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EFFECT OF POULTRY LITTER APPLICATION RATE AND MATURITY ON GROWTH COMPONENTS AND NUTRITIONAL VALUE OF SUPER NAPIER GRASS AS RUMINANT FEED

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ABSTRACT

The study was conducted at the Livestock Teaching and Research Farm of the Federal University Wukari, Taraba State, Nigeria, to evaluate the effect of poultry litter application rate and harvesting age on growth components, herbage yield and nutritional value of Super-Napier grass (*Pennisetum purpureum* × *Pennisetum americanum*). The experiment was a 4 × 4 factorial arranged in a Randomised Complete Block Design (RCBD) with three replicates. Four levels of poultry litter (0, 5, 10, and 15 t/ha) and four harvesting ages (45, 60, 75, and 90 days after cutback) were evaluated. Results showed that increasing poultry litter application rate significantly (P<0.05) improved plant height, stand circumference, number of tillers, stem girth, leaf area index, and biomass yield. Plots that received 15 t/ha recorded the highest plant height (272.81 cm) and biomass yield (71.70 t/ha), while the control recorded the lowest (232.53 cm and 29.57 t/ha, respectively). Harvesting at 90 days after cutback produced the tallest plants (297.42 cm) and the highest biomass (60.14 t/ha), but with the lowest crude protein content (6.27% DM) and the highest Lignin fraction (19.71%). The 60-day harvest yielded the highest crude protein (7.32% DM). A significant (P<0.05) interaction effect was observed between application rate and harvesting age for most growth and nutritional parameters. It was concluded that poultry litter at 10 t/ha combined with harvesting at 60 days after cutback optimizes both yield and nutritional quality of Super Napier grass for ruminant feeding in the Nigerian Guinea Savanna zone.

Keywords: Herbage yield, crude protein, harvesting age, poultry litter, Super Napier Grass

INTRODUCTION

Inadequacy of quality forage has been a major constraint to the ruminant subsector in Nigeria especially during the prolonged dry season that characterise the Guinea Savanna and Sahel zones. The production of forages which constitute the bulk of economical feed resource for ruminant livestock is often militated against by poor soil fertility, inappropriate management and limited adoption of improved grass varieties (Ayub et al., 2022). Research attention is being focused on Super-Napier grass (*Pennisetum purpureum* × *Pennisetum americanum*) owing to its superior biomass productivity, rapid regrowth, wide adaptability, and comparatively high crude protein content in comparison with conventional Napier grass (Mwendia et al., 2021; Neumann et al., 2022).

Forage grass productivity is influenced by soil fertility management. Although inorganic fertilizers are effective in their ease of mineralization, their cost is beyond the capability of smallholder livestock farmers in Nigeria. Poultry litter, a readily available organic by-product of the poultry industry, offers a sustainable and cost-effective alternative. It is recognized as a balanced source of macro- and micronutrients, including nitrogen, phosphorus, potassium, and trace elements, and improves soil physical and biological properties when applied at appropriate rates (Bello et al., 2021; Guo et al., 2023). Studies on conventional Napier grass have reported significant positive responses to organic manure application in terms of yield and nutritional quality, but information on the Super-Napier hybrid under Nigerian ecological conditions, and particularly in Wukari in Guinea Savana zone remains sparse.

Harvesting age is a vital management variable. It governs the balance between yield and quality, since advancing maturity generally increases biomass accumulation but simultaneously reduces crude protein and increases structural carbohydrate fractions, thereby reducing digestibility and voluntary intake by ruminants (Tessema et al., 2020; Adjolohoun et al., 2021). Determining the optimal harvest interval that maximises both yield and nutritional value is therefore essential for sustainable forage production systems, fixing a suitable standpoint for the tradeoff between quality and quantity.

Despite the economic and nutritional importance of Super-Napier grass, scientific data on the combined influence of organic manure application and harvesting age on its agronomic and nutritional attributes are limited in the Nigerian context. This study was therefore conducted to determine the effect of poultry litter application rate and harvesting age on growth components, herbage yield, and nutritional value of Super-Napier grass, with a view to developing site-specific management recommendations for smallholder ruminant producers in Taraba State and similar agroecologies in the Guinea Savana zone of Nigeria.

MATERIALS AND METHODS

Study Area

The experiment was conducted at the Teaching and Research Farm of the Federal University Wukari, Taraba State, Nigeria with Latitude 7°51'N; Longitude 9°46'E; altitude approximately 178 m above sea level. The area lies within the Southern Guinea Savanna agro-ecological zone, with mean annual rainfall of approximately 1,100 mm distributed between April and October. Mean daily temperature ranges between 24°C and 36°C. The soil is classified as sandy loam Alfisol (Gani & Awwal, 2025).

