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# SUSTAINABLE AND CHEMICAL-FREE CULTIVATION OF PAW SAN RICE VARIETIES IN YEKYI TOWNSHIP, AYEYARWADY REGION AT MYANMAR

***Phyu Pya Lwin[1], Kyi Khaing Soe[2] and Thein Htut[3]***

[1]Ph.D. (Soil and Water Science), Regional Research center (Myaungmya), Ayeyarwady Region, Department of Agricultural Research (DAR)
[2,3] Nwar Ye Taik village (Farmer Based Research Station) Yekyi Township

## Abstract

The Ayeyarwady Region of Myanmar, known as the nation's "rice bowl," has historically been famous for Paw San rice varieties, valued for aroma and grain quality. Increasing use of chemical fertilizers and pesticides has raised concerns over soil degradation, environmental health, and consumer safety. Farmer-participatory research was conducted from 2022 to 2024 in Yekyi Township to evaluate the performance of Paw San rice varieties under chemical-free cultivation using natural fertilizers and biocontrol measures. Six varieties were tested, and detailed yield, soil, and grain quality assessments were conducted. Results showed that Phyar Pon Paw San Yin, Ayeyarwady Paw San Gyi, and Phyar Pon Paw San Gyi consistently produced the highest yields (up to 127 baskets per acre). Chemical-free rice demonstrated superior consumer quality traits, including stronger aroma and softer texture. Market trials confirmed high consumer acceptance, leading to expanded cultivation up to 200 acres in 2023. This research highlights the potential of integrating traditional rice varieties with organic inputs to enhance soil fertility, preserve cultural heritage, and capture niche markets for high-value rice.

| CORRESPONDING AUTHOR: | RESEARCH ARTICLE |
|---|---|
| **Phyu Pya Lwin**<br>Ph.D. (Soil and Water Science), Regional Research center (Myaungmya),<br>Ayeyarwady Region, Department of Agricultural Research (DAR), Myanmar<br>Email: phyupyalwin@gmail.com | |

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## 1. Introduction

Rice (*Oryza sativa* L.) is one of the most important cereal crops worldwide, feeding more than half of the global population and serving as a staple food for billions, particularly in Asia (FAO, 2021). In Myanmar, rice is the major staple food and the foundation of rural livelihoods, contributing to household income and national food security (MOALI, 2020). Approximately 70% of the population resides in rural areas, where rice cultivation plays a dominant role. The Ayeyarwady Region, Myanmar's "rice bowl," is renowned for its fertile deltaic soils and traditional Paw San rice varieties, valued for aroma, grain quality, and cooking properties (Myint & Napasintuwong, 2016). Despite these advantages, rice production faces challenges from over-reliance on chemical fertilizers and pesticides, which lead to soil degradation, nutrient imbalance, and environmental pollution (Dobermann & Fairhurst, 2000; Linquist et al., 2015). Additionally, consumer demand for chemical-free and safe foods is rising both domestically and internationally (Pretty et al., 2018; Sombilla et al., 2018). Sustainable cultivation practices using organic fertilizers, green manure, and biocontrol agents have been reported to maintain yields while improving soil health in Southeast Asia (Chakraborty et al., 2010; Hossain et al., 2015). Aromatic rice grown under organic systems can also fetch higher market prices, offering farmers economic benefits (Suwannarat, 2019). Recognizing this potential, the Department of Agricultural Research (DAR) and the Ayeyarwady Regional Government initiated farmer-participatory trials from 2022 to 2024 to evaluate chemical-free Paw San rice cultivation. This study aimed to: 1) Identify Paw San varieties most suitable for chemical-free cultivation in Yekyi Township; 2) Assess the effects of natural fertilizers and biocontrol agents on yield and soil fertility; 3) Explore consumer and market responses to chemical-free Paw San rice.

## 2. Materials and Methods

### 2.1 Study Site

Research was conducted in Nwar Ye Taik village (Farmer Based Research Station) Yekyi Township, Ayeyarwady Region, during the monsoon seasons of 2022, 2023, and 2024. Trials were implemented on the farm of local farmer field, in collaboration with the Farmer-Based Research Station.

