International Journal of Multidisciplinary Research and Bulletin
ISSN 3108-1428 (Online)

Article History
Received: 29 July 2026
Accepted: 25 Sep 2026
Published: 17 Oct 2026

International Journal of Multidisciplinary Research and Bulletin
Volume 5 Issue 5 (Sep – Oct) 2026

DOI:
10.5281/zenodo.23436773

Copyright © 2026, Authors retain copyright. Licensed under the Creative Commons Attribution 4.0 International License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Keywords: In-land flood plains, Rice varieties, River Niger, Water application frequencies, Yield.

Yield Evaluation of Some Rice Varieties Subjected to Water Application Frequencies in In-Land Flood Plains of River Niger, Lokoja, Kogi State, Nigeria

U.T MUSA[1*], M YUSUF[1,2], E.S ATTAH[1]

***Correspondence:** U.T MUSA

[1]Department of Crop Production, Prince Abubakar Audu University Anyigba PMB 1008, Kogi State, Nigeria.

[2]Department of Agricultural Technology, School of Agricultural Technology, Kogi State Polytechnic, Itakpe Campus, Lokoja 263101, Nigeria.

ABSTRACT

A field trial was conducted within the inland floodplains of the River Niger in Lokoja, Kogi State, Nigeria, to evaluate the growth and yield response of seven rice varieties; FARO 44, FARO 45 (ITA 257), FARO 46 (ITA150), FARO 47, FARO 51, FARO 55 (NERICA 1), and Farmer's Variety (Local) to four irrigation frequencies (daily, 2-day, 4-day and 6-day intervals). The experiment was laid out in a Randomized Complete Block Design with twenty-eight treatment combinations replicated three times. Irrigation frequency exerted a significant effect ($p<0.05$) on leaf production at 6 and 9 weeks after sowing, with the 4-day interval producing the highest leaf counts, while daily watering became superior by 12 weeks after sowing. Varietal differences were highly significant and consistent across nearly every growth and yield parameter measured, with FARO 55 (NERICA 1) consistently outyielding all other varieties in leaf number, panicle number, panicle length, filled spikelet per panicle, panicle weight, grain yield and straw yield, while the unimproved Farmer's-Variety performed poorest throughout. Although irrigation frequency alone did not significantly alter panicle-level and yield traits, a significant F×V interaction was obtained for panicle length, filled spikelet per panicle, panicle weight and grain yield, indicating that varietal response to irrigation frequencies were not uniform. Across all varieties, yield and yield components declined progressively as irrigation frequency was reduced from daily to 6-day intervals, but FARO 55 (NERICA 1) sustained the highest absolute performance at every frequency level, recording the highest grain

yield (6.06 t/ha) under daily irrigation and remaining the top performer (4.30 t/ha) even under the least frequent 6-day regime. These findings demonstrate that variety selection, more than irrigation frequency alone is the primary determinant of productivity under floodplain conditions, and that FARO 55 (NERICA 1) combined with a daily to 2-day watering regime offers the most reliable pathway to improved rice productivity for smallholder farmers in the river Niger floodplain ecology.

INTRODUCTION

Rice (*Oryza sativa* L.) is an important cereal crop considered a global food security staple crop across virtually all socioeconomic strata of the Nigerian population. Consumption has risen faster than domestic production for several decades in Nigeria, sustaining a persistent supply gap that is bridged partly through importation and partly through the expansion of cultivated area rather than through genuine productivity gains. Nigeria's average national paddy yield, at approximately 2.0 t/ha, still lags considerably behind the global average of about 4.3 t/ha (Wudil *et al*., 2023a). This shortfall is attributed less to the unavailability of land than to the persistently low technical efficiency, water-use efficiency, and management sophistication that characterise most rice production systems in the country (Anonymous 2021). Bridging this yield gap has therefore become a recurring policy and research priority, particularly given the scale of water, land, and labour resources that continued area expansion would otherwise require. Rice production in Nigeria is mostly adapted to wide range of ecologies, from rainfed upland systems to rainfed and irrigated lowland systems, and to the seasonally inundated floodplains popularly referred to as FADAMA lands. Each of these ecologies imposes a distinct water regime on the crop, and each has correspondingly different potential for productivity improvement (Rajput *et al*., 2020). Inland floodplains, nourished by the seasonal overflow and residual moisture of major river systems, are widely regarded as among the most agronomically favourable but least exploited of these ecologies. Floodplain soils, formed from repeatedly deposited alluvium, tend to be naturally fertile, well supplied with organic matter and exchangeable bases, and capable of retaining moisture long after flood recession, conditions that in principle should support higher and more stable rice yields than either purely rainfed upland or degraded irrigation-scheme soils (Arouna *et al*., 2023).

Kogi State, situated at the confluence of the Rivers Niger and Benue, is uniquely positioned to benefit from this floodplain potential. The state possesses an extensive stretch of riverine land

along both rivers, land that is inundated during the peak flood months and left with substantial residual soil moisture as the floodwaters recede. This natural hydrological cycle offers smallholder farmers around Lokoja and its environs the opportunity to raise rice under minimal supplementary irrigation and in some pockets to attempt more than one cropping cycle within a single agricultural year. In practice, however, much of this potential remains under-realised. Farmers in these floodplain communities frequently rely on unimproved local landraces, apply water to their fields according to informal habit rather than any scientifically determined schedule, and have limited access to extension guidance on how water should be managed once the natural flood recedes and supplementary application becomes necessary. The result is a wide variability in on-farm yields even among neighbouring plots subjected to ostensibly similar conditions. Central to closing this variability is a proper understanding of the water requirements of rice at each stage of its growth cycle. A substantial body of evidence has now demonstrated that rice can be grown successfully, and in many cases more efficiently, under intermittent or non-continuous water application regimes, provided that critical growth stages are protected from prolonged moisture deficit (Mallareddy *et al*., 2023). The practical implication is that the frequency with which water is applied, as distinct from the cumulative volume applied, has an independent and often decisive influence on crop growth, tillering behaviour, panicle development, and ultimately grain yield. Empirical work conducted within Nigerian irrigation schemes lends direct support to this position.