Experimental Design and Treatment

The experiment was a 4 × 4 factorial arranged in a Randomised Complete Block Design (RCBD) with three replicates, giving a total of 48 experimental plots. The two factors were: (i) poultry litter application rate at four levels: T_1: 0 t/ha (control), T_2: 5 t/ha, T_3: 10 t/ha, and T_4: 15 t/ha; and (ii) harvesting age at four levels: 45, 60, 75, and 90 days after cutback (DAC) replicated thrice. Each plot measured 3 m × 2.5 m (7.5 m²), with 1.0 m alleys between plots with plant spacing of 80 cm x 50 cm.

Planting and Management

Super-Napier grass stem cuttings of three nodes were planted at a spacing of 80 cm × 40 cm. The grass was allowed to establish for 45 days before a uniform cutback was carried out at 10 cm above soil level to standardize the regrowth cycle. Composted and dried poultry litter was applied at the treatment application rates stated above by broadcasting and incorporation into the topsoil (0–15 cm) immediately after cutback to ensure plant roots absorb the nutrients as they mineralized. Weeding was carried out manually to ensure the plots were always weed free.

Growth Parameters Data Collection

Super Napier grass re-growth was harvested at four intervals: 45, 60, 75 and 90 days after cutback. At each interval, the grass was harvested by cutting all the six plant stands that constitute the middle rows at 10 cm above ground level, excluding all the14 plant stands at the edge of each plot. Parameters measured included plant height, measured with a measuring tape from ground level to the apex of the longest leaf determined by compressing the leaves to select the longest leaf on the tallest plant per stand; leaf length, measured with measuring tape from the collar of the sheath of the leaf selected for plant height; leaf width, measured with measuring tape at the widest point on the leaf used for length determination; stand circumference, measured by firmly folding a measuring tape around the base of the plant stand and taking the circumference; number of leaves per plant; stem girth, measured from the third node above the ground level on tallest stem per plant stand; number of tillers, leaf-to-stem ratio measured by detaching all leaves from the selected plant per stand and weighing the leaves and stem separately using sensitive weighing scale; and leaf area index (LAI) estimated using the formula: LAI = {leaf length (m) × leaf width (m) × leaf number x tiller number × 0.75}.

Herbage Yield Data Collection

For fresh biomass yield determination, all the plants harvested from each plot were weighed using a digital weighing scale and the yield expressed in tonnes per hectare. From each tallest tiller used for height determination, stem and leaf samples were collected, placed in labeled airtight zipper plastic bags to preserve their integrity and transported promptly to the Central Laboratory, Federal University Wukari for dry matter and other nutrient composition determination as described by Meel *et al.* (2025).

Proximate Composition and Cell Wall Fiber Fractions

Representative dried and ground samples (1 mm screen) were analyzed for proximate composition: dry matter (DM), crude protein (CP), ether extract (EE), crude fiber (CF), ash, and nitrogen-free extract (NFE) following the procedures of the Association of Official Analytical Chemists (AOAC, 2019). Cell wall fiber fractions comprising neutral detergent fiber (NDF), acid detergent fiber (ADF), acid detergent lignin (ADL), cellulose, and hemicellulose were determined according to the sequential detergent fiber procedures of Van Soest et al. (1991). Cellulose was calculated as ADF − ADL, and hemicellulose as NDF − ADF.

Statistical Analysis

Data collected were subjected to a two-way analysis of variance (ANOVA) using JMP Clinical 18. Significant treatment means were separated using the Tukey–Kramer Honestly Significant Difference (HSD) test at the 5% level of significance. Interaction effects between poultry litter application rate and harvesting age were also evaluated.

RESULTS AND DISCUSSION

Effect of Poultry Litter Application Rate on Growth Components and Yield

The effects of poultry litter application rate on growth parameters and biomass yield of Super-Napier grass are presented in Table 1. Poultry litter application rate significantly ($P<0.05$) influenced all growth parameters except the leaf-to-stem ratio ($P=0.5189$). Plant height, leaf width, stand circumference, number of leaves, number of tillers, stem girth, LAI, and biomass yield all increased progressively with increasing application rate. The highest values for plant height (272.81 cm), number of tillers (11.35), stem girth (8.70 cm), LAI (8.00), and biomass yield (71.70 t/ha) were recorded in T_4 (15 t/ha), which differed significantly ($P<0.05$) from the control (T_1) but was comparable to T_3 (10 t/ha) for most parameters. The LAI values in this study are within the range of 5.7 – 9.49 reported by Soumya (2011) with Napier grass of different varieties with similar spacing. The control had the lowest plant height (232.53 cm) and biomass yield (29.57 t/ha).