### 2.2 Varieties Tested

Six Paw San-related varieties were included: 1. Myaungmya Paw San Yin 2. Phyar Pon Paw San Yin 3. Shwe War Yin 4. Phyar Pon Paw San Gyi 5. Ayeyarwady Paw San Gyi 6. Shwebo Paw San Yin.

### 2.3 Fertilizer and Biocontrol Treatments

Dried cow dung 65 kg + rice bran 17 kg + humic fertilizer 2–3 kg per acre were applied at panicle initiation and at 50 % flowering stage. Bio-pesticide was applied at early pest infestation. Trichoderma-based biofungicide was applied at the rate of 5 packs/acre to control sheath blight.

### 2.4 Experimental Design

The experiment was conducted using a randomized complete block design (RCBD) with three replications, and each plot measured 4 × 4 meters. The study was carried out over three consecutive monsoon seasons, spanning the years 2022, 2023, and 2024. Data were collected on various growth and yield parameters, including days to flowering, number of tillers per hill, filled grains per panicle, percentage of filled grains, 1000-grain weight, and overall yield expressed in baskets per acre. These measurements allowed for a comprehensive evaluation of crop performance across different years under consistent experimental conditions.

### 2.5 Quality and Market Testing

Chemical-free of Ayeyarwady Paw San Gyi (No. 1) and chemical applied Ayeyarwady Paw San Gyi (No.2) rice samples were sent to the Department of Biotechnology Laboratory, Ministry of Science and Technology for chemical and sensory analysis. Grain aroma, texture, and stickiness were evaluated. Packaged 3-kg bags were also marketed at MSME exhibitions for consumer testing.

## 3. Results

### 3.1 Varietal Yield Performance in Research Plots

The performance of six Paw San rice varieties varied across three years (Figure 1). In 2022, Phyar Pon Paw San Yin produced the highest yield (127 baskets/acre), followed by Ayeyarwady Paw San Gyi and Phyar Pon Paw San Gyi. Myaungmya Paw San Yin and Shwebo Paw San Yin showed moderate yields, while Shwe War Yin was the lowest. In 2023, Ayeyarwady Paw San Gyi outperformed others (118 baskets/acre), indicating strong adaptability. In 2024, Phyar Pon Paw San

Gyi achieved the highest yield (117 baskets/acre), showing certain varieties maintain competitive performance over multiple years (Table 1).

### 3.2 Performance under Expanded Farmer

Managed Cultivation Pilot-scale trials confirmed chemical-free cultivation potential. In 2022, 30 acres of Ayeyarwady Paw San Gyi yielded an average of 100 baskets/acre. Expansion to 66 acres in 2023 increased yield to 103 baskets/acre. By 2024, cultivation expanded to 200 acres, with average yield of 91.7–95 baskets/acre. Slight reductions likely reflected greater variability in farmer practices, soil heterogeneity, and climatic influences.

### 3.3 Soil analysis under Chemical-Free Practices

The status of soil nutrients was analyzed at initial and after harvest of the third season. The initial soil was slightly acid condition having soil pH at 6.3. The amount of organic matter, available nitrogen, phosphorus and potassium were low levels. Soil organic matter was very low level in this soil. According to the soil analysis results after harvest of third season, the pH status of chemical free soil remained as the initial status. The level of available nitrogen was found to be medium. Organic matter value changed from very low to low level. Available phosphorus and potassium remained as the initial status. This indicates that natural fertilizers and humic amendments improved soil health while maintaining rice productivity (Table 1).