A field trial on the Farro 44 rice variety grown under a range of water application rates and scheduling intervals in an irrigation scheme in Niger State found that plant height, tiller survival, root development, and grain yield all varied significantly with the depth and frequency of water applied, with plots receiving moderate, well-timed water outperforming both the excessively flooded and the water-stressed treatments (Otuaro *et al*., 2024). The same study reported that irrigation scheduling intervals of six to eight days, rather than daily or continuous flooding, produced water savings of over 45 % relative to conventional farmer practice without a corresponding collapse in grain yield, underscoring that indiscriminate or excessive water application is not synonymous with higher productivity. Complementary evidence from a two-year multi-location field study that combined variable irrigation regimes with different nitrogen application rates found that a recommended irrigation-scheduling regime and irrigation at field capacity produced growth and yield outcomes statistically comparable to continuous flooding, while simultaneously improving the benefit-cost ratio of production, reinforcing the view that

carefully timed water application, rather than water abundance per se, is the primary determinant of profitable rice cultivation (Mir *et al*., 2025).

Emerging sensor-guided approaches to intermittent irrigation scheduling have extended this evidence further within the Nigerian context specifically. A recent working paper evaluating a smart alternate wetting and drying system on rice farms in southeastern Nigeria found that plots managed under sensor-guided intermittent irrigation used substantially less water than continuously flooded plots while maintaining comparable or improved yield outcomes, demonstrating that precision-timed water application frequencies can be adapted profitably to smallholder Nigerian conditions once appropriate scheduling information is made available to farmers (Ume and Ume, 2024). Such findings are encouraging, but they were generated predominantly within established irrigation-scheme or upland contexts. The residual-moisture dynamics, water-table behaviour, and flood-recession timing that characterise an inland floodplain ecology such as that of Lokoja differ sufficiently from a canal-fed or borehole-irrigated scheme that scheduling recommendations developed elsewhere cannot be assumed to transfer directly without local validation. A further dimension that compounds the water-frequency question is genetic variation among rice varieties in their tolerance of, and response to, differing moisture regimes. Rice varieties differ appreciably in root architecture, drought and waterlogging tolerance, tillering vigour, and sensitivity to moisture stress at specific phonological stages such as tillering, panicle initiation, and grain filling, meaning that a water application frequency that is optimal for one variety may be suboptimal, or even detrimental, for another. Field evaluation of selected NERICA rice cultivars grown under rainfed and supplementary irrigation conditions in Oyo State found marked differences among cultivars in their yield stability under fluctuating moisture availability, with some cultivars sustaining grain yield far better than others under the same water regime (Fawole *et al*., 2024). This genotype-by-water-management interaction is precisely why generic, variety-blind recommendations on irrigation frequency are of limited practical value to floodplain farmers who often cultivate more than one variety within the same season.

Despite this accumulating evidence, there remains a notable scarcity of localized, variety-specific empirical data on rice water management within the inland floodplain ecology of the Niger-Benue confluence area, and within Kogi State's Lokoja floodplains in particular. Existing studies have concentrated largely on established irrigation schemes in Niger, Kano, and other northern states, or on rainfed and upland ecologies elsewhere in the country, leaving the specific

interaction between water application frequency and varietal performance under Lokoja's floodplain hydrology empirically untested. Given the acknowledged agronomic potential of this floodplain, and the practical urgency of guiding farmers toward water-efficient, high-yielding practices as pressure on the Niger River's flow regime increases, this gap represents both a scientific and a developmental priority. It is against this backdrop that the present study becomes necessary. This study therefore evaluates the yield performance of selected rice varieties subjected to different water application frequencies within the inland floodplains of the River Niger in Lokoja, Kogi State. Specific objectives include;

i. Assessing the growth and yield response of the selected varieties to varying water application frequencies;
ii. Identifying the variety-irrigation frequency combination(s) that optimise grain yield under floodplain conditions and;
iii. Generating locally applicable guidance that floodplain rice farmers and extension agencies in Kogi State can use to improve both productivity and water-use efficiency.

MATERIALS AND METHOD

Study Area Description

The field experiment was carried out in the inland valley flood plains of River Niger, in Lokoja, Kogi State, Nigeria (Lat $7^{o}48'$ N, Long $6^{o}44'$ E) on elevation of 45 – 125 m above sea-level on the western bank of the Niger River, close to its confluence with Benue River. The field has clayey-to-loess textured soil and slightly acidic (pH 5.3), moderate in organic carbon (2.3%), low in available nitrogen (418 kg/ha), phosphorus (10.22 kg/ha) and slightly high in available potassium (380 kg/ha).

Experimental Design and Agronomic Practices

The experiment was laid out in a Randomized Complete Block Design (RCBD) with twenty-eight (28) treatments replicated three times. The treatments were allotted randomly in each replication. Each plot measured 3 m × 4 m (12 m^2), tilled and levelled into basins to allow for irrigation water to be ponded within every plot. Each plot/treatment was given equal irrigation water volume (25 litres) using a calibrated container. Four irrigation frequencies of daily, 2-day, 4-day and 6-day were applied throughout the period of the experiment. Watering (irrigation) frequencies started three weeks (3 WAS) after seedling emergence.

