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ASSESSMENT OF SYSTEMS OF RICE INTENSIFICATION (SRI) PRINCIPLES ON ROK-34 GROWTH AND YIELD UNDER RAINFED CONDITIONS IN MOYAMBA DISTRICT, SIERRA LEONE

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ABSTRACT

Climate variability, declining soil fertility, and diminishing effectiveness of conventional agronomic practices increasingly constrain rice (*Oryza sativa* L.) production in Sierra Leone. The System of Rice Intensification (SRI) is an alternative that is resource-efficient, but empirical evidence on its performance with locally important varieties is lacking. This study assessed ROK 34 growth and yield responses to SRI components, soil amendment, plant spacing, and planting method under rainfed circumstances in Moyamba District, Sierra Leone, during the June-November 2024 growing season. The experiment used a randomized complete block design with four blocks. The treatments consisted of two soil amendments (rice straw compost at 12.5 t ha⁻¹ and no compost), two spacing regimes (15 cm x 15 cm and 25 cm x 25 cm), and three planting methods (direct seeding, 12-day seedlings, and 30-day seedlings). Data were analyzed by Analysis of Variance (ANOVA), correlation analysis, and principal component analysis. The independent and additive effects of compost application, wider spacing (25 cm), and younger seedlings (12 days) on grain yield were observed. In comparison to the average farmer output of 1.5 t ha⁻¹, the optimal combination of amended soil, 25 cm spacing, and 12-day seedlings produced 2.91 t ha⁻¹, representing a 94% increase. ANOVA results showed that grain yield was significantly influenced by soil amendment ($\beta^* = -0.243$, $p < 0.001$), plant spacing ($\beta^* = -0.277$, $p < 0.001$), and planting method ($\beta^* = -0.196$, $p = 0.018$). There was no discernible interactive effect among treatments. Additionally, plant height ($\beta^* = -0.190$, $p = 0.011$) and leaf count ($\beta^* = -0.237$, $p = 0.002$) were significantly affected by the planting method. Also, correlation analysis revealed an association between grain yield and number of grains ($r = 0.99$, $p < 0.001$), effective panicles ($r = 0.92$, $p < 0.001$) and 1000-grain weight ($r = 0.29$). Principal component (PC) analysis explained 83.1% of the total variance. PC1 (54.8%) was dominated by grain yield, number of grains, and effective panicles, and PC2 (28.3%) was dominated by thousand-grain weight. These results prove that the SRI practices can improve the productivity of ROK 34 rice under rainfed conditions. Extension workers should therefore encourage smallholder farmers to gradually shift to soil amendments, increase plant spacing, and transplant younger seedlings to attain better yield stability of ROK 34.

Key words: Soil amendment, planting method, local farmers, resources-constrained, rice production

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INTRODUCTION

Over half of the world's population depends primarily on rice (*Oryza sativa* L.) for food and livelihood security [1]. For most rural households in Sierra Leone, rice is both an essential food supply and a vital source of income. However, due to the unpredictability of climate change, diminishing soil fertility, and inefficient conventional methods, productivity is still well below its potential. Production risks have increased due to variable precipitation patterns, frequent flooding, and prolonged droughts, underscoring the urgent need for alternative production systems that improve resilience, productivity, and resource efficiency. To overcome the limitations of traditional rice agriculture, which is characterized by frequent flooding, dense planting, and a heavy reliance on chemical inputs, several alternative strategies have been developed. Conventional farming practices result in soil fertility loss, excessive water consumption, methane emissions, and environmental degradation [2, 3].

Aerobic rice systems: This method involves growing crops in soils intended for dryland cultivation that are neither flooded nor puddled. Because of increased weed competition, nutritional deficits, and soil-borne diseases, aerobic systems reduce water usage by 30 to 50% while increasing yield by 20 to 40% less than flooded rice [2, 3].

Rice conservation agriculture (CA) for rice: This system encompasses crop diversification, constant soil cover, and minimal land disturbance. The results of conservation agriculture (CA) in rice systems have been uneven, and because soil structure and organic matter change gradually, yield increases often take several seasons to materialize.

The System of Rice Intensification (SRI): Young seedlings, widely spaced, sporadic irrigation, and organic soil supplementation are all part of this system's set of rules that can be tailored to local conditions [4]. Global meta-analyses have shown that SRI can increase water productivity, reduce irrigation water use by 25 to 50 percent, and increase yields by an average of 20 to 50 percent above traditional management [5, 6]. The SRI has the potential to reduce water use by 20 to 40% while increasing production by 30 to 60% in the African setting [7]. The fundamental mechanisms of SRI performance are fundamentally different from those of other alternative systems.

Aerobic rice only focuses on saving water (at the cost of a reduction in yield), and conservation agriculture focuses on soil conservation (which necessitates deploying its methods over multiple seasons); in contrast, SRI addresses the development of roots, soil biological health, and plant canopy structure [8, 9]. This study evaluates SRI practices (soil amendment, wider spacing, and younger seedlings) that are

consistent with climate-smart outcomes, as reported, which include improved resource use. However, direct measurement of key climate-related variables (such as greenhouse gas fluxes, water productivity, and soil carbon dynamics) is beyond the scope of our investigation. Thus, the use of the term “climate-smart” in this work is based on established mechanistic concepts and existing literature and not on direct observations from this study. SRI research in Sierra Leone is still limited in practice, especially in the Moyamba district, despite considerable evidence internationally. Limited published studies have examined SRI principles for improved rice cultivars like ROK 34, which is mostly preferred by farmers for its adaptability and grain quality. Given the specific concerns of rainfall variability and water scarcity in Moyamba District, there is a need to investigate the yield potential of ROK 34 under SRI principles and encourage farmers to practice this set of principles in their production system. Unlike prior SRI studies that have considered SRI as a set “package,” our study was aimed at analyzing the independent and additive impacts of each SRI component (soil amendment, plant spacing, and planting method). This approach allows us to discover which components will significantly contribute to yield gains and also whether partial adoption, especially for resource-constrained farmers, can deliver considerable benefits. The purpose of this study was to:

- (i) assess the growth and yield responses of ROK 34 rice to individual and combined SRI components (soil amendment, plant spacing, and planting method) under rain-fed conditions in Moyamba District, Sierra Leone;
- (ii) determine the relative contribution of each SRI component to ROK 34 rice yield;
- (iii) identify optimal treatment combinations for this variety and environment to guide extension services.