These findings are consistent with the well-established stimulatory effect of organic manure on grass productivity. Nitrogen, the principal growth-limiting nutrient in tropical soils, is supplied in considerable quantities by poultry litter and promotes meristematic activity, leaf expansion, tiller differentiation, and ultimately biomass accumulation (Bello et al., 2021). The nutrient-supplying capacity of poultry litter also improves soil organic matter, water-holding capacity, and cation exchange capacity, creating a more favourable rhizosphere environment for root exploration and nutrient uptake (Guo et al., 2023). Comparable improvements in Napier grass yield in response to organic manure application have been reported by Adjolohoun et al. (2021) and Tessema et al. (2020), who attributed the responses primarily to improved nitrogen availability. The non-significant effect on leaf-to-stem ratio suggests that the structural development of the plant was proportionally maintained regardless of the fertility level imposed.

Table 1: Effect of Poultry Litter Application Rate on Growth Parameters and Yield of Super Napier Grass

P.L.A Rates	Plant height (cm)	Leaf Length. (cm)	Leaf Width. (cm)	Stand Circum-ference (cm)	No. of leaves	No. of tillers	Leaf: Stem ratio	Stem Girth (cm)	LAI	Biomass (tons/Ha)
T_1	232.53^{c}	110.26^{b}	3.90^{c}	45.09^{c}	16.89^{b}	6.57^{c}	1.98	7.64^{b}	5.09^{c}	29.57^{c}
T_2	257.38^{b}	111.86^{b}	4.32^{b}	53.48^{b}	19.08^{a}	8.28^{b}	2.05	7.98^{b}	5.75^{bc}	51.78^{b}
T_3	265.02^{ab}	122.64^{a}	4.29^{b}	61.21a	18.91^{a}	9.46^{b}	2.37	7.88^{b}	7.03^{ab}	66.30^{a}
T_4	272.81^{a}	113.51^{b}	4.84^{a}	56.77^{ab}	18.79^{a}	11.35^{a}	2.18	8.70^{a}	8.00^{a}	71.70^{a}
SEM	3.3294	1.213	0.066	1.536	0.226	0.434	0.198	0.130	0.4865	2.920
P-Value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.5189	<0.0001	0.0001	<0.0001

Means with different superscripts on same column are significantly (P < 0.05) different, P.L.A = Poultry Litter Application, T_1 = Control, T_2 = 5 tons/Ha, T_3 = 10 tons/Ha, T_4 = 15 tons/Ha, LAI = Leaf area index

Effect of Harvesting Age on Growth Components and Yield

From the results presented in Table 2, harvesting age significantly (P<0.05) affected plant height, leaf length, leaf width, stand circumference, number of leaves, number of tillers, leaf-to-stem ratio, and stem girth, but not LAI (P=0.4018). Plant height increased consistently from 223.51 cm at 45 DAC to 297.42 cm at 90 DAC, reflecting continued vegetative elongation with advancing maturity. Similarly, stand circumference and number of leaves were highest at 90 DAC, consistent with the accumulation of structural biomass over time. Biomass yield was highest at 90 DAC (60.14 t/ha) and lowest at 60 DAC (50.15 t/ha), though the 75 and 90 DAC harvests were statistically comparable.

The progressive increase in plant height and biomass yield with advancing harvest age is consistent with the report of Neumann et al. (2022) who noted such increase as a common feature of tall tropical grasses and attributed it to the ontogenetic shift from juvenile to mature growth phases, characterized by accelerated internode elongation and increased structural tissue deposition. The relatively lower yield at 60 DAC compared to 75 and 90 DAC may be attributable to the rapid mobilization of reserves post-cutback, with net productivity increasing as the canopy approaches light saturation (Mwendia et al., 2021). The non-significant effect on LAI may reflect compensatory canopy architecture across ages under the experimental conditions. These results agree with the findings of Ayub et al. (2022), who reported increasing yield with advancing maturity in *Pennisetum* species.