**Table 1. Before and after soil analysis of chemical free of Ayeyarwady Paw San Gyi rice**

| Soil sample | pH | | Available N | | Available P | | Available K | | Organic matter | |
|---|---|---|---|---|---|---|---|---|---|---|
| | reaction | rating | mg/kg | rating | mg/kg | rating | mg/kg | rating | % | rating |
| Before | 6.3 | Slightly acid | 54 | Low | 2 | Low | 31 | Low | 0.47 | Very Low |
| After | 6.2 | Slightly acid | 61 | Medium | 9 | Low | 56 | Low | 1.9 | Low |

### 3.4 Grain Quality and Sensory Attributes

Chemical-free Paw San rice exhibited stronger aroma, softer texture, and slightly stickier quality, highly preferred by consumers. Chemical applied Paw San rice was less aromatic and less appealing in texture. Laboratory testing confirmed these observations, highlighting the advantages of chemical-free production. (Table. 2)

**Table 2. Grain Quality and Sensory test of chemical free of Ayeyarwady Paw San Gyi rice**

| Sample Name | Aroma | | Softness | Stickiness |
|---|---|---|---|---|
| | Cooked Rice Test | Grain Aroma Test with KOH (1.7%) | | |
| Ayeyarwady Paw San Gyi (1) | Light | Light | Hard | Separable |
| Ayeyarwady Paw San Gyi (2) | Light | Strong | Little Soft | Low Sticky |

### 3.5 Market Acceptance and Recognition

Packaged chemical-free Paw San rice sold successfully at MSME exhibitions. Consumers cited aroma, texture, and chemical safety as key preferences. In March 2025, Yekyi Township's chemical-free Paw San rice won first prize at the National Paw San Forum Competition, judged anonymously based on grain appearance, cooking quality, and adherence to natural cultivation practices (Figure 1).

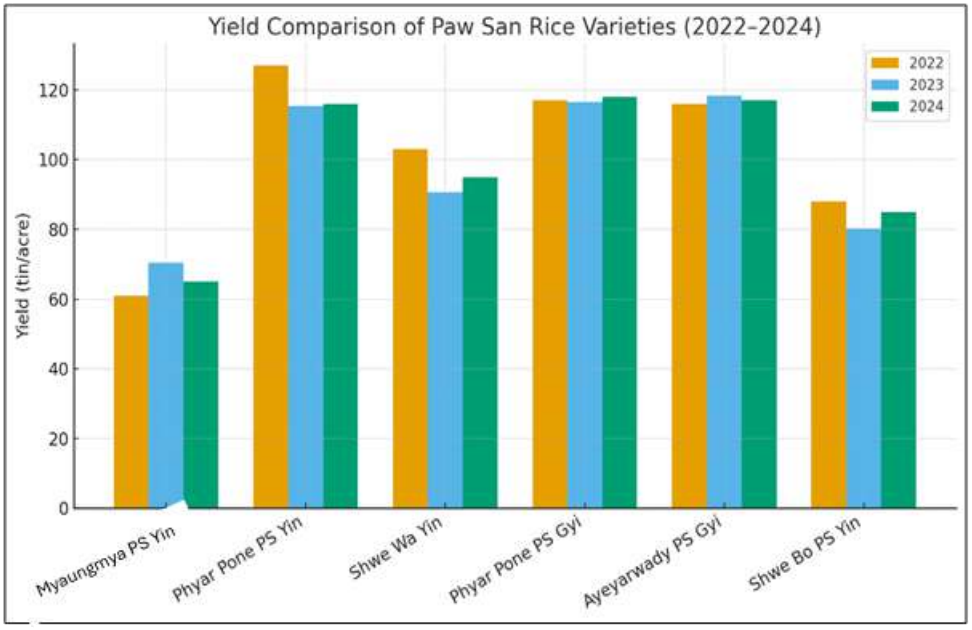


Figure 1. Yield performance of different Paw San Rice varieties across 2022–2024 Season