The results provided one of the first empirical bases and proof of concept for scaling SRI as a resource-efficient strategy for rice production in Sierra Leone and similar agro-ecological situations.

MATERIALS AND METHODS

Description of Experimental Site

The experiment was conducted at the Agricultural Engineering research site (8.112074°N, -12.082009°W) at the Njala University campus, Moyamba District, Sierra Leone, during the June-November 2024 growing season. The site is located in the Kori Chiefdom (Figure 1); the rainfall pattern is unimodal with a humid tropical climate.



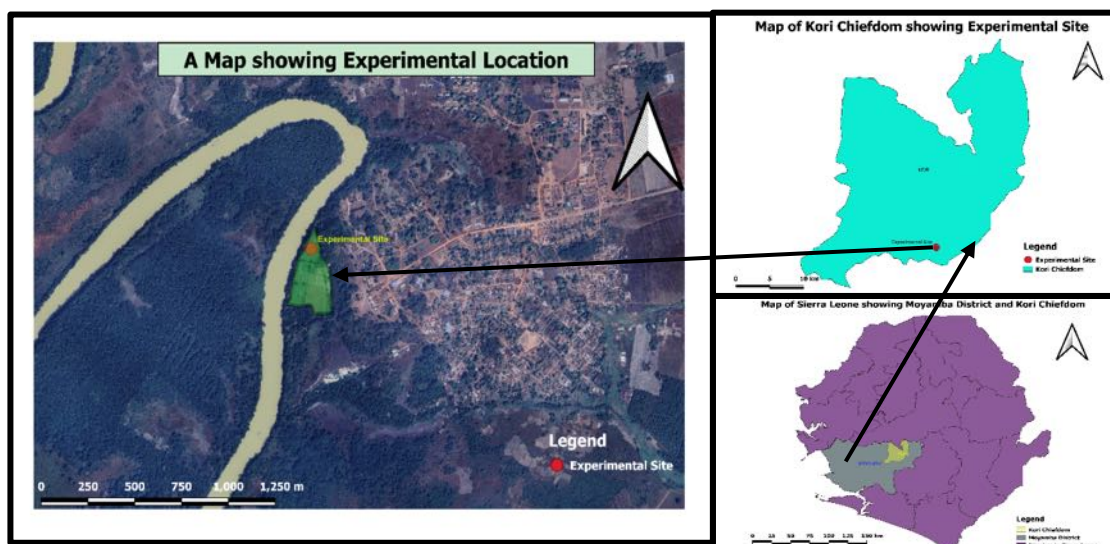


Figure 1: Location of the Experimental Site, Kori Chiefdom, Moyamba District, Southern Province, Sierra Leone

Soil Properties

According to the United States Department of Agriculture (USDA) textural categorization, the soil at the experimental site was categorized as sandy loam. Before site preparation, baseline soil samples were taken from a depth of 0 to 20 cm. The results showed extremely acidic conditions, with a pH (H₂O) of 4.39, which is typical of severely weathered tropical soils and below the ideal range of 5.5 to 6.5 for rice production. Total nitrogen (TN) was low (0.34%), and total organic carbon (TOC) was moderate (3.67%), which is consistent with the low organic inputs typical of smallholder farms in the area under continuous cultivation. The amount of available phosphorus was 13.1 mg kg⁻¹, which is insufficient for growing rice and may restrict tillering and early vegetative growth. 63.5 mg kg⁻¹ of exchangeable potassium is categorized as low to intermediate.

These edaphic properties suggest that the soils are inherently low in fertility, with acidity and phosphorus availability being the main edaphic constraints to realizing the potential yields under conventional cultivation practices.

Climatic Conditions

During the June to November 2024 growing season, the average minimum and maximum temperatures were 23.50°C and 33.20°C, respectively; the average solar radiation was 13.6 MJ m⁻² day⁻¹; the potential evapotranspiration was 398.7 mm; and the total rainfall was 2,467.8 mm. During the growth season, rainfall was equally distributed, and there were no severe extended dry spells.

Experimental Design and Field Layout

The study used a 3×2×2 factorial experiment in a Randomized Complete Block Design (RCBD) with four replications (blocks). The three factors considered were planting method (direct seeding, seedlings of 12 days, and seedlings of 30 days), soil treatment (amended soil and unamended soil), and plant spacing (15 cm × 15 cm and 25 cm × 25 cm). This led to 12 treatment combinations. All 12 treatment combinations were completely randomized within each block, totaling 48 experimental plots across the study site. Each plot was 4 m × 3 m, and a 50 cm footpath was left between plots and blocks for management and data collection purposes.

Compost Characterization and Application

Rice (*Oryza sativa* L.) straw was composted in a pit in situ for a period of 90 days. The final compost's C: N ratio of 55.8 indicates stable organic matter with gradual nutrient release characteristics. Although rice straw compost is known to be low in nitrogen and phosphorus, it greatly increases soil organic matter, microbial activity, and soil structure; a thorough investigation of NPK was not conducted in this work. Compost was applied at 12.5 t ha⁻¹ and incorporated into the top 15 cm of soil 7 days before transplanting. The unamended soil was used as a control treatment.