Sowing of the seeds of various varieties FARO 44 (Sippi), FARO 45 (ITA 257), FARO 46 (ITA 150), FARO 47 (ITA 117), FARO 51 (CISDANE), FARO 55 (NERICA) and Farmer variety (Local) were done by hand-drilling as per the treatments on 18th November, 2023. A common irrigation frequency was given before seedling emergence. Water application frequency (treatment) commenced after three (3) weeks after seedling emergence. Later irrigations (watering) were done as per the treatments.

Fertilizer, using urea (46% N), was applied to the field two times before harvest. A total of 100 kg N/ha was adopted, split into two equal application rates. The first application of 0.132 kg urea/plot (½ the recommended dose) was applied six weeks after seedling emergence. The balance of 0.132 kg urea/plot was applied at the booting stage for each of the varieties used in the experiment. Harvesting was done when the different varieties showed physiological maturity and the grains completely dried.

Sampling and Measurement

Except for number of leaves/plant, where only five tagged plants per plot were used at 6, 9 and 12 weeks after seedling emergence, all other characters such as; number of leaves produced/plant at tillering, number of leaves produced/plant at flowering, average number of panicles/plants at tillering, were measured at tillering, flowering and maturity. Measurements of yield components such as; weight of panicle, grain weight and straw yield/ha were recorded after harvest of the crop.

Statistical Analysis

The data collected from the experiment were statistically analyzed by adopting a standard method known as Analysis of Variance (ANOVA) using CropStat7.2.2007.3 software (IRRI, Metro Manila, Philippines) statistical package. Means of significantly different treatment effects were subjected to post hoc test using new Duncan multiple range test at 0.05 level of probability.

RESULTS

Effect of varieties and frequencies of irrigation on growth, yield and yield characters of rice varieties at the In-land flood plains of river Niger, Lokoja, Kogi State.

Results (Table 1) shows that frequencies of irrigation significantly differ ($p<0.05$) at different samplings periods. Watering at 4-Days interval consistently yield highest number of leaves at 6 and 9 WAS, daily watering gave the highest number of leaves at 12WAS. FARO 55 (NERICA 1)

varieties consistently produced the maximum number of leaves at the in-land valley river Niger at all sampling stages, while Farmer's Variety (Local) performed the least.

Table 1. Number of leaves of rice varieties produced/plant at different sampling periods under different irrigation frequencies in in-land valley ecology of River Niger, Lokoja, Kogi State.

Treatment	Sampling Periods (weeks after sowing)		
	6	9	12
Frequencies of Irrigation (F)			
Daily	19.8^{ab}	22.6^{ab}	27.8^{a}
2-Day	20.4^{ab}	23.4^{ab}	25.4^{ab}
4-Day	21.6^{a}	23.4^{a}	25.4^{ab}
6-Day	18.3^{b}	20.1^{b}	22.4^{b}
Variety (V)			
FARO 44 (sippi)	21.3^{b}	24.3^{b}	26.3^{b}
FARO 45 (ITA 257)	18.7^{bc}	19.4^{d}	22.4^{b}
FARO 46 (ITA150)	10.0^{bc}	22.4^{bcd}	25.5^{b}
FARO 47 (ITA-117)	19.3^{bc}	21.6^{bcd}	22.6^{b}
FARO 51 (CISDANE)	21.3^{b}	22.8^{bcd}	24.8^{b}
FARO 55 (NERICA 1)	25.4^{a}	30.6^{a}	39.3^{a}
Farmer's Variety (Local)	18.3^{c}	19.8^{cd}	21.6^{b}
Interaction (F × V)			
Irrigation Frequency × Variety	ns	ns	ns

Mean(s) followed by the different superscript and ending with an asterisk (*) shows significant difference at 1% level of probability.

Frequencies of irrigation did not significantly affect ($p>0.05$) the number of leaves of rice produced at tillering, flowering and grain filling periods of rice growth and development (Table 2). However, FARO 55 (NERICA 1) variety performed optimally on number of leaves produced during these growth stages amongst other varieties with Farmer's Variety (Local) showing least performance consistently. Similarly, number of panicles per plant, panicle length, and number of filled spikelet/panicle were not significantly affected by frequencies of irrigation (Table 3), FARO 55 (NERICA 1) variety consistently outperformed others on the yield characters aforementioned (Table 3) with Farmer's Variety (Local) being the least.

Panicle length and number of filled spikelet/panicle showed significant interaction between frequencies of irrigation and variety. The coefficient of variations of 8.4, 11.83 and 18.50 % were obtained for number of leaves per plant at tillering, flowering and grain filling periods of growth respectively (Table 2). Similarly, CVs of 18, 21.6 and 23.2 % were obtained for number of panicle/plants, panicle length and number of filled spikelet/panicle.

International Journal of Multidisciplinary Research and Bulletin
ISSN 3108-1428 (Online)

Table 2. Number of leaves of rice varieties produced/plant at various growth stages under different irrigation frequencies in in-land valley ecology of River Niger, Lokoja, Kogi State.

Treatment	Growth stages		
	Tillering	Flowering	Grain Falling
Frequencies of Irrigation (F)			
Daily	6.8	10.4	10.3
2-Day	6.8	9.8	9.4
4-Day	5.4	9.7	9.4
6-Day	3.8	6.3	5.3
Variety (V)			
FARO 44 (sippi)	5.7^{ab}	8.4^{ab}	8.6^{ab}
FARO 45 (ITA 257)	5.3^{ab}	9.3^{a}	8.7^{ab}
FARO 46 (ITA150)	6.8^{a}	9.6^{a}	8.9^{ab}
FARO 47 (ITA-117)	5.3^{ab}	8.4^{ab}	7.3^{b}
FARO 51 (CISDANE)	5.6^{ab}	8.7^{ab}	8.8^{ab}
FARO 55 (NERICA 1)	7.8^{a}	10.3^{a}	11.5^{a}
Farmer's Variety (Local)	3.3^{b}	5.4^{b}	4.9^{b}
C.V. (%)	8.4	11.83	18.50
Irrigation Frequency × Variety	ns	ns	ns

Mean(s) followed by the different superscript and ending with an asterisk (*) shows significant difference at 1% level of probability

Table 3. Average number of panicles, panicle length and number of filled spikelet/panicle of rice varieties produced per plant at tillering stage under different irrigation frequencies in in-land valley ecology of River Niger, Lokoja, Kogi State.

