G. S. New Plant Type of Rice for Increasing the Genetic Yield Potential. In *Rice Breeding and Genetics*; Nanda, J. S., Ed.; Science Publishers: New Hampshire, USA, **2000**; pp 1–99.
- [34] Arif, M.; Tasneem, M.; Bashir, F.; Yaseen, G.; Iqbal, R. M. Effect of Integrated Use of Organic Manures and Inorganic Fertilizers on Yield and Yield Components of Rice. *J. Agric. Res.* **2014**, *52*(2), 197–206.
- [35] Silguera, M. S. C.; Dollison, M. D. Performance of Hybrid and Inbred Rice Varieties under Vermicast Application. *ASEAN J. Sci. Tech. Rep.* **2024**, *27*(6). <https://doi.org/10.55164/ajstr.v27i6.253202>
- [36] Jeng, T. L.; Tseng, T. H.; Wang, C. S.; Chen, C. L.; Sung, J. M. Yield and Grain Uniformity in Contrasting Rice Genotypes Suitable for Different Growth Environments. *Field Crops Res.* **2006**, *99*, 59–66. <https://doi.org/10.1016/j.fcr.2006.03.005>
- [37] Wang, E.; Wang, J.; Zhu, X.; Hao, W.; Wang, L.; Li, Q. Control of Rice Grain-Filling and Yield by a Gene with a Potential Signature of Domestication. *Nat. Genet.* **2008**, *40*, 1370–1374. <https://doi.org/10.1038/ng.220>
- [38] Kumar, A.; Taparia, M.; Madapu, A.; Rajalakshmi, P.; Marathi, B.; Desai, U. B. Discrimination of Filled and Unfilled Grains of Rice Panicles Using Thermal and RGB Images. *J. Cereal Sci.* **2020**, *95*, 103037. <https://doi.org/10.1016/j.jcs.2020.103037>
- [39] Tadesse, K.; Asrat, M.; Admau, A. Malting Barley Response to Integrated Organic and Mineral Nutrient Sources in Nitisol. *Int. J. Recycl. Org. Waste Agric.* **2015**, *7*(2), 125–134. <https://doi.org/10.1007/s40093-018-0198-6>
- [40] Chen, K.; Łyskowski, A.; Jaremko, Ł.; Jaremko, M. Genetic and Molecular Factors Determining Grain Weight in Rice. *Front. Plant Sci.* **2021**, *12*, 605799. <https://doi.org/10.3389/fpls.2021.605799>
- [41] Panomjan, N.; Jandum, S.; Petkaew, W. Grain Quality Characteristics and Structure of Opaque and Translucent Endosperm in Sang Yod Rice Variety. *ASEAN J. Sci. Tech. Rep.* **2018**, *21*(3). <https://ph02.tci-thaijo.org/index.php/tsujournal/article/view/151753>
- [42] Khan, N. I.; Qazi, M. A.; Umar, F.; Nasir, M.; Muhammad, S.; Gul, R.; Naveed, M.; Nazir, S.; Bhatti, M. A.; Amin, F.; Khan, M. S. A.; Qammar, J.; Hameed, Z. Effect of Tillage and Fertilizer Application on Growth of Conventional and Hybrid Maize. *Pak. J. Sci.* **2021**, *73*(2). <https://doi.org/10.57041/pjs.v73i2.669>

-
- [43] Scarpore, F. B.; Van Lier, Q. J.; De Camargo, L.; Pires, R. C. M.; Ruiz-Corrêa, S. T.; Bezerra, A. H. F.; Gava, G. J. C.; Dias, C. T. S. Tillage Effects on Soil Physical Condition and Root Growth Associated with Sugarcane Water Availability. *Soil Tillage Res.* **2019**, 187, 110–118. <https://doi.org/10.1016/j.still.2018.12.005>