Data Collection and Analysis

To monitor the growth performance of the crop, the morphological traits such as plant height, number of tillers, and number of leaves were collected from 5 representative plants per plot. At harvest, post-harvest data (effective and ineffective panicles, number of spikelets, number of grains, above-ground biomass, 1000-grain weight, and yield) were recorded from 1 m² in each plot. The analysis was performed using R software (Version 4.3.3). Data on growth parameters and yield components were analyzed using analysis of variance (ANOVA) with soil treatment (amended vs. unamended), plant spacing (15 cm vs. 25 cm), and planting method (direct seeding, 12-day seedlings, 30-day seedlings) as fixed factors. Where ANOVA effects were significant ($p < 0.05$), treatment means were separated using Tukey's Honestly Significant Difference (HSD) test. Pearson correlation coefficients were calculated for the yield components, and principal component analysis (PCA) was performed on standardized yield data for multivariate relationships.

RESULTS AND DISCUSSION

Growth Dynamics of ROK 34 Under SRI Practices

The combination of compost amendment, 25 cm spacing, and 12-day seedlings showed greater plant height, tiller number, and leaf number than other treatment combinations (Figure 2). This finding is similar to studies, where younger seedlings experience less transplanting shock and therefore establish faster [8, 10].



The planting method greatly influenced plant height ($p = 0.011$) and leaf number ($p = 0.002$) (Supplementary Table S1), and 12-day-old seedlings showed better performance than 30-day-old seedlings. Similarly, the influence of seedlings' age on early canopy development has been reported by [2, 11, 12]. None of the treatment combinations significantly affected the number of tillers ($p > 0.05$ for all factors).

Amended treatments resulted in taller plants and increased leaf numbers in both spacing regimes. This could possibly be attributed to improved soil physical conditions, enhanced microbial activity, and slow release of nutrient supply from rice straw compost (C: N 55.8) [11, 12].

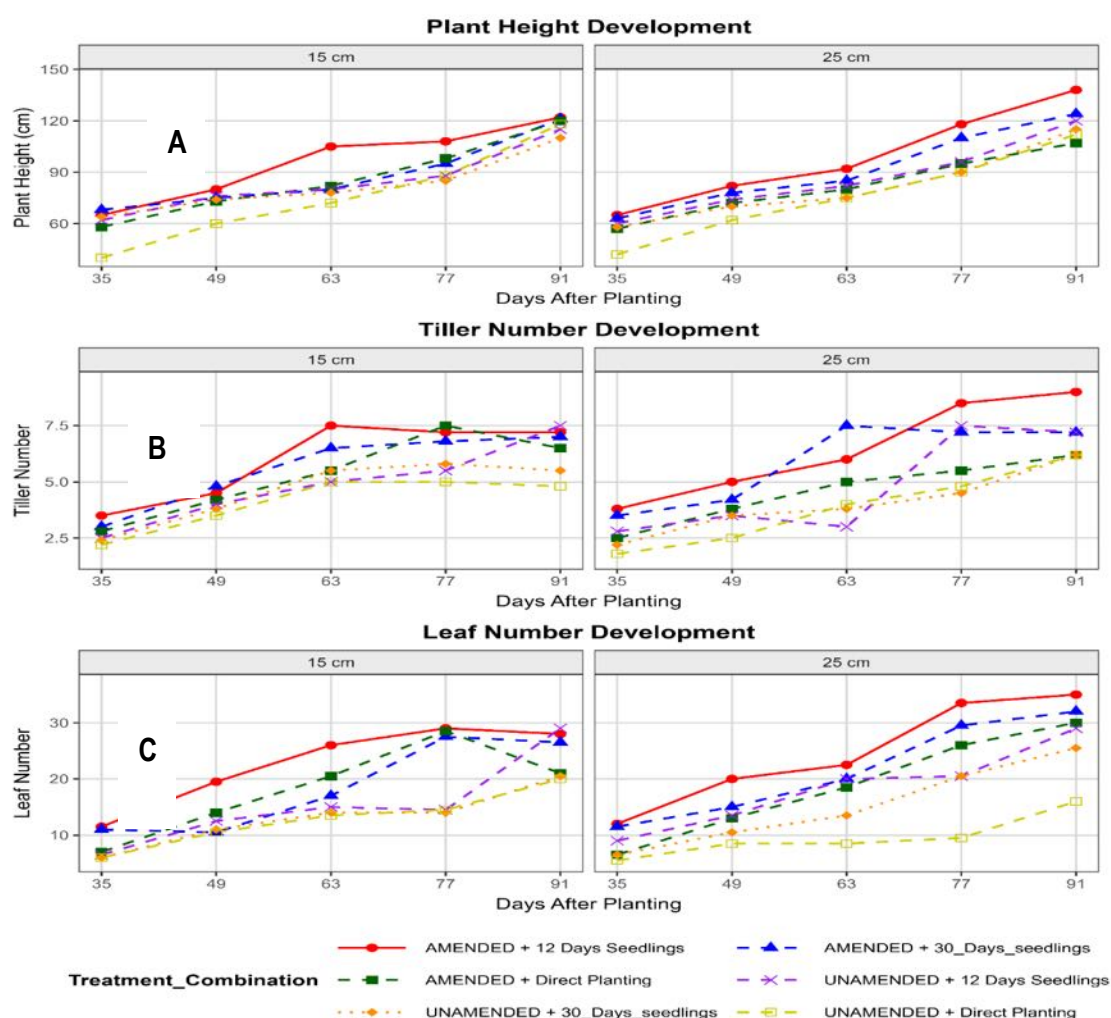


Figure 2: Growth dynamics of ROK 34 rice under different SRI practices at the Njala University research site, Moyamba District, Sierra Leone (2023 growing season). Panels show (A) plant height, (B) tiller number, and (C) leaf number development over 91 days after planting under soil treatments (AMENDED versus UNAMENDED), spacings (15 cm versus 25 cm), and planting methods

Yield Drivers and Component Effects of SRI Practices

Descriptive statistics (Table 1) revealed considerable variation in growth performance and yield attributes among treatments. The phenotypic plasticity of plant height and leaf number was high, while the variation of 1000-grain weight and above-ground biomass was narrower, indicating a greater genetic determination of plant biomass and 1000-grain weight [2, 11, 12].