Treatments	No. of Panicle/Plant (gm)	Panicle Length	No. of filled spikelet/Panicle
Frequencies of Irrigation			
Daily	4.00	26.30	157.00
2-Day	4.00	22.74	150.00
4-Day	3.50	19.70	143.00
6-Day	3.00	14.30	113.00
Variety V			
FARO 44 (sippi)	3.40^{cd}	16.50^{ab}	160.33^{a}
FARO 45 (ITA 257)	4.30^{b}	17.80^{ab}	147.00^{abc}
FARO 46 (ITA150)	4.00^{c}	23.00^{ab}	130.30^{bc}
FARO 47 (ITA-117)	4.00^{c}	24.00^{ab}	130.20^{bc}
FARO 51 (CISDANE)	3.00^{d}	17.00^{ab}	134.00^{bc}
FARO 55	6.00^{a}	25.40^{a}	173.25^{a}

(NERICA 1)			
Farmer's Variety (Local)	3.60[d]	15.00[b]	121.00[c]
C.V %	18	21.6	23.20
Interaction (F×V)	ns	*	*

Mean(s) followed by the different superscript and ending with an asterisk (*) shows significant difference at 1% level of probability

Frequencies of irrigation were significantly not different ($p>0.05$) for panicle weight, grain yield and straw yield during the period of the experiment (Table 4). However, FARO 55 (NERICA 1) variety had the highest panicle weight, grain weight and straw yield per hectare. This was followed by FARO 44 (sippi) > FARO 45 (ITA 257) > FARO 51 (CISDANE) > FARO 47 (ITA-117) > FARO 46 (ITA150) > Farmer's Variety (Local) in that order. CVs of 14.3, 24.34 and 26.50 were consistently obtained for panicle weight, grain weight and straw yield per hectare respectively.

Table 4. Weight of panicles/plant, grain weight and straw yield per hectare of rice varieties subjected to different irrigation frequencies at the in-land valley ecology of River Niger, Lokoja, Kogi State.

Treatments	Weight of Panicle/Plants (gm)	Grain Weight (t ha^{-1})	Straw Yield (t ha^{-1})
Frequencies of Irrigation			
Daily	5.17	5.64	25.38
2-Day	5.00	4.78	21.51
4-Day	4.28	3.30	14.85
6-Day	3.40	2.11	9.50
Variety V			
FARO 44 (sippi)	5.30[ab]	5.34[ab]	24.03[a]
FARO 45 (ITA 257)	4.91[b]	4.31[abc]	19.35[ab]
FARO 46 (ITA150)	3.84[bc]	3.28[bc]	14.76[ab]
FARO 47 (ITA-117)	3.33[cd]	3.81[bc]	17.15[ab]
FARO 51 (CISDANE)	4.84[bc]	3.17[bc]	14.27[ab]
FARO 55 (NERICA 1)	6.80[a]	6.48[a]	27.16[a]
Farmer's Variety (Local)	2.40[d]	1.84[c]	8.48[b]
C.V %	14.3	24.34	26.50
Interaction (F×V)	*	*	ns

Mean(s) followed by the different superscript and ending with an asterisk (*) shows significant difference at 1% level of probability

Interaction of frequencies of irrigation and variety (F × V) on yield and yield components of rice grown on the in-land flood plains of river Niger, Lokoja, Kogi State.

Figure 1 shows that panicle length declines steadily as irrigation frequencies decreases across each variety. This confirms that water stress directly suppresses panicle elongation. FARO 55 (NERICA 1) had the longest panicles at every irrigation level, peaking at 25.85 cm under daily irrigation (Best responsive; 77 % stability). FARO 46 (ITA150) with panicle length decreasing from 24.65 to 18.65 cm and FARO 47 (ITA-117) with panicle length decreasing from 25.15 to 19.15 cm across irrigation levels has best relative stability peaking at 76 %. Farmer's Variety (Local) is the least-responsive with the shortest panicles at every irrigation level confirming that local landraces underperform improved varieties under both well-watered and stress conditions.

On the filled spikelet/panicle (figure 2), F×V interaction presents FARO 55 (NERICA 1) as the best responsive variety, the variety consistently produced the highest number of filled spikelet at every irrigation level. Other variety responses follow; FARO 44 (sippi) > FARO 45 (ITA 257) > FARO 46 (ITA150) > FARO 47 (ITA-117) > FARO 51 (CISDANE) in that order. These varieties did not however significantly differ in their responses. Farmer's Variety (Local) is the least responsive variety producing the lowest number of filled spikelet at every irrigation levels.

