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Comparative analysis on the use of good agricultural practices (GAP) and conventional farming in rice production

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Abstract

The study was conducted to compare and analyze the effects of good agricultural practices and conventional farming strategies on the growth, yield, and economic returns of rice (*Oryza sativa*). Using the Randomized Complete Block Design (RCBD), three treatments were evaluated: Treatment 1 – Farmers' Practice (FP), Treatment 2 – Bureau of Soils and Water Management Recommendation (BSWM), and Treatment 3 – Good Agricultural Practices (GAP). The results revealed no significant differences in most agronomic traits, such as plant height, panicle length, and the number of days to 50% flowering. However, significant differences were observed in productive tillers, the number of filled grains, and yield. Treatment 2 (BSWM) recorded the highest yield (5.04 tons/ha), followed closely by Treatment 3 (GAP) at 4.74 tons/ha. The economic analysis showed that GAP had the highest return on investment (ROI) of 60.49%, indicating its cost-effectiveness compared to the other treatments. The study concludes that both BSWM and GAP are effective in increasing yield and income, with GAP being recommended for its ability to reduce production costs without significant yield loss.

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Introduction

Rice is a staple food for more than half of the world's population, making its production a critical topic in agricultural research and development. With the growing demand for rice due to increasing population and urbanization, improving rice yields while ensuring sustainability has become paramount. This comparative analysis focuses on two distinct approaches to rice cultivation: traditional farmer practices and Good Agricultural Practices (GAP). Agriculture is a cornerstone of human civilization, providing food, fiber, and resources essential for survival and economic development. The methods employed in agricultural practices can significantly influence environmental sustainability, crop yield, and soil health. Good Agricultural Practices (GAP) and conventional farming represent two distinct approaches to agriculture, each with its own set of principles and outcomes.

Good Agricultural Practices encompass a range of techniques aimed at enhancing productivity while minimizing environmental impact. These practices include crop rotation, integrated pest management, and soil conservation methods, which collectively contribute to sustainable farming systems (FAO, 2018). By focusing on the health of the ecosystem, GAP promotes biodiversity and reduces reliance on chemical inputs, thereby fostering resilience against climate change and pest outbreaks (Pretty, 2008).

In contrast, conventional farming typically emphasizes high-input agricultural systems that rely on synthetic fertilizers, pesticides, and monoculture cropping. While this approach can lead to increased short-term yields, it often results in soil degradation, loss of biodiversity, and increased vulnerability to pests and diseases (Tilman *et al.*, 2002). The reliance on chemical inputs can also pose risks to human health and the environment, raising concerns about the long-term sustainability of conventional practices (Pimentel *et al.*, 2005).

As the global population continues to grow, the challenge of feeding billions while ensuring environmental sustainability becomes increasingly critical. This paper will explore the differences between Good Agricultural Practices and conventional farming, examining their respective impacts on agricultural productivity, environmental health, and food security. Ultimately, the goal is to contribute to the ongoing conversations around agricultural development and food security, emphasizing the importance of understanding and improving rice production methods worldwide.

Materials and methods

Procurement of Planting Materials

The seeds of NSIC Rc 222 were bought in an accredited farm supply in Tuguegarao City Two (2) weeks prior to the conduct of the experiment.

Soil Sampling

Soil samples were collected in every treatment in the field with 1 kg soil sample per hole. The soil samples were mixed, air dried and 1 kg refined soil sample was taken and submitted to the Cagayan Valley Integrated Agricultural Laboratory (CVIAL) at Tuguegarao City for nutrient analysis.

Land Preparation

The experimental area was thoroughly prepared using the conventional system of land preparation i.e., 2 times plowing at one (1) week intervals to give ample time for the weeds and weed seeds to decompose. A 5-cm depth of water was maintained to avoid loss of nitrogen from the decomposed weeds and rice stubbles and to prevent the growth of weeds.

Experimental Design and Layout

An area of 17 meters x 14 meters as experimental plots was laid out using the Randomized Complete Block Design (RCBD). Each block was further subdivided into 3 plots with a dimension of 5m x 4m and the distance between blocks was 1m as alleyways to test the following treatments.