Table 2: Effects of Age on Growth Parameters and Yield of Super Napier Grass

AGE (DAC)	Plant height (cm)	Leaf Lenght. (cm)	Leaf Width (cm)	Stand Circumf. (cm)	No. leaves	No. tillers	Leaf: Stem ratio	Stem Girth (cm)	LAI	Biomass (tons/Ha)
45	223.51^{d}	125.93^{a}	4.40^{a}	46.63^{c}	16.37^{c}	9.53^{a}	1.84^{bc}	7.75^{b}	6.6.1	50.80^{b}
60	238.03^{c}	116.75^{b}	4.50^{a}	53.75^{b}	18.65^{b}	7.82^{b}	1.68^{c}	8.48^{a}	5.7.5	50.15^{bc}
75	268.76^{b}	105.24^{d}	4.36^{a}	51.83^{bc}	18.29^{b}	8.72^{ab}	2.64^{a}	8.46^{a}	6.74	58.26^{a}
90	297.42^{a}	110.36^{c}	4.08^{b}	64.33^{a}	20.36^{a}	9.59^{a}	2.42^{ab}	7.52^{b}	6.7.7	60.14^{a}
SEM	3.3294	1.2127	1.0651	1.5357	0.22539	0.43418	0.19837	0.12962	0.4865	2.9196
P-Value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0128	0.0013	<0.0001	0.4013	0.028

Means with different superscripts along same column are significantly (P < 0.05) different, 45, 60, 75 and 90 are harvesting ages in days., LAI = Leaf Area Index

Interaction Effect of Poultry Litter Application Rate and Harvesting Age on Growth Components and Yield

A significant (P<0.05) interaction was observed between poultry litter application rate and harvesting age for all parameters measured as presented in Table 3. The combination of T_4 (15 t/ha) at 90 DAC produced the tallest plants (317.22 cm), while $T_3 \times 60$ DAC yielded the highest biomass (84.88 t/ha) among all treatment combinations. Conversely, the lowest biomass was recorded in $T_1 \times 90$ DAC (28.37 t/ha).

The significant interaction implies that the response of Super-Napier grass to harvesting age was modified by the prevailing fertility level. At higher fertility levels, accelerated canopy closure and enhanced photosynthate production may have increased the rate of dry matter accumulation at specific harvest intervals, thus amplifying yield differences across ages. The superior performance of $T_3 \times 60$ DAC in terms of biomass (84.88 t/ha) suggests a critical threshold at which nutrient availability and harvest timing converge to maximize productivity, without the excessive fiber accumulation characteristic of later harvests. This importantly denotes that producers can achieve high biomass yields by applying 10 t/ha of poultry litter and harvesting at 60 DAC rather than waiting longer, thereby increasing annual harvest frequency. Similar interactive effects of manure and harvest management was reported in Napier and elephant grass in sub-Saharan Africa (Adjolohoun et al., 2021; Bello et al., 2021).

Table 3: Effect of Interaction of Poultry Litter Application Rate and Age on Growth Parameters and Yield of Super Napier Grass

P.L.A * AGE	Plant height (cm)	Leaf Length. (cm)	Leaf Width (cm)	Stand Circum-ference (cm)	No. of leaves	No. of tillers	Leaf: Stem ratio	Stem Girth (cm)	LAI	Biomass (tons/Ha)
T_1,45	197.83^{g}	114.06^{bcd}	3.89^{cd}	40.12^{f}	15.59^{fg}	7.66^{cde}	1.03^{de}	7.33^{cde}	4.04^{bc}	30.93^{d}
T_1,60	194.94^{g}	113.44^{bcd}	4.37^{bc}	44.78^{ef}	17.83^{cde}	5.28^{e}	1.58^{bcde}	7.99^{bcde}	3.41^{c}	28.83^{d}
T_1,75	261.89^{cde}	108.44^{cde}	3.91^{cd}	47.44^{def}	15.78^{efg}	7.89^{cde}	2.03^{bcde}	8.33^{bcd}	9.82^{a}	30.13^{d}
T_1,90	275.44^{bcd}	105.11^{de}	3.44^{d}	48.00^{def}	18.33^{bcd}	5.44^{e}	3.26^{abc}	6.89^{e}	3.06^{c}	28.37^{d}
T_2,45	233.22^{ef}	120.53^{b}	4.78^{ab}	47.26^{def}	16.78^{defg}	7.78^{cde}	1.45^{cde}	8.40^{abcd}	5.78^{abc}	51.37^{cd}
T_2,60	243.72^{def}	113.67^{bcd}	4.39^{bc}	49.83^{def}	19.72^{abc}	5.83^{de}	1.73^{bcde}	8.28^{bcd}	4.39^{bc}	31.11^{d}
T_2,75	260.44^{cde}	106.89^{cde}	4.02^{cd}	50.28^{def}	18.50^{bcd}	11.06^{abc}	1.57^{bcde}	7.74^{cde}	6.52^{abc}	64.94^{abc}
T_2,90	292.11^{abc}	106.33^{cde}	4.09^{cd}	66.56^{ab}	21.33^{a}	8.44^{cde}	3.45^{ab}	7.51^{cde}	6.32^{abc}	59.72^{abc}
T_3,45	238.78^{ef}	151.78^{a}	4.18^{bc}	49.80^{def}	17.78^{cdef}	9.22^{bcde}	3.26^{abc}	7.22^{de}	8.40^{ab}	48.67^{cd}
T_3,60	$251d^{ef}$	124.06^{b}	4.48^{bc}	59.00^{bcde}	18.56^{bcd}	9.78^{abcd}	1.46^{cde}	8.54^{abc}	7.64^{abc}	84.88^{a}
T_3,75	265.39^{cde}	98.72^{e}	4.18^{bc}	58.78^{bcde}	18.56^{bcd}	7.89^{cde}	2.15^{bcde}	8.156^{bcd}	3.89^{bc}	55.15^{bcd}
T_3,90	304.9^{ab}	115.99^{bcd}	4.31^{bc}	77.26^{a}	20.76^{a}	10.94^{abc}	2.61^{bcd}	7.62^{cde}	8.20^{ab}	76.49^{abc}
T_4,45	224.22^{fg}	117.33^{bc}	4.76^{ab}	49.36^{def}	15.33^{g}	13.44^{ab}	1.62^{bcde}	8.02^{bcde}	8.23^{ab}	72.22^{abc}
T_4,60	262.44^{cde}	115.83^{bcd}	4.78^{ab}	61.39^{bcd}	18.50^{bcd}	10.39^{abc}	1.95^{bcde}	9.09^{ab}	7.56^{abc}	55.78^{bcd}
T_4,75	287.33^{abc}	106.89^{cde}	5.34^{a}	50.83^{cdef}	20.33^{ab}	8.06^{cde}	4.80^{a}	9.61^{a}	6.71^{abc}	82.82^{ab}
T_4,90	317.22^{a}	114.00^{bcd}	4.49^{bc}	65.50^{abc}	21.00^{a}	13.50^{a}	0.36^{e}	8.07^{bcde}	9.49^{a}	75.97^{abc}
SEM	6.6589	2.4255	0.1326	3.0715	0.4508	0.8683	0.3968	0.2592	0.9730	5.8393
P-Value	0.0003	<0.0001	< 0.0001	0.015	<0.0001	<0.0001	<0.0001	0.0021	< 0.0001	< 0.0001