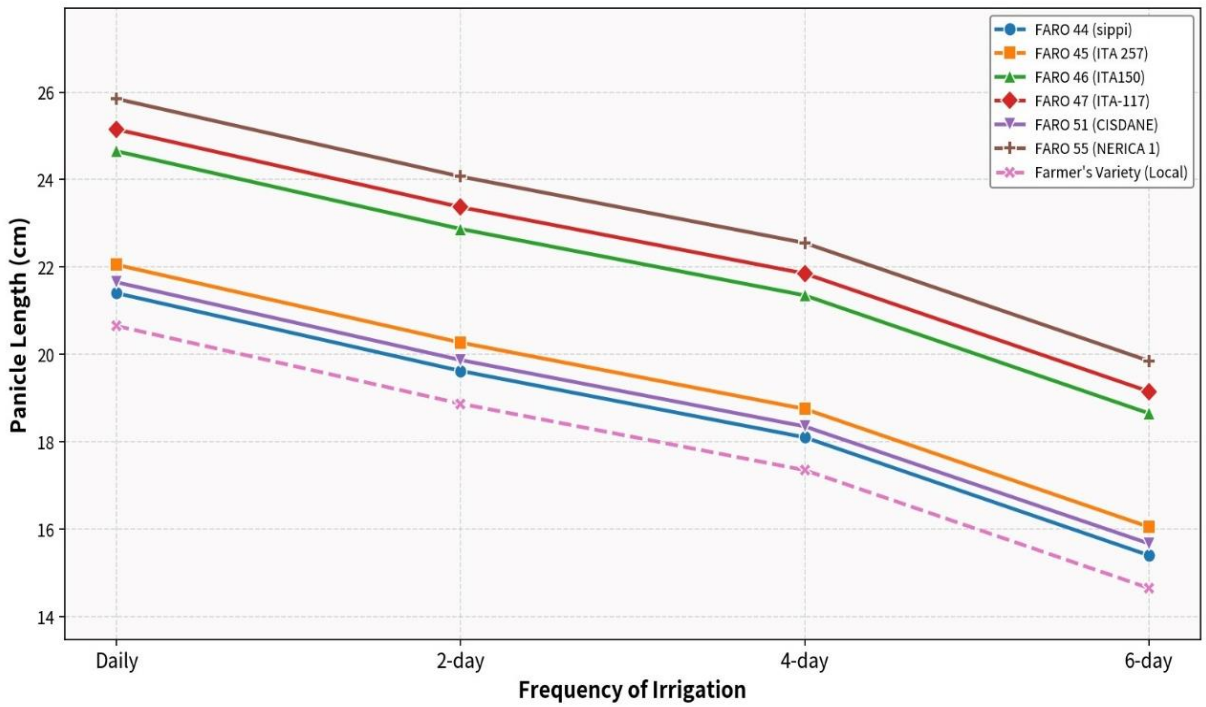


Figure 1. Interaction of Frequency of Irrigation (F) × Variety (V) on the panicle length (cm) of rice grown on the In-land Flood Plains of River Niger, Lokoja, Kogi State.

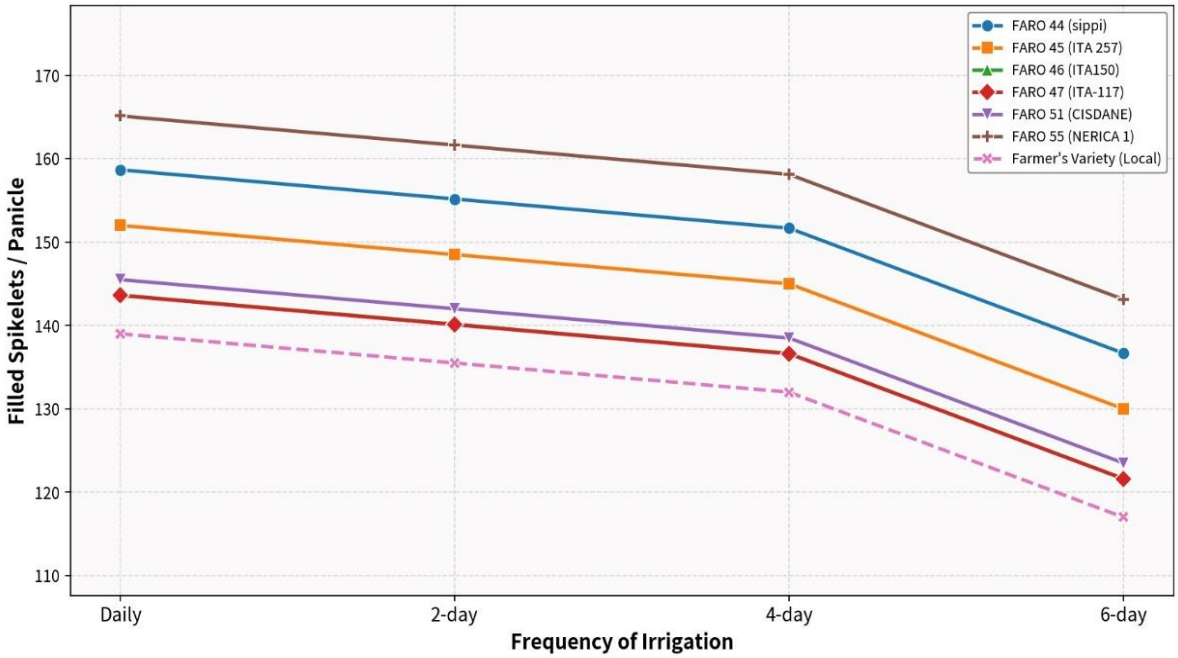


Figure 2. Interaction of Frequency of Irrigation (F) × Variety (V) on the filled spikelet/panicle of rice varieties grown on the In-land flood plains of River Niger, Lokoja, Kogi State.

Weight of panicles and grain yield were also affected by F×V interactions. FARO 55 (NERICA 1) had the maximum weight of panicles and grain yield at every irrigation level; these yields decrease with decrease in irrigation frequencies. Other varieties respond with a decrease in weight of panicles as frequencies of irrigation decreases. This implies that frequent water application is a factor for increased panicle weight. Farmer's Variety consistently produced lowest panicle weight across all irrigation level (figure 3). Similarly, yield decreases with decrease in irrigation frequencies amongst all varieties. Farmer's Variety offers the least response consistently producing the lowest yield across all irrigation levels (figure 4).