The planting method had a significant effect on plant height ($p = 0.011$) and leaf number ($p = 0.002$) (Supplementary Table S1). These further emphasize the need to transplant seedlings at a younger stage to facilitate early establishment with strong vigor, thus improving canopy development [13].

In respect of yield formation, the soil amendment had the largest effect on grain yield ($\eta^2 = 0.94$), followed by plant spacing ($\eta^2 = 0.83$) and planting method ($\eta^2 = 0.69$) (Table 2). These effects were highly significant ($p < 0.001$ for soil amendment and spacing; $p = 0.018$ for planting method) and consistent with research demonstrating that more productive tillers are produced when there is less competition due to wider spacing [2].

No significant interaction effects were observed among soil treatment, spacing, and planting method ($p > 0.05$ for all interactions). This additive pattern indicates that each SRI component contributed independently towards yield, which is relevant for smallholder farmers who might adopt components incrementally [5, 13].

The SRI practices evaluated in this study, i.e., soil amendment, wider spacing, and younger seedlings, have been reported to have a higher resource-use efficiency compared to continuously flooded systems [5, 8, 9]. Climate-related variables were not directly measured; therefore, references to climate-smart traits are derived from well-established mechanisms in the literature.

Correlation Matrix of ROK 34 Yield and Yield Attributes

Correlation analysis showed a high positive correlation of grain yield with the number of grains ($r = 0.99$) and the number of effective panicles ($r = 0.92$) (Figure 3). Grain yield was positively correlated with above-ground biomass ($r = 0.55$). Thousand-grain weight was poorly correlated with grain yield ($r = 0.30$).

Among the characteristics, the number of grains was strongly correlated with the number of effective panicles ($r = 0.91$). These trends were also observed in India, where variation in yield was mainly associated with sink-related traits (grain number and panicle number), rather than grain weight [12, 13].

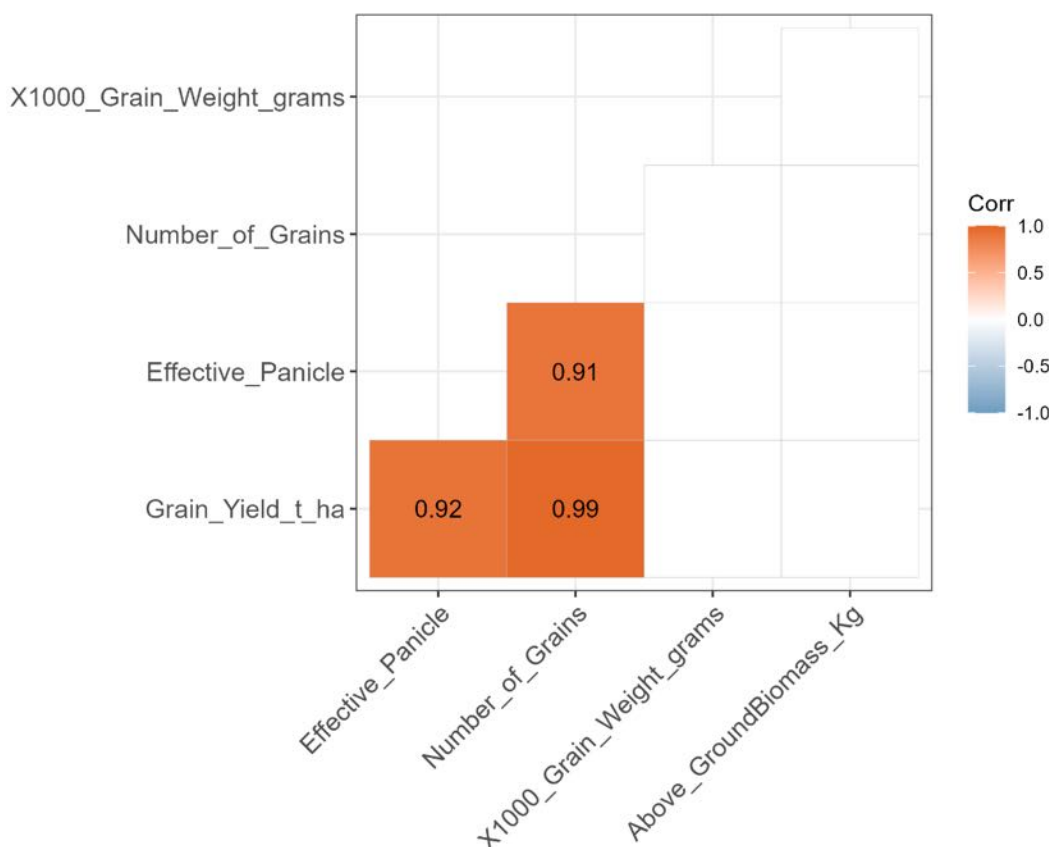


Figure 3: Correlation heatmap of yield components of ROK 34 rice under SRI practices. Values represent Pearson correlation coefficients