Means with different superscripts along columns are significantly (P < 0.05) different, T_1 = Control, T_2 = 5 tons/Ha, T_3 = 10 tons/Ha, T_4 = 15 tons/Ha, P.L.A*AGE = Interaction of Poultry Litter Application Rate and Age, 45, 60, 75 and 90 as harvest age in days

Effect of Poultry Litter Application Rate on Proximate Composition and Cell Wall Fiber Fractions

The effect of poultry litter application rate on proximate composition and cell wall fiber fractions is presented in Table 4. Poultry litter application rate significantly (P<0.05) influenced crude protein, ether extract, ash, ADL, and hemicellulose contents, but had no significant (P>0.05) effect on DM, crude fiber, NFE, NDF, ADF, and cellulose. Crude protein was significantly (p - < 0.05) highest in T_2 (7.09%) and progressively declined at T_3 (6.87%) and T_4 (6.63%), the latter being significantly lower than T_2. Ash content increased with increasing application rate, being highest in T_3 (11.77%). Hemicellulose was highest in T_1 (4.77%) and lowest in T_3 (3.92%).

The relatively modest differences in CP across treatment levels are noteworthy. While poultry litter is an effective nitrogen source, the high plant biomass accumulation at elevated application rates may have diluted the per-unit nitrogen concentration in plant tissues. This aligns with Van Soest et al. (1991 and Guo et al. (2023) who described such phenomenon as 'growth dilution'. Elevated ash content with increasing poultry litter rates reflects the mineral-rich nature of poultry litter and enhanced mineral uptake by the plant. The non-significant effects on structural carbohydrate fractions

(NDF, ADF, cellulose) suggest that organic manure application did not substantially alter the cell wall deposition process at these application rates, which agrees with the findings of Tessema et al. (2020) in Napier grass. The significant reduction in hemicellulose at higher rates warrants further investigation but may reflect altered carbohydrate partitioning pathways under enhanced nutrient availability.