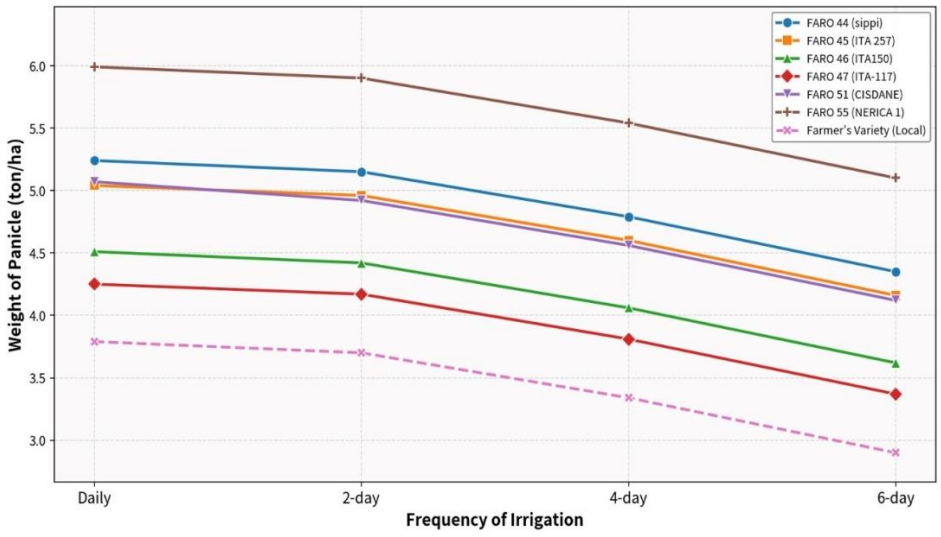


Figure 3. Interaction of Frequency of Irrigation (F) × Variety (V) on the weight of panicle (ton ha^{-1}) of rice varieties grown on the In-land Flood Plains of River Niger, Lokoja, Kogi State.

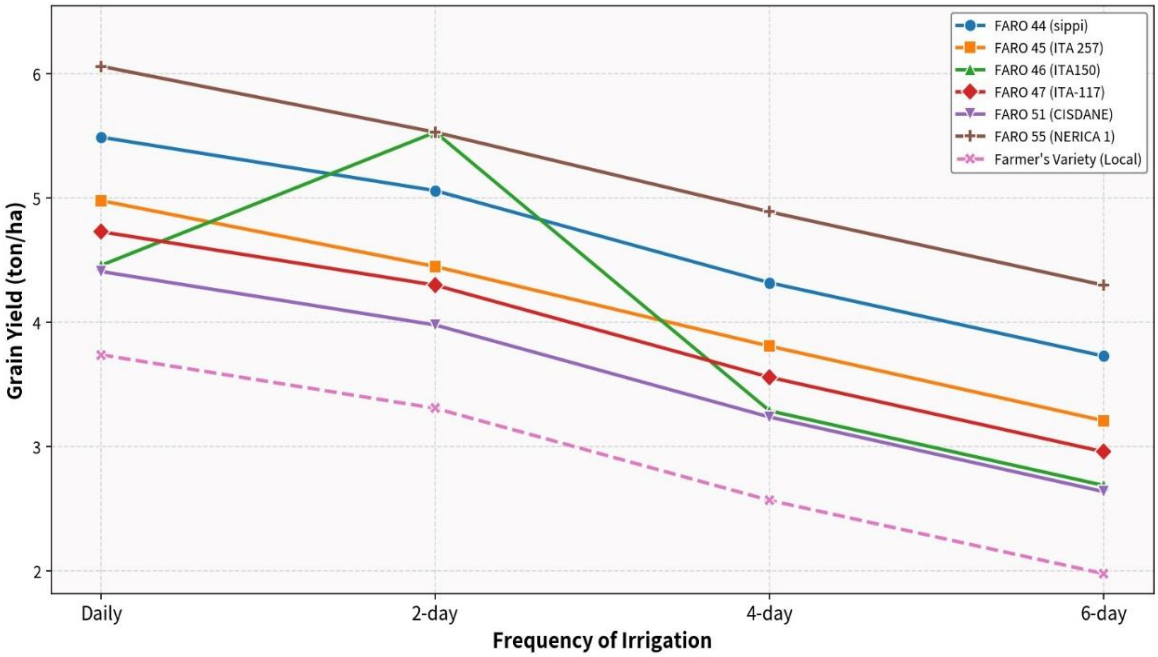


Figure 4. Interaction of Frequency of Irrigation (F) × variety (V) on the grain yield (ton ha^{-1}) of rice varieties grown on the In-land flood plains of River Niger, Lokoja, Kogi State.

DISCUSSION

The present study confirm that variety was the dominant source of variation in growth and yield performance of rice grown under the inland floodplain conditions of Lokoja. This is consistent with a growing body of literature that genetic differences among rice genotypes, rather than management alone, frequently determine the peak on attainable yield under variable moisture regimes (Fawole *et al*., 2024). In a rainfed evaluation of NERICA cultivars in Igboora, Oyo State, Fawole *et al*. (2024) similarly reported that NERICA-derived genotypes sustained markedly higher and more stable yields than conventional checks under fluctuating moisture availability, this pattern mirrors the consistent superiority of FARO 55 (NERICA 1) recorded across every growth and yield trait in the present study. The physiological basis for this superiority is well documented: NERICA cultivars were deliberately bred to combine the drought and stress resilience of *Oryza glaberrima* with the yield architecture of *Oryza sativa*, and this hybrid background confers advantages in tillering vigour, root development and reproductive-stage stress tolerance that are largely absent in unimproved landraces (Fawole *et al*., 2024). Working with a comparable genetic contrast, Mohamed *et al*. (2019) subjected fourteen rice genotypes, including NERICA 7 as a drought-tolerant check and Giza 177 as a drought-sensitive

check, to water deficit at the reproductive and ripening stages and found that the sensitive genotype lost more than 80 % of its grain yield under combined stress while the NERICA check lost comparatively little, this corresponds with the gap observed between FARO 55 (NERICA 1) and the Farmer's-Variety (Local) at every irrigation frequency in the present study.