Table 1. **Three-Year Average Comparison of Paw San Rice Varieties (2022–2024)**

| No. | Variety Name | 50% Flowering Days | Tillers per hill | Total grains | Fertile grain % | 1000-Grain weight (g) | Yield (tin/acre) |
|---|---|---|---|---|---|---|---|
| 1 | Myaungmya Paw San Yin | 115 | 9.7 | 94.0 | 70.2 | 28.1 | 65.5 |
| 2 | Phyar Pon Paw San Yin | 114.7 | 14.0 | 141.3 | 93.8 | 28.9 | 119.5 |
| 3 | Shwe War Yin | 110.3 | 10.3 | 115.0 | 89.6 | 29.4 | 96.2 |
| 4 | Phyar Pon Paw San Gyi | 119.7 | 14.7 | 135.3 | 92.9 | 28.8 | 117.8 |
| 5 | Ayeyarwady Paw San Gyi | 131.0 | 14.0 | 135.0 | 92.3 | 28.8 | 117.8 |
| 6 | Shwe Bo Paw San Yin | 95.3 | 10.7 | 107.3 | 83.6 | 29.1 | 84.4 |
| F-test | | ** | ** | ** | ** | ** | ** |
| LSD0.05 | | 1.0 | 1.2 | 1.0 | 0.5 | 1.3 | 1.2 |
| CV (%) | | 3.6 | 4.0 | 0.7 | 0.6 | 0.8 | 1.0 |

## 4.Discussion

The results of this study demonstrate that chemical-free of Paw San rice is both feasible and beneficial in the Ayeyarwady Region. Across three consecutive monsoon seasons, Phyar Pon Paw San Yin, Ayeyarwady Paw San Gyi, and Phyar Pon Paw San Gyi consistently produced the highest yields, confirming their strong adaptability to local soil conditions, climate, and water management practices (Hossain et al., 2015; Chakraborty et al., 2010). Minor fluctuations in yield across years were associated with natural variations in rainfall, soil moisture, and nutrient availability, which are typical in monsoon-driven rice agroecosystems. Expansion to larger farmer-managed plots resulted in slight reductions in yield compared to controlled research plots, reflecting heterogeneity in field management and soil microenvironments (Linquist et al., 2015). Nevertheless, the yields achieved

remained economically viable, supporting the practical adoption of chemical-free systems by local farmers.

Soil analyses indicated that the use of natural fertilizers and humic amendments enhanced soil fertility, increasing the availability of essential nutrients and improving soil organic matter content (Pretty et al., 2018; Dobermann & Fairhurst, 2000). These improvements likely contributed to enhanced panicle development, higher 1000-grain weight, and superior grain aroma. Grain quality assessments confirmed that chemical-free Paw San rice exhibited better aroma, texture, and consumer-preferred characteristics compared to conventionally grown rice. Market trials and recognition at competitions further demonstrated commercial potential and consumer acceptance of chemical-free rice, indicating that such practices can provide premium market value and additional income for farmers (Suwannarat, 2019; Sombilla et al., 2018).

Overall, these findings suggest that integrating traditional Paw San rice varieties with chemical-free cultivation can achieve multiple objectives: sustaining yields, improving soil health, preserving local biodiversity, and enhancing rural livelihoods. This approach exemplifies a practical, environmentally responsible, and economically viable model for sustainable rice production in the Ayeyarwady delta and similar agroecosystems.

## Conclusion

Chemical-free cultivation of Paw San rice in Yekyi Township is a sustainable and viable agricultural practice. Key findings of this study include

1. Varietal performance: Phyar Pon Paw San Yin, Ayeyarwady Paw San Gyi, and Phyar Pon Paw San Gyi consistently exhibited the highest yields and adaptability across multiple seasons.
2. Soil health improvement: Application of natural fertilizers and humic amendments enhanced nutrient availability and soil fertility, supporting long-term productivity.
3. Grain quality: Chemical-free Paw San rice demonstrated superior aroma, texture, and overall consumer acceptability.
4. Market potential: Consumers strongly preferred chemical-free rice, and recognition at competitions demonstrated readiness for commercialization.

The study confirms that traditional Paw San varieties, when cultivated using chemical-free practices, can support sustainable agriculture, protect environmental and human health, and provide economic incentives for farmers. Scaling up these practices with technical support, farmer training, and market linkages is recommended to maximize benefits in the Ayeyarwady delta and other regions with similar agroecological conditions.

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**AI** Data references provided by AI were used to support the preparation and analysis of this study.

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