T1 - Farmers Practice

T2 - Bureau of Soils Recommendation (Control)

T3 – Good Agricultural Practices

Seedbed preparation

Three slightly elevated beds measuring 1.5 meters wide with a 40 cm alleyway in between beds were constructed before seed sowing.

Seed Soaking and Pre-germination of Seeds

Seeds were washed and then soaked in clean water for 24 hours. After 24 hours, seeds were taken from the container and rinsed with clean water. Water was allowed to drain from the seeds for 30 minutes.

Incubation

Soaked seeds were placed in a loosely tied sack enough to give room for seed expansion. The sack was laid in a shaded area over a pallet and was covered with rice straw. Seeds were incubated for 20-24 hours or until the radicle or whitish roots became visible. Seeds were sprinkled with water as the seed arose. Sacks were turned every 6 hours to attain uniform germination of seeds.

Seed Sowing & Care of Seedlings

Seeds were sown evenly at the rate of 50 grams or one handful per square meter seedbed. Seedbeds were irrigated 3-5 days after sowing. A water level of 2-3 cm was maintained and was increased gradually to 5 cm up to pulling. A complete fertilizer was applied 7-10 days after sowing at a rate of 1 kilogram per plot.

Transplanting and Replanting

Seedlings were transplanted 18 days after seed sowing. One seedling per hill was transplanted following the straight-row planting. Plants were spaced 20cm in between rows and 25 in between hills. Missing hills were replanted 7 days after transplanting to ensure 100% crop stand.

Water management

The field was irrigated to a depth of 2-3 cm until 20 DAT. Water was gradually increased to 5 cm as the crops grew. Intermittent irrigation was practiced until the panicle initiation stage. Water depth of up to 3-5 cm was maintained during panicle initiation up to the soft dough stage. The experimental field was drained a few days before harvesting.

Fertilizer Application

The amount, kind, and timing of application were based on the schedule of specific treatments.

T1 – Farmers Practice

1st Topdress – Apply 4 bags/ha14-14-14 and 2 bags 46-0-0 at 10 DAT

2nd Topdress – Apply 2 bags 16-20-0, and 1 bag 46-0-0 at 25 DAT

3rd Topdress – apply 1 bag 46-0-0 at 40 DAT

T2 – Bureau of Soils Recommendation

During land preparation - Incorporate 20 bags/ha organic fertilizer into the soil.

Basal Application - Apply 3.0 bags/ha 14-14-14, 0.5 bag/ha 46-0-0

0.3 bag/ha 0-0-60

1st Topdress – Apply 1.0 bag/ha 21-0-0, 7 DAT

2nd Topdress – Apply 2.0 bags/ha 46,0,0, 25 DAT

3rd Topdress – Apply 0.5 bag/ha, 46-0-0, 35 DAT

T3 – Good Agricultural Practices

Basal Application – Apply 40 bags/ha organic fertilizer and 1 bag/ha 14-14-14

1st Topdress – Apply 1 bag 16-20-0 and 1 bag 21-0-0 at 7 DAT

2nd Topdress – Apply 2 bags 46-0-0, 25 DAT

Weeding

Hand weeding was done as the need arose to minimize crop-weed competition for nutrients, water, and light.

Pest and Disease Management

Insect pests and diseases were controlled as soon as they were observed attacking and infecting the plants by spraying Lanate and Solomon following the dosage prescribed on the label.

Harvesting

Harvesting was done when 90% of the grains had turned yellow. The designated harvest area of one (1) square meter per plot was used in gathering the growth and yield parameters. The weight of harvest in the said area was also included in the total harvest per plot, excluding plants at the border rows and 0.5-meter edge of the inner rows.

Statistical Tool

The Analysis of Variance (ANOVA) and Tukey's Honest Significance Difference test at 5% and 1% were used to determine the significance of the different treatments tested.