Table 4: Effect of Poultry Litter Application Rate on Proximate Composition and Cell Wall Fiber Fraction of Super Napier Grass

P.L.A rate	Treatment (%)										
	Dry Matter	Crude Protein	Ether Extract	Crude Fiber	Ash	NFE	NDF	ADF	ADL	Cellulose	Hemice-llulose
T_1	93.16	6.80^b	3.41^b	29.37	11.20^c	42.04	43.33	38.37	18.89^{ab}	19.45	4.77^a
T_2	93.21	7.09^a	3.31^c	28.9	11.40^{bc}	42.14	42.65	38.19	18.79^{ab}	19.38	4.29^c
T_3	93.66	6.87^b	3.33^c	29.17	11.77^a	42.13	42.65	38.37	18.66^b	19.68	3.92^d
T_4	93.86	6.63^c	3.82^a	29.43	11.46^b	42.13	43.12	38.60	19.17^a	19.4	4.41^b
SEM	0.011	5.48x10^{-5}	0.00003	0.0003	0.0001	0.0006	0.0005	0.0005	0.0002	0.0002	0.00004
P – value	0.7235	< 0.0001	0.0001	0.0963	< 0.0001	0.9894	0.1007	0.5966	0.0068	0.1732	<0.0001

Means with different superscript on the same column are significantly (P < 0.05) different. P.L.A = Poultry Litter Application, T_1 =Control, T_2 = 5 tons/Ha, T_3 = 10 tons/Ha, T_4 = 15 tons/Ha, 45, 60, 75 and 90 are harvesting ages

Effect of Harvesting Age on Proximate Composition and Cell Wall Fiber Fractions

Harvesting age significantly (P<0.05) influenced all proximate and fiber fraction parameters except DM (P=0.5319) as presented in Table 5. Crude protein was highest at 60 DAC (7.32% DM) and lowest at 90 DAC (6.27% DM). Ether extract declined progressively with advancing age, from 5.07% at 45 DAC to 2.32% at 90 DAC. Conversely, crude fiber, ash, NFE, NDF, ADF, ADL, cellulose, and hemicellulose all increased significantly with advancing harvesting age as expected.

The progressive decline in crude protein with advancing maturity is a classical characteristic of tropical grasses and is attributed to the dilution of nitrogen-containing cellular components by rapidly accumulating structural carbohydrates, lignification of cell walls, and the redistribution of nitrogen from older to younger leaves (Tessema et al., 2020; Adjolohoun et al., 2021). The peak CP at 60 DAC (7.32%) rather than 45 DAC may reflect an optimum between leaf area development and nitrogen dilution. The concurrent increase in NDF (38.90% at 45 DAC to 46.09% at 75 DAC), ADF, ADL, cellulose, and hemicellulose with advancing maturity indicates progressive cell wall thickening and lignification, which are known to reduce ruminal fermentability and voluntary intake in ruminants (Van Soest et al., 1991; Neumann et al., 2022). The high hemicellulose content at 90 DAC (6.49%) compared to 45 DAC (1.81%) further illustrates this developmental trajectory. From a nutritional standpoint, these results suggest that harvesting at 60 DAC represents a favourable compromise between yield and quality for ruminant feeding.

Table 5: Effect of Harvesting Age on Proximate Composition and Cell Wall Fiber Fraction of Super Napier Grass

Harvest Age (DAC)	Parameters (%)										
	Dry Matter	Crude Protein	Ether Extract	Crude Fiber	Ash	Nitrogen Free Extract	Nitrogen Detergent Fiber	Acid Detergent Fiber	Acid Detergent Lignin	Cellulose	Hemi-Cellulose
45	92.89	6.80^c	5.07^a	28.84^b	9.53^c	42.46^b	38.90^d	37.04^c	19.33^a	17.71^d	1.81^d
60	93.89	7.32^a	4.43^b	29.08^{ab}	11.57^b	41.22^c	41.78^c	37.57^c	17.62^c	19.95^b	4.18^c
75	93.74	7.03^b	2.44^c	29.60^a	13.34^a	41.08^c	46.09^a	40.39^a	18.88^b	21.50^a	5.70^b
90	93.36	6.27^d	2.32^d	29.35^{ab}	11.53^b	43.68^a	45.03^b	38.54^b	19.71^a	18.83^c	6.49^a
SEM	0.011	0.00005	0.00003	0.0003	9.8x10^{-5}	0.0006	0.0006	0.0005	0.00017	0.0002	0.00004
P – value	0.5319	<0.001	<0.001	0.0076	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Means with different superscript on the same column are significantly (P < 0.05) different, 45, 60, 75 and 90 are harvesting ages.

Interaction Effect of Poultry Litter Application Rate and Harvesting Age on Proximate Composition and Cell Wall Fiber Fractions

From the results in Table 6, a significant interaction ($P<0.05$) between poultry litter application rate and harvesting age was observed for CP, EE, CF, ash, NFE, cellulose and hemicellulose, while DM, NDF, ADF, and ADL showed non-significant interactions. The highest CP was recorded in $T_2 \times 60$ DAC (7.80% DM), whereas the lowest was in $T_4 \times 90$ DAC (6.10% DM). The $T_2 \times 75$ DAC and $T_1 \times 75$ DAC combinations recorded the highest ash contents (13.95% and 11.98%, respectively), linked to both extended growing periods and available mineral pools.