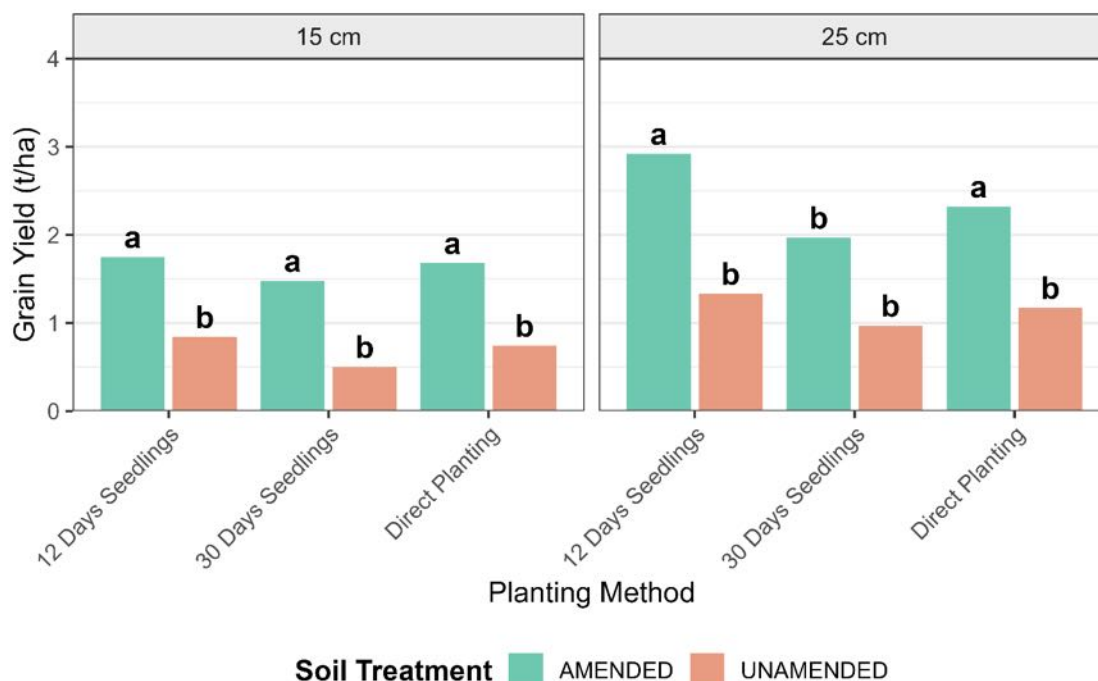
Thousand-grain weight was poorly or non-significantly correlated with other yield components ($r = -0.18$ to 0.33), which is consistent with the observation that grain size is generally stable under SRI, whereas grain number is more plastic to management [9, 14].

Grain Yield Response to SRI Components

The grain yield patterns across soil treatments, plant spacing, and planting methods are presented in Figure 4, and treatment means are summarized in Table 3 with mean separations shown in Table 4. Soil treatments ($p < 0.001$) and planting methods ($p = 0.018$) had significant differences in grain yield (Table 2). Amended soil treatments (group "a") produced significantly more than unamended treatments (group "b") (Table 4). Table 4. Among planting methods, 12-day seedlings (group "a") produced significantly higher yields than 30-day seedlings (group "b"), while direct planting (group "ab") was intermediate with no significant difference.

Compost-amended soil produced the highest yields for all spacing and planting method combinations, consistent with dramatic benefits at 25 cm spacing (Figure 4; Table 3). For example, 12-day seedlings in amended soil at 25 cm spacing gave

2.91 t ha⁻¹ compared to 1.34 t ha⁻¹ in unamended soil at the same spacing. This resulted in a 94 % increase over the average farmer yield of 1.5 t ha⁻¹.



Bars sharing the same letter are not significantly different (Tukey's HSD, $p < 0.05$)

Figure 4: Grain yield of ROK 34 rice as affected by soil amendment (amended vs. unamended), plant spacing (15 cm vs. 25 cm), and planting method (12-day seedlings, 30-day seedlings, direct planting). Bars represent mean yield. Letters above bars indicate significant differences (Tukey's HSD, $p < 0.05$)

Wider spacing (25 cm) produced a greater yield than 15 cm spacing ($p < 0.001$) regardless of planting method (Table 2). Cultivating rice with lower plant density will develop stronger root systems and higher canopy efficiency due to fewer transplanting shocks [12, 15].

Soil treatment, planting technique, and spacing did not show any significant interaction effects ($p > 0.05$ for all interactions). This additive pattern implies that rather than working collectively, the impacts of planting method, spacing, and soil treatment were independent. This means that smallholder farmers can benefit practically from this by adopting each component separately and still achieve an observable yield difference.

Principal Component Analysis (PCA) and Biplot

The multivariate relationships among yield components under different SRI management practices were summarized by principal component analysis (Figure

5). The first two major components accounted for 83.1% of the total variation in yield components, with PC1 accounting for 54.8% and PC2 for 28.3% (Figure 5A).

Grain yield, number of grains, and effective panicles were the main contributors to PC1. The thousand-grain weight had less contribution toward PC1. This indicates that PC1 is a yield productivity axis related to sink-related traits. Thousand-grain weight dominated PC2, and loading of above-ground biomass had a negative loading, indicating that grain size was independent of biomass accumulation.