Data gathered

1. *Plant height at maturity (cm).* This was determined by measuring the height from the base up to the tip of the flag leaf of rice. The total height was divided by 10 to get the mean.
2. *Number of days to flower.* This data was observed by counting the number of days of plant transplanting up to 5 0% of the plant population per plot will bear flower.
3. *Number of productive and unproductive tillers.* The number of tillers that bore grains/hill and did not bear grains in every treatment was counted using the 10 representative samples.
4. *Panicle length (cm).* The length of the panicle was measured from the base up to the tip of the panicle of rice in the representative samples.
5. *Number of Filled Grains.* The number of filled grains per panicle per treatment was counted.
6. *Number of Unfilled Grains.* The number of unfilled grains per panicle per treatment was counted.
7. *Weight of 1000 seeds.* The weight of 1000 grains was weighed from the replication sample using manual counting.
8. *Computed yield (tons ha-1).* The formula below was used in the determination and projection of yield per hectare of this data.

$$\text{Computed yield (tons ha}^{-1}) = \frac{\text{Weight of grains (kg)}}{\text{Area (m}^2) \times 10{,}000\ \text{m}^2/\text{ha}}$$

The quotient was divided by 1000 kg to convert the yield to tons/ha

9. *Cost and Return Analysis.* The profitability analysis was computed by subtracting all the cost of production from the gross sales and net income per hectare was computed. The ROI was computed by dividing the net income to the total cost.

Results and discussion

Height at Maturity (cm)

Crops under T3 have registered the tallest with a mean of 108.32 cm, closely followed by T2 and T1 with a mean of 108.57 and 110.67 cm, respectively. Despite numerical variations, analysis of variance revealed no significant difference among the treatments in terms of maturity of the rice crop.

Number of Days to 50% Flowering

Results show that all treatments produced flowers almost at the same number of days after germination. This is consistent with the reported characteristics of NSIC Rc222 which bear flowers from 50-60 days after transplanting this is based on data retrieved from the knowledge bank of the Philippine Rice Research Institute (PhilRice).

Panicle Length (cm)

Results revealed that the longest panicle was produced by plants in T2, followed by T3, and T1, with corresponding means of 23.62 cm, 22.71 cm, and 22.22 cm, respectively. However, despite the numerical variations, no significant difference was observed between treatments.

Number of Productive Tillers (cm)

Data shows that the average number of productive tillers per plant ranged from 10-12 regardless of treatments, with a significant difference observed.

This implies that NSIC 222 manifested that did not show a similar trend of response on the nutrient management practices tested.

According to Allah *et al.*, (2010), highly tillered plants tend to have a short root system and hence a negative relationship with drought resistance. Low tillering capacity appears to be one desirable characteristic when rice plants must depend on soil moisture retained in the deep soil layers during drought stress.

Nayak *et al.* (2007) reported a significant increase in effective tillers per hill due to the application of chemical fertilizer with organic fertilizer.

Table 1. Agronomic and yield response on the comparative analysis of different nutrient management in rice production.

Treatment	Height at Maturity (cm)	Number of Days to 50% Flowering	Panicle Length (cm)	Number of Productive Tillers	Number of Filled Grains	Number of Unfilled Grains	Weight of 1000 grains (g)	Computed Yield (tons/ha)
T1 – FP	110.67	53.0	22.22	9.5	120.3	25.67	23.51	4.17
T2 - BSWM	108.57	52.67	23.62	11.83	127.37	25.5	23.21	5.04
T3 – GAP	108.32	53.67	22.71	10.43	126.4	21.7	23.07	4.74
RESULT	ns	ns	ns	*	*	Ns	ns	**
CV (%)	2.26	1.66	3.14	7.05	1.26	6.76	7.00	3.71

Note: ns – not significant

* - significant

** - highly significant.

Number of Filled Grains

Table 1 shows that T2 had the greatest number of filled grains with a mean of 127.37, closely followed by T3 with a mean of 126.4. The least number of filled grains per panicle was obtained in T1 with a mean of 120.3. Statistical analysis reveals significant differences among the treatments tested.

It can be inferred that NSIC Rc222 failed to produce its normal size of grain (the seed density of plants applied with recommended fertilizer is presumed to be normal) when not given the required nutrients.

Number of Unfilled Grains

Results revealed that the highest number of unfilled grains was registered by T1 with a mean of 25.67. The least number of unfilled grains per panicle was obtained in T3 with 21.7. Despite numerical differences, analysis of variance shows no significant difference was noted among the three treatments tested.