The absence of a significant effect of irrigation frequency on later-stage growth traits and yield components such as panicle weight, grain yield and straw yield (Tables 3 and 4) may suggest that water application frequency is of limited agronomic consequence within this floodplain ecology. This interpretation would, however, be premature, since the frequency-by-variety interaction was significant for panicle length, filled spikelet/panicle, panicle weight and grain yield (figures 1-4). Mallareddy *et al*. (2023), in a comprehensive review of water-saving irrigation technologies for rice, emphasized that the productivity of any given irrigation regime is rarely uniform across genotypes, therefore scheduling recommendations validated on one cultivar cannot be assumed to transfer directly to others without local variety-specific testing, this aligns with significant irrigation frequency × variety interactions result. Similarly, Wudil *et al*. (2023b), stressed that inconsistent irrigation schedule translated into significant yield differences even within a single scheme, working within the Kano River Irrigation Project, they demonstrated that the frequency and reliability of water delivery, not merely its cumulative volume, is a decisive productivity lever in Nigerian rice systems.

The magnitude of yield decline with reduced irrigation frequency nonetheless carried clear physiological and practical significance. Grain yield fell from a floodplain-wide daily-irrigation mean of 5.64 t/ha to 2.11 t/ha under the 6-day regime (Table 4), a reduction of over 60%, underscoring that even in a moisture-retentive floodplain, supplementary irrigation frequency remains agronomically decisive once the natural flood has receded. This finding aligns with the physiological understanding that although rice tolerates continuous flooding through aerenchyma-mediated oxygen transport, water deficit at critical reproductive stages directly suppresses panicle elongation and spikelet fertility (Mallareddy *et al*., 2023). Working specifically on the tillering-to-panicle-initiation window, Gao *et al*. (2025) demonstrated that alternate wetting and drying imposed at the tillering stage altered sucrose and cytokinin content within developing panicles in ways that preserved spikelet fertility and spikelet number, indicating that the physiological consequences of irrigation timing are established well before flowering and are later expressed as the panicle length and filled spikelet reductions observed with lengthening irrigation intervals in the present study (figures 1 and 2).

At the same time, the interaction data reveal an important practical nuance. FARO 55 (NERICA 1) not only produced the highest absolute yields at every irrigation frequency but also retained a comparatively high proportion of its daily-irrigation yield potential even under the 6-day regime, whereas the Farmer's-Variety remained the least responsive and lowest-yielding genotype under every water regime tested. This V×F interaction reinforces the position that generic, variety-blind irrigation recommendations are of limited value to floodplain farmers who typically cultivate multiple varieties within the same cropping cycle (Fawole *et al*., 2024). Comparable evidence from an irrigation scheme in Niger State found that scheduling interval, rather than cumulative water volume, was an independent determinant of tiller survival, panicle development and grain yield in Farro 44 rice, with 6-8 days intervals reducing water use substantially without a proportionate yield collapse (Otuaro *et al*., 2024). Likewise, a two-year multi-location study combining variable irrigation regimes with nitrogen management found that a recommended irrigation-scheduling regime performed statistically comparably to continuous flooding while improving the benefit-cost ratio of production (Mir *et al*., 2025), and a Southeast Nigerian pilot of sensor-guided alternate wetting and drying achieved a 30% reduction in water use relative to continuous irrigation without a corresponding yield penalty (Ume and Ume, 2024). For Lokoja's floodplain farmers, these results collectively suggest that where water and labor permit daily or near-daily watering after flood recession, FARO 55 (NERICA 1) offers the greatest yield return; however, where water access or labor is constrained, a 2-day interval still preserves a substantial share of attainable yield relative to the sharp losses observed under the 4- and 6-day watering regimes, consistent with the broader principle that well-timed, non-continuous water application, rather than water abundance per se, is what ultimately governs profitable rice cultivation under floodplain and irrigation-scheme conditions alike (Arouna *et al*., 2023).

CONCLUSION

This study demonstrated that variety and irrigation frequency, and particularly their interaction, are important determinants of growth and yield performance in the inland floodplains of the River Niger, Lokoja, Kogi State. Variety was the single most consistent source of variation, with FARO 55 (NERICA 1) outperforming all others, across nearly all the traits measured. While irrigation frequency did not always exert a significant effect on yield components, the significant V×F interaction and the consistent decline in yield and yield-related traits as watering interval lengthened confirmed that reduced irrigation frequency imposes a real yield decline once residual flood moisture is exhausted. Daily to 2-day irrigation intervals, in combination with FARO 55

(NERICA 1), produced the best overall growth and yield outcomes and are recommended for floodplain farmers seeking to maximize productivity where water and labor resources allow. Where these resources are limiting, a 2-day interval offers a more water-conserving option that still retains a meaningfully greater share of attainable yield than the 4- or 6-day regimes. The continued reliance of many floodplain farmers on local landraces such as the Farmer's-Variety used in this study represents a significant and readily addressable constraint on productivity; extension efforts directed at improving variety adoption, alongside locally validated irrigation-scheduling guidance, may therefore be imperative as complementary and cost-effective levers for narrowing the rice yield gap in Kogi State's floodplain communities. Further multi-season trials that incorporate direct water-use efficiency and cost-benefit measurements are recommended to refine these recommendations and support their scaling to comparable floodplain ecologies along the Niger-Benue confluence.