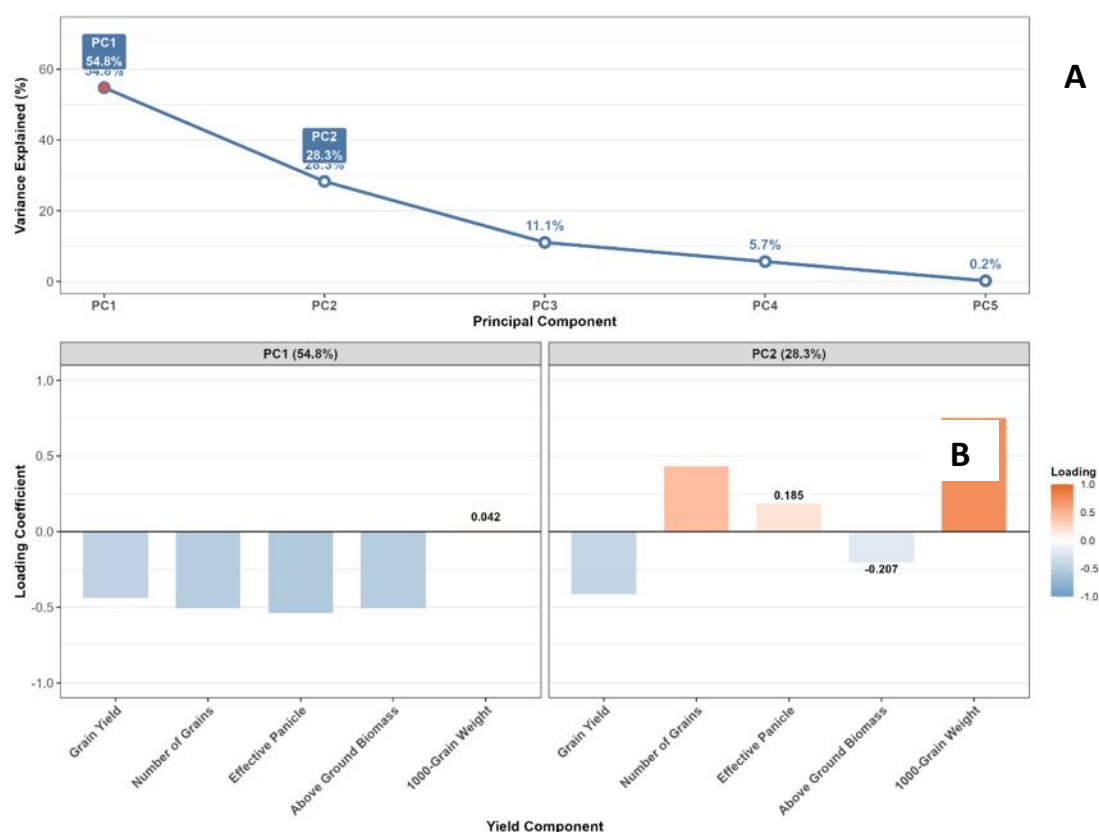


Figure 5: Principal component analysis of yield components of ROK 34 rice under SRI practices. (A) Scree plot showing variance explained by each principal component. (B) PCA biplot showing variable loadings and treatment distribution along PC1 and PC2

The distribution of treatments along the first two principal components is shown in the biplot (Figure 5B). Amended soil and 25 cm spacing were grouped on the right side of PC1 (high yield region), while unamended soil with 15 cm spacing and 30-day seedlings were on the left side (low yield region). Such segregation indicates the strong influence of soil amendment and spacing on yield productivity.

The correlation analysis showed positive and significant ($r = 0.91$ to 0.99) intercorrelations among grain yield, number of grains, and effective panicles,

supported by the biplot, which showed the close association among grain yield, number of grains, and effective panicles. Thousand-grain weight was orthogonal to these traits, confirming that grain size was not a major determinant of yield variation in this study.

These findings are consistent with the SRI literature, which indicates that yield gains under SRI are mainly a result of an increase in sink size (number of grains and panicle density) rather than the weight of individual grains [16, 17]. A similar decoupling of grain size and yield has been reported under SRI as improvements in root function and tiller survival result in more sinks without a proportional increase in grain weight [18,19].

Limitations of the Study

Several limitations are worth noting in this study.

First, this study was conducted over a single growing season (June-November 2024) at a single location (Njala University research site, Moyamba District). Site-specific soil characteristics and interannual climate variability may have an impact on treatment effects. Therefore, before generalizing these results, multi-season, multi-location validation experiments are needed.

Second, just one type of rice (ROK 34) was examined. SRI techniques may have different effects on other locally adapted types. Future research should use a variety of genotypes to assess the genetic heterogeneity in the SRI response.

Third, post-harvest soil nutrient dynamics were not measured, despite the characterization of baseline soil parameters. It is unknown how applying compost may affect soil organic matter, pH, and nutrient availability in the long run.

Lastly, the NPK content of the compost employed in this study (rice straw, C:N ratio 55.8) was not examined. This is typical of actual smallholder situations where comprehensive compost analysis is frequently unavailable; nevertheless, future research should incorporate comprehensive compost analysis to facilitate nutrient budgeting.

Notwithstanding, this study presents the first empirical evidence and proof of concept for the applicability of SRI to ROK 34 rice under rainfed conditions in Sierra Leone. The results provide a foundation for future multi-site, multi-season validation trials.

CONCLUSION AND RECOMMENDATIONS FOR DEVELOPMENT

This research assessed the growth and yield responses of the ROK 34 rice variety to SRI components. The study showed that amended soil, wider spacing (25 cm), and younger seedlings (12 days) had additive effects on grain yield. Amended soil was the most important predictor of yield ($\eta^2 = 0.94$), followed by spacing ($\eta^2 = 0.83$) and planting method ($\eta^2 = 0.69$). The mode of planting significantly influenced the

vegetative growth, affecting the plant height ($p = 0.011$) and leaf number ($p = 0.002$). Grain number ($r = 0.99$) and effective panicles ($r = 0.92$) were positively correlated with yield improvement, whereas thousand-grain weight contributed minimally ($r = 0.29$).

The best treatment combination for this variety was amended soil (12.5 t ha^{-1}), 25 cm spacing, and 12-day seedlings, which gave 2.91 t ha^{-1} , which is a 94% increase over the average farmer yield of 1.5 t ha^{-1} underfed conditions.

However, it is worth stating that there was no direct measurement of climate-related variables (greenhouse gas emissions, water productivity, soil carbon). Therefore, the references to climate-smart outcomes are not direct measurements from this experiment, but rather references to the existing literature.

Recommendations

Farmers: Compost-based soil management (12.5 t/ha), use of 8–12-day-old seedlings, and wider spacing ($25 \text{ cm} \times 25 \text{ cm}$) can improve grain yield. Even partial adoption, compost alone or wider spacing alone, can help increase yields.