Weight of 1000 grains (g)

Data showed very slight differences among seeds obtained from plots regardless of water management, with mean weights ranging from 23.07 to 23.51 grams.

Computed Yield (tons/ha)

As shown in Table 1, the test crop under T2 obtained the highest yield with 5.04 tons/ha closely followed by T3 and T1 with a yield of 4.74 and 4.17 tons/ha. Statistical analysis reveals highly significant differences among the treatments tested. On comparison among means, When T2 and T3 are compared with each other there is no significant difference observed but when compared to T1 there is a significant difference. This implies that nutrient management strategies applied for rice production affect the yield of a rice crop. Thakur *et al.* (1997) observed that the application of fertilizer at an optimum rate increased the number of effective tillers/hill and filled grain panicles resulting in a higher grain yield of rice than control.

Tillering in rice is one of the most important agronomic characteristics for grain production (Smith and Dilday, 2003) because the tiller number per plant determines the panicle number, a key component of grain yield (Yan *et al.*, 1998). Miller *et al.* (1991) reported that tillering is a major determinant of production in rice. According to Gallagher and Biscoe (1978), tillering ability affects total yield in rice.

Satyanarayana *et al.* (2002) found a significant increase in rice grain yield due to the application of NPK fertilizer. The combined application of different doses of organic and inorganic fertilizer had a significant effect on the grain yield of rice. Ali *et al.* (2012) also claimed increased yields of rice with the use of organic or in combination with chemical fertilizers. Table 2 also shows the comparative analysis of economic returns of rice production under different nutrient management practices.

Table 2. Cost and Return Analysis of rice production under different nutrient management practices.

Particulars	T 1	T 2	T 3
A. Inputs			
Seeds	1800	1800	1800
Organic (Vermicast)		5000	10,000
Inorganic			
14-14-14	5800	4350	1450
16-20-0	2500		1250
21-0-0		950	950
46-0-0	6000	4500	3000
0-0-60		1700	
Labor			
Plowing	2400	2400	2400
Puddling	2400	2400	2400
Uprooting and Planting	7000	7000	7000
Organic (Vermi)		800	1200
Inorganic Application	2400	4000	2400
Weeding	1600	1600	1600
Irrigation	4000	4000	4000
Pest and Disease	2400	1200	1200
Harvesting	6000	6000	6000
Total Inputs	42500	37450	32700
B. Miscellaneous			
Food	3600	3600	3600
Incidental Allowance	6375	5617.5	4905
Total Miscellaneous	9975	9217.5	8505
C. Total Cost of Prod	52475	46667.5	41205
Estimated Yield	4170	5040	4740
D. Sales (@22.00/kilo	91740	110880	104280
E. Net Income	39265	64212.5	63075
F. ROI	42.80	57.91	60.49

Based on the result, rice crops applied with different technologies T2 (Bureau of Soils Recommendation) recorded the highest net income of P64212.5, followed by T3 (Good Agricultural Practices) with a net income of P63075 and the least was obtained in T1 (Farmers Practice) with P39265. In terms of return on investment, T3 obtained the highest with 60.49%, followed by T2 and T1 with 57.91% and 42.80% in the same order. The high cost incurred in farmers' practice and bureau of soils recommendation is due to the heavy use of inorganic fertilizers, pesticides, and labor costs compared to GAP farming technology.

Conclusion

Based on the findings, both the Bureau of Soils and Water Management (BSWM) recommendations and Good Agricultural Practices (GAP) are effective nutrient management strategies for improving rice yield and profitability compared to traditional farmers' practices (FP). While BSWM achieved the highest yield (5.04 tons/ha), GAP demonstrated the highest return on investment (60.49%) by reducing production costs without significant yield reduction (4.74 tons/ha). This makes GAP a cost-effective and sustainable option for smallholder farmers. It is recommended that farmers adopt GAP to optimize resource use, enhance economic returns, and promote environmentally sustainable rice production practices. Future research should focus on scaling up GAP adoption and assessing its long-term impacts on soil health and productivity.

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