The significant interactions for CP and EE suggest that the nutritional quality response of Super-Napier grass to harvesting age was modified by the fertility level. At intermediate nitrogen supply (T_2: 5 t/ha), the 60-day harvest interval maximized protein concentration, possibly by sustaining metabolic nitrogen demand without the luxury uptake or growth dilution effects seen at higher rates. These results concur with Ayub et al. (2022) and Mwendia et al. (2021), who demonstrated that the relationship between organic input and forage quality is not linear and is significantly mediated by harvest management. The non-significant interaction for NDF and ADF confirms that structural carbohydrate deposition is more strongly driven by developmental age than by the fertility regime, consistent with the physiological primacy of cell wall synthesis in maturing grass tissues (Van Soest et al., 1991)

Table 6: Effect of Interaction of Poultry Litter Application rate and Harvesting Age on Proximate Composition and Cell Wall Fiber Fraction of Super Napier Grass

P.L.A. rate* Age	Dry Matter	Crude Protein	Ether Extract	Crude Fiber	Ash	Nitrogen Free Extract	Nitrogen Detergent Fiber	Acid Detergent Fiber	Acid Detergent Lignin	Cellulose
T_1,45	92.38	7.01^{b}	5.32^{b}	28.24^{c}	9.33^{f}	42.33^{bc}	38.92	36.9	19.44^{abc}	17.46^{hi}
T_1,60	92.92	7.15^{bc}	3.90^{e}	29.86^{ab}	12.04^{c}	39.8^{de}	42.55	37.58	17.32^{f}	20.26^{bc}
T_1,75	93.43	6.86^{cd}	2.19^{g}	29.54^{abc}	11.98^{c}	42.69^{abc}	46.48	40.45	18.89^{bcd}	21.56^{a}
T_1,90	93.86	6.22^{f}	2.63^{f}	29.86^{ab}	11.56^{cde}	43.38^{ab}	45.44	38.58	19.96^{a}	18.62^{efg}
T_2,45	93.47	6.90^{bcd}	5.16^{b}	28.39^{bc}	9.54^{f}	43.29^{ab}	39.05	37.15	19.53^{abc}	17.62^{ghi}
T_2,60	93.55	7.80^{a}	4.04^{de}	28.58^{abc}	11.23^{de}	41.71^{bcd}	41.38	36.93	17.48^{f}	19.45^{cde}
T_2,75	92.55	7.09^{bc}	2.48^{f}	30.09^{a}	13.95^{ab}	38.78^{e}	45.17	39.98	18.73^{bcd}	21.25^{ab}
T_2,90	93.24	6.59^{de}	2.01^{h}	28.57^{abc}	11.07^{e}	44.82^{a}	45.03	38.73	19.45^{abc}	19.28^{cdef}
T_3,45	92.63	6.93^{bcd}	4.91^{c}	29.1^{abc}	9.65^{f}	41.88^{bcd}	38.46	37.46	18.8^{bcd}	18.66^{efg}
T_3,60	94.69	7.28^{b}	4.14^{d}	28.74^{abc}	11.72^{cd}	42.56^{abc}	41.43	37.88	17.63^{ef}	20.25^{bc}
T_3,75	94.14	7.16^{bc}	2.57^{f}	29.42^{abc}	14.09^{a}	40.68^{cde}	46.22	40.16	18.59^{cde}	21.57^{a}
T_3,90	93.06	6.16^{f}	2.08^{gh}	29.43^{abc}	11.82^{cd}	43.40^{ab}	44.55	37.99	19.66^{ab}	18.33^{fgh}
T_4,45	93.04	6.37^{ef}	4.91^{c}	29.64^{abc}	9.59^{f}	42.36^{bc}	39.19	36.68	19.56^{abc}	17.12^{i}
T_4,60	94.35	7.07^{bc}	5.77^{a}	29.15^{abc}	11.32^{de}	40.81^{cde}	41.76	37.92	18.05^{def}	19.87^{cd}
T_4,75	94.75	7.0^{bc}	2.53^{f}	29.37^{abc}	13.39^{b}	42.21^{bc}	46.49	40.97	19.33^{abc}	21.64^{a}
T_4,90	93.24	6.10^{f}	2.58^{f}	29.55^{abc}	11.69^{cde}	43.14^{ab}	45.10	38.86	19.77^{ab}	19.09^{def}
SEM	0.044	0.0002	0.0001	0.0012	0.0004	0.0022	0.0023	0.0019	0.0007	0.0007
P – value	0.906	<0.0001	<0.0001	0.0033	<0.0001	<0.0001	0.745	0.427	0.1696	<0.0001