Extension services: Training programs on compost preparation, seedling handling, and spacing techniques. Farmers can learn from demonstration plots of full and partial SRI adoption.

Decision makers: Support community composting initiatives to strengthen rice production systems. They should also support the integration of SRI into agricultural development frameworks before wide generalization; validation trials for local varieties across multiple locations and seasons are recommended.

Future research: Direct measurement of greenhouse gas emissions, water-use efficiency, and soil carbon dynamics is required to quantify climate-related outcomes associated with SRI practices in rainfed systems of Sierra Leone.

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Conflict of interest

The authors declare that there are no conflicts of interest associated with this manuscript.



Table 1: Descriptive statistics of growth and yield parameters for the ROK 34 rice variety under all SRI practices

Parameter	Mean	SD	Minimum	Maximum
Growth Parameters				
Plant Height (cm)	86.35	25.58	41.16	138.00
Tiller Number	5.10	2.10	1.30	9.50
Leaf Number	23.47	12.52	5.20	49.45
Yield Parameters				
Grain Yield (t/ha)	1.47	0.70	0.49	2.91
Effective Panicle	69.00	31.6	35.3	136.70
Number of Grains	3113.00	2252.00	737.00	8613.00
1000-Grain Weight (g)	29.62	3.94	23.13	34.55
Above Ground Biomass (kg)	1.32	0.50	0.70	2.27

Table 2: Analysis of variance (ANOVA) for grain yield of the ROK 34 rice variety as influenced by soil treatment, plant spacing, and planting method under SRI practices

Variable Source	DF	Sum Sq	Mean Sq	F-value	P-value	Effect Size (η^2)
Soil Treatment	1	3.532	3.532	108.338	<0.001	0.94
Plant Spacing	1	1.122	1.122	34.431	<0.001	0.83
Planting Method	2	0.495	0.248	7.596	0.018	0.69
Residuals	7	0.228	0.033			

Note: No significant interaction effects were detected ($p > 0.05$). η^2 = partial eta-squared (effect size). Values ≥ 0.14 indicate large effects

Table 3: Treatment combination means yield (t ha⁻¹) and the relative yield (%) performance of the ROK 34 rice variety under all SRI practices

Treatment Combination	Mean Yield (t ha ⁻¹)	Relative Yield (%)
Amended soil		
25 cm + 12-day seedlings	2.91	594
25 cm + direct planting	2.32	473
25 cm + 30-day seedlings	1.95	398
15 cm + 12-day seedlings	1.75	357
15 cm + Direct planting	1.68	343
15 cm + 30-day seedlings	1.46	298
Unamended soil		
25 cm + 12-day seedlings	1.34	273
25 cm + direct planting	1.16	237
25 cm + 30-day seedlings	0.97	198
15 cm + 12-day seedlings	0.86	176
15 cm + Direct planting	0.74	151
15 cm + 30-day seedlings*	0.49	100

*Baseline treatment: 30-day-old seedlings, 15 cm spacing, unamended soil (typical farmer practice). Relative yield (%) = (Treatment yield / Baseline yield) × 100

Table 4: Mean separation tests for significant main effects using Tukey's Honestly Significant Difference (HSD) test

Factor	Level	Mean Yield (t ha ⁻¹)
Soil Treatment	Amended	2.01a
	Unamended	0.93b
Plant Spacing	25 cm	1.78a
	15 cm	1.16b
Planting Method	12-day seedlings	1.72a
	Direct planting	1.48ab
	30-day seedlings	1.22b

Note: Means within each factor followed by the same letter are not significantly different at $p < 0.05$ (Tukey's HSD Test)

Supplementary Table

S1: Complete analysis of variance (ANOVA) for all growth and yield parameters of ROK 34 rice variety

Variable Source	DF	F.value	P.value	Significance
Plant Height (cm)				
Soil Treatment	1	0.557	0.480	ns
Plant Spacing	1	1.045	0.341	ns
Planting Method	2	9.188	0.011	*
Tiller Number				
Soil Treatment	1	0	0.989	ns
Plant Spacing	1	0.019	0.894	ns
Planting Method	2	0.143	0.869	ns
Leaf Number				
Soil Treatment	1	0.304	0.598	ns
Plant Spacing	1	0.872	0.381	ns
Planting Method	2	17.896	0.002	**
Grain Yield (t/ha)				
Soil Treatment	1	108.338	<0.001	**
Plant Spacing	1	34.431	<0.001	**
Planting Method	2	7.596	0.018	*
Effective Panicle				
Soil Treatment	1	2.185	0.183	ns
Plant Spacing	1	0.001	0.971	ns
Planting Method	2	1.304	0.330	ns
Number of Grains				
Soil Treatment	1	1.813	0.220	ns
Plant Spacing	1	0.024	0.882	ns
Planting Method	2	1.73	0.245	ns
1000 – Grain Weight (g)				
Soil Treatment	1	0.677	0.438	ns
Plant Spacing	1	0.127	0.732	ns
Planting Method	2	0.467	0.645	ns
Above Ground Biomass (kg)				
Soil Treatment	1	22.086	0.002	**
Plant Spacing	1	0.089	0.774	ns
Planting Method	2	0.666	0.543	ns

Significance codes: ***P < 0.001, **P < 0.01, *P < 0.05, ns = not significant (P ≥ 0.05)