Article Publication Details
This article is published in the **International Journal of Multidisciplinary Research and Bulletin**, ISSN 3108-1428 (Online). In Volume 5 Issue 5 (Sep – Oct) 2026.
The journal is published and managed by **IRPG**.

Acknowledgements
The authors sincerely acknowledge the Tertiary Education Trust Fund (TETFund) for its support through the Institution-Based Research (IBR) intervention. They also express their sincere gratitude to the riverine farmers along the Niger and Benue rivers for their cooperation and support throughout the experimental period. Furthermore, the authors appreciate the editors and reviewers for their valuable comments and suggestions, which contributed to improving the quality of this manuscript.

Authors' Contributions
Musa, U. T. conceived and designed the study, wrote the protocol, collected the preliminary data, carried out the final data analysis, interpreted and discussed the results. Yusuf, M. and E. S Attah, conducted the preliminary literature review, executed the experiment with support from Musa U.T., performed the preliminary data analysis, and wrote the manuscript, which was critically reviewed by Musa U.T. All the authors read and approved the final manuscript.

Funding
This research was funded by the Tertiary Education Trust Fund (TETFund) under the Institution-Based Research (IBR) intervention.

Data availability
The datasets generated and analyzed during the current study are available with the corresponding author on reasonable request.

Declarations
Ethics approval and consent to participate
The author(s) declare that it is not applicable.

Consent for publication
The author(s) declare that this is not applicable.

Competing interests
The author(s) declare that they have no competing interests.

References

1. Anonymous. Annual report 2021–22. Department of Agriculture, Cooperation and Farmers Welfare, GOI, 2021; pp. 48–49.
2. Arouna, A., Dzomeku, I. K., Shaibu, A. G., & Nurudeen, A. R. Water management for sustainable irrigation in rice (*Oryza sativa* L.) production: A review. *Agronomy*, 2023;13(6), 1522. https://doi.org/10.3390/agronomy13061522
3. Fawole, T.O., Ogunsina, O.A., Popoola, O.J., Oyeniyi-Robinson, M.O. and Bidmos, F.A. The Performance of Selected NERICA Rice (*Oryza sativa* L.) Cultivars under a Rainfed Irrigation System in Igboora, Oyo State, Nigeria. *Journal of Agricultural and Environmental Science Research*, 2024;6(1).
4. Gao, T., Xie, K., Hu, Q., Wu, C., Wang, Z., Wang, W., Xiong, D., Huang, J., Peng, S., & Cui, K. (2025). Alternate wetting and drying irrigation at tillering stage enhances the heat tolerance of rice by increasing sucrose and cytokinin content in panicles. *Frontiers in Plant Science*, 16, 1598652. https://doi.org/10.3389/fpls.2025.1598652
5. Mallareddy, M., Thirumalaikumar, R., Balasubramanian, P., Naseeruddin, R., Nithya, N., Mariadoss, A., Eazhilkrishna, N., Choudhary, A. K., Deiveegan, M., Subramanian, E., Padmaja, B., & Vijayakumar, S. Maximizing water use efficiency in rice farming: A comprehensive review of innovative irrigation management technologies. *Water*, 2023;15(10), 1802. https://doi.org/10.3390/w15101802
6. Mir, M. S., Raja, W., Kanth, R. H., Dar, E. A., Shah, Z. A., Bhat, M. A., Mir, A. H., Wani, F. J., Bhat, T. A., Bhat, J. A., Summuna, B., Fayaz, U., Fayaz, S., Bhat, B. A., Al-Ansari, N., Mattar, M. A., & Salem, A. Optimizing irrigation and nitrogen levels to achieve sustainable

rice productivity and profitability. *Scientific Reports*, 2025;15(1), 6675. https://doi.org/10.1038/s41598-025-90464-8

7. Mohamed, A., Sedeek, S., & Galal, A. Effect of water deficiency as abiotic stress on the reproductive and ripening stage of rice genotypes. *International Journal of Plant Science and Agriculture*, 2019;2(1), 13-19.
8. Otuaro, E. A., Musa, J. J., Kuti, A. I., Obasa, P., & Daniel, S. E. Effect of water application rate on growth parameters of Farro 44 rice grown in a selected irrigation scheme in Niger State, Nigeria. *Agricultural Sciences*, 2024;15, 533-547. https://doi.org/10.4236/as.2024.155030
9. Rajput P, Singh A K, Rajput R K and Singh A. Effect of nitrogen levels on yield and yield attributes of rice (*Oryza sativa* L.) grown under different planting geometry. *Indian Journal of Agronomy* 2020;65(2): 235–37.
10. Ume, C., & Ume, S. Leveraging artificial intelligence for sustainable irrigated rice production: A case of smart alternate wetting and drying in Nigeria. IAAE 2024 Conference, August 2-7, 2024, New Delhi, India. International Association of Agricultural Economists. https://doi.org/10.22004/ag.econ.344260
11. Wudil, A. H., Ali, A., Usman, M., Radulescu, M., Sass, R., Prus, P., & Musa, S. Effects of inequality of access to irrigation and water productivity on paddy yield in Nigeria. *Agronomy*, 2023b;13(9), 2195. https://doi.org/10.3390/agronomy13092195
12. Wudil, A.H., Ali, A., Mushtaq, K., Baig, S.A., Radulescu, M., Prus, P., Usman, M. and Vasa, L. Water Use Efficiency and Productivity of Irrigated Rice Cultivation in Nigeria: An Application of the Stochastic Frontier Approach. *Sustainability*, 2023a;15(10), 7824.

Publisher's Note:
IRPG remains neutral with regard to jurisdictional claims in published maps and institutional affiliations. The statements, opinions, and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of IRPG and/or the editor(s). IRPG disclaims responsibility for any injury to people or property resulting from any ideas, methods, instructions, or products referred to in the content.