Means with different superscripts along same column are significantly ($P < 0.05$) different, T_1 = Control, T_2 = 5 tons/Ha, T_3 = 10 tons/Ha, T_4 = 15 tons/Ha, 45, 60, 75 and 90 = age (days after cutback), P.L.A*AGE = Interaction of Poultry Litter Application Rate and Age

CONCLUSION AND RECOMMENDATIONS

Poultry litter application rate and harvesting age significantly influenced the growth parameters, biomass yield, and nutritional quality of Super-Napier grass. Increasing poultry litter application up to 15 t/ha enhanced plant height, number of tillers, stem girth, LAI, and biomass yield, while extending harvesting age to 90 DAC progressively increased biomass but reduced crude protein and increased fiber fractions. Based on the combined consideration of productivity and nutritional value for ruminant feeding, it is recommended that Super-Napier grass be fertilized with 10 t/ha of poultry litter and harvested at 60 days after cutback to optimize both yield and crude protein content in the Southern Guinea Savanna agro- ecological zone of Nigeria. Subsequent research should evaluate the effect of these management practices on animal performance and economic returns over multiple ratoon cycles.

REFERENCES

Adjolohoun, S., Bindelle, J., Adandedjan, C., & Sinsin, B. (2021). Some agronomic and nutritive characteristics of the elephant grass *Pennisetum purpureum* selected as desirable for smallholder livestock feeding in Benin. *Biotechnologie, Agronomie, Société et Environnement*, 25(2), 101–110. https://doi.org/10.25518/1780-4507.18743

AOAC. (2019). Official Methods of Analysis of the Association of Official Analytical Chemists (21st ed.). AOAC International.

Ayub, M., Tanveer, A., Nadeem, M. A., & Husnain, A. (2022). Biomass yield and quality of Napier grass cultivars as influenced by nitrogen application and harvesting intervals. *Grass and Forage Science*, 77(1), 45–57. https://doi.org/10.1111/gfs.12546

Bello, A. O., Afolabi, O. A., & Omojasola, P. F. (2021). Poultry manure application rates and soil fertility enhancement for sustainable forage grass production in the Nigerian Guinea Savanna. *Journal of Agricultural Science and Technology*, 23(3), 212–224.

Gani, A. T., & Awwal, Y. A. (2025). Assessment of soil degradation and resilience index across different topographic positions in Wukari, Taraba State, Nigeria. *Soil and Environment*. https://soilenvironment.com/index.php/OSSE/article/view/26

Guo, T., Zhang, Q., Li, S., & Wang, Y. (2023). Organic amendments improve soil fertility and herbage quality of perennial ryegrass: A meta-analysis. *Field Crops Research*, 294, 108877. https://doi.org/10.1016/j.fcr.2023.108877

Meel, R.K., Sharma, P., and Patel, S. (2025). Impact of fertilization and harvesting interval on nutritive value of Super Napier grass. Journal of forage and Grassland Science, 41 (2), 115-123.

Mwendia, S. W., Njarui, D. M. G., Githinji, J. M., & Muinga, R. W. (2021). Agronomic performance and fodder quality of Super-Napier grass genotypes in semi-arid Kenya. *Tropical Grasslands-Forrajes Tropicales*, 9(2), 78–89. https://doi.org/10.17138/TGFT(9)78-89

Neumann, M., Leão, G. F. M., Pereira, D. H., & Nussio, L. G. (2022). Yield, morphological composition, and nutritive value of Napier grass hybrids under different cutting managements. *Animal Feed Science and Technology*, 284, 115200. https://doi.org/10.1016/j.anifeedsci.2021.115200

SAS Institute. (2019). SAS/STAT User's Guide (Version 9.4). SAS Institute Inc.

Soumya, P. (2011). Evaluation of Promising hybrid Napier Cultivars under Varying Plant Population. Dissertation, College of Horticulture, Vellanikkara, Kerala Agricultural University, Thrissur, India. 73p.

Tessema, Z. K., de Boer, W. F., Baars, R. M. T., & Prins, H. H. T. (2020). Changes in soil nutrients and vegetation characteristics following different rates of organic and inorganic fertiliser application in Ethiopian highland Napier grass. *Grass and Forage Science*, 75(3), 298–310. https://doi.org/10.1111/gfs.12485

Van Soest, P. J., Robertson, J. B., & Lewis, B. A. (1991). Methods for dietary fiber, neutral detergent fiber, and nonstarch polysaccharides in relation to animal nutrition. *Journal of Dairy Science*, 74(10), 3583–3597. https://doi.org/10.3168/jds.S0022-0302(91)78551-2