REFERENCES

1. **Asma J, Subrahmanyam D and D Krishnaveni** The global lifeline: A staple crop sustaining two-thirds of the world's population. *Agricultural Archives*. 2023; **2(3)**: 15–18. <https://doi.org/10.51470/AGRI.2023.2.3.15>
2. **Berkhout E, Glover D and A Kuyvenhoven** On-farm impact of the system of rice intensification (SRI): Evidence and knowledge gaps. *Agricultural Systems*. 2014; **132**: 157–166. <https://doi.org/10.1016/j.agsy.2014.10.001>
3. **Chapagain T, Riseman A and E Yamaji** Assessment of system of rice intensification (SRI) and conventional practices under organic and inorganic management in Japan. *Rice Science*. 2011; **18(4)**: 311–320. [https://doi.org/10.1016/S1672-6308\(12\)60010-9](https://doi.org/10.1016/S1672-6308(12)60010-9)
4. **Doni F, Zain CRCM, Isahak A, Fathurrahman F, Sulaiman N, Uphoff N and WMW Yusoff** Relationships were observed between Trichoderma inoculation and characteristics of rice grown under system of rice intensification (SRI) versus conventional methods of cultivation. *Symbiosis*. 2017; **72(1)**: 45–59. <https://doi.org/10.1007/s13199-016-0438-3>
5. **Midya A, Saren BK, Dey JK, Maitra S, Praharaj S, Gaikwad DJ, Gaber A, Alsanie WF and A Hossain** Crop establishment methods and integrated nutrient management improve crop performance, water productivity and profitability of rice (*Oryza sativa* L.). *Agronomy*. 2021; **11(9)**: 1860. <https://doi.org/10.3390/agronomy11091860>
6. **Mondal D, Ghosh A, Roy D, Kumar A, Bera S, Ghosh R, Bandopadhyay P and A Majumder** Yield loss assessment of rice (*Oryza sativa* L.) due to different biotic stresses under system of rice intensification (SRI). *Journal of Entomology and Zoology Studies*. 2017.
7. **Nirmala B, Tuti MD, Mahender Kumar R, Waris A, Muthuraman P, Parmar B and TV Singh** Integrated assessment of system of rice intensification versus conventional method of transplanting for economic benefit, energy efficiency, and lower global warming potential in India. *Agroecology and Sustainable Food Systems*. 2021; **45(5)**: 745–766. <https://doi.org/10.1080/21683565.2020.1868648>

8. **Kumar RM, Chintalapati P, Rathod S, Singh TV, Kuchi S, Mannava PBBB, Latha PC, Somasekhar N, Bandumula N, Madamsetty SP, Prasad JVNS, Vijayakumar S, Srinivas D, Sreedevi B, Tuti MD, Arun MN, Sailaja B and RM Sundaram** Comparison of system of rice intensification applications and alternatives in India: Agronomic, economic, environmental, energy, and other effects. *Agronomy*. 2023; **13**(10): 2492. <https://doi.org/10.3390/agronomy13102492>
9. **Omwenga KG, Mati BM and PG Home** Determination of the effect of the system of rice intensification (SRI) on rice yields and water saving in Mwea irrigation scheme, Kenya. *Journal of Water Resource and Protection*. 2014; **6**(10): 895–901. <https://doi.org/10.4236/jwarp.2014.610084>
10. **Reuben P, Kahimba FC, Katambara Z, Mahoo HF, Mbungu W, Mhenga F, Nyarubamba A and M Maugo** Optimizing plant spacing under the system of rice intensification (SRI). *Agricultural Sciences*. 2016; **7**(4): 270–278. <https://doi.org/10.4236/as.2016.74026>
11. **Sato S and N Uphoff** A review of on-farm evaluations of system of rice intensification methods in Eastern Indonesia. *CABI Reviews*. 2007. <https://doi.org/10.1079/PAVSNNR20072054>
12. **Thakur AK, Mandal KG, Verma OP and RK Mohanty** Do system of rice intensification practices produce rice plants phenotypically and physiologically superior to conventional practices? *Agronomy*. 2023; **13**(4): 1098. <https://doi.org/10.3390/agronomy13041098>
13. **Thakur AK, Rath S, Roychowdhury S and N Uphoff** Comparative performance of rice with system of rice intensification (SRI) and conventional management using different plant spacings. *Journal of Agronomy and Crop Science*. 2010; **196**(2): 146–159. <https://doi.org/10.1111/j.1439-037X.2009.00406.x>
14. **Truong TTA, Fry J, Van Hoang P and HH Ha** Comparative energy and economic analyses of conventional and system of rice intensification (SRI) methods of rice production in Thai Nguyen Province, Vietnam. *Paddy and Water Environment*. 2017; **15**(4): 931–941. <https://doi.org/10.1007/s10333-017-0603-1>

15. **Uphoff N** Higher yields with fewer external inputs? The system of rice intensification and potential contributions to agricultural sustainability. *International Journal of Agricultural Sustainability*. 2003; **1(1)**: 38–50. <https://doi.org/10.3763/ijas.2003.0105>
16. **Doni F, Isahak A, Fathurrahman F and WMW Yusoff** Rice plants' resistance to sheath blight infection is increased by the synergistic effects of Trichoderma inoculation with SRI management. *Agronomy*. 2023; **13(3)**: 711. <https://doi.org/10.3390/agronomy13030711>
17. **Kesh H, Ram K and K Jangid** System of rice intensification: A review on resource conserving method of rice crop establishment. *International Journal of Current Microbiology and Applied Sciences*. 2017; **6(11)**: 2315–2328. <https://doi.org/10.20546/ijcmas.2017.611.275>
18. **Antony E, Uphoff N and AK Thakur** An assessment of physiological effects of system of rice intensification (SRI) practices compared with recommended rice cultivation practices in India. *Experimental Agriculture*. 2010; **46(1)**: 77–98. <https://doi.org/10.1017/S0014479709990548>
19. **Harwood R, Uphoff N and A Kassam** SRI as a methodology for raising crop and water productivity: Productive adaptations in rice agronomy and irrigation water management. *Paddy and Water Environment*. 2011; **9(1)**: 3–11. <https://doi.org/10.1007/s10333-010-0224-4>