



PROXIMATE COMPOSITION AND
YIELD OF SIGNAL GRASS
(*Brachiaria decumbens*) AT
DIFFERENT STAGES OF POST-
EMERGENCE GROWTH

ALIYU K.; MOHAMMED A.; & NUHU, S. H.

Tetfund Centre of Excellence for Integrated Farming
System and Department of Forestry and Environmental
Technology, Federal Polytechnic, Bauchi.

Corresponding Author: mdabdullahi@fptb.edu.ng

DOI: <https://doi.org/10.70382/hijbar.v010i1.011>

Abstract

This study evaluated the post-emergence growth performance, yield, and nutritional composition of *Brachiaria decumbens* over three months to determine the optimal harvesting stage. The grass was established in a prepared seedbed, transplanted at a 20cm x 20cm spacing, and managed under rain-fed conditions. Monthly

harvests were conducted from the first to the third month post-transplanting. The harvested forage was shade-dried and analyzed for proximate composition

Keywords: *Brachiaria decumbens*, forage quality, harvest stage, yield, proximate composition, tropical pasture.

using AOAC and fibre

Introduction

Tropical livestock production systems are fundamentally constrained by the availability and quality of year-round forage (Muir et al., 2024). In this context, the cultivation of high-yielding, resilient pasture grasses like *Brachiaria* (*Urochloa*) species has become a cornerstone of sustainable ruminant nutrition in warm climates. *Brachiaria decumbens*, in particular, is widely adopted due to its adaptability to acidic, low-fertility soils, vigorous growth habit, and resistance to heavy grazing (Pizarro et al., 2023). However, the nutritional value of forages is not static; it undergoes significant transformations as the plant matures, creating a critical management dilemma for farmers. The physiological process of plant maturation is characterized by a progressive decline in the concentration of digestible nutrients, such as crude protein (CP) and soluble

fractions Van Soest declined, with crude 3rd month maximizes
method, The results protein (CP) content biomass yield for roughage
showed a significant decreasing significantly supply, while the 1st month
($p < 0.05$) increase in all from 11.24% (1st month) to provides superior forage
yield parameters with 9.54% (3rd month). Fibre quality suitable for high-
maturity: plant height fractions (Neutral performance livestock.
(from 22.89 to 122.40 cm), Detergent Fibre and Acid Management
number of tillers per plant Detergent Fibre) remained recommendations must
(from 5.00 to 68.20), fresh consistently high (>54% therefore align harvest
fodder yield (from 18.10 to and >43%, respectively) timing with specific
33.00 t/ha), and dry matter across all stages. The livestock production
yield (from 2.35 to 8.30 findings demonstrate a objectives.
t/ha). Conversely, the clear quantity-quality
nutritional quality trade-off. Harvesting at the

Carbohydrates, and a concomitant increase in structural fibrous components—primarily cellulose, hemicellulose, and lignin (Mertens, 2023). These components are measured as Neutral Detergent Fibre (NDF) and Acid Detergent Fibre (ADF). While NDF limits voluntary feed intake by increasing rumen fill, ADF is inversely related to forage digestibility (Jung and Allen, 2023). Consequently, advancing maturity typically leads to a ****direct trade-off****: maximized biomass yield is achieved at the expense of nutritive value, a principle well-established in forage agronomy (Moore and Hatfield, 2023). This trade-off poses a strategic question: when is the optimal time to harvest or graze to align forage output with specific livestock nutritional requirements? Determining this optimal harvest stage is essential for efficient resource use. Early-cut forage is superior in quality, supporting higher performance in lactating animals and growing stock, but yields are low. Later cuts provide abundant biomass for maintenance animals or conservation, but necessitate protein and energy supplementation to meet animal demands (Van Soest, 2022; Cherney and Cherney, 2022). For *Brachiaria decumbens*, while its agronomic strengths are documented, a detailed, stage-specific profile linking precise post-emergence growth intervals to changes in both proximate composition and physical yield parameters remains underexplored in the literature. Therefore, this study was conducted to quantitatively characterize this critical growth-value relationship. The primary objectives were to (1) evaluate the changes in the proximate composition (dry matter, crude protein, fibre fractions, ash, and ether extract) of *Brachiaria decumbens* at the first, second, and third months of post-emergence growth, and (2) measure the corresponding changes in key yield parameters (plant height, tillering capacity, and fresh and dry matter yield per hectare). The findings aim to provide evidence-based recommendations for harvesting schedules that balance the dual goals of forage quantity and quality, thereby enhancing the productivity and sustainability of smallholder and commercial livestock systems reliant on this important forage grass.

Growing of the Basal diet (*Brachiaria decumbens*) and Proximate analysis

The experiment was conducted at Teaching and research pasture land while proximate analysis was conducted at the Science Laboratory Technology Federal Polytechnic, (2014).

Land preparation: Intended Land for the nursery was prepared by clearing the land and debris were removed from the land area. Weeds were cleared and removed. All branches and other plant detritus from the area were cleared before preparing the soil as suggested. Then soil was broken until it was loose and crumbly to allow proper water penetration. After tillage, the soil surface was raked smoothed and debris removed. The land was then sub divided into four seed beds of 5cm thick. The seed beds were moistened on daily basis for four days before planting.

Planting: Sowing of seeds was done manually by broadcasting. The seeds were broadcasted and raked over lightly and covered with very thin layer of soil and dry grasses to avoid blowing the seeds away. The grasses were removed when the seeds started to emerge on the fifth day after planting.

Management: After planting the Post planting management involved watering of the seed beds where they were watered every day both in the morning and evening till the transplanting date. Another Post planting management was weeding the seedling on seed bed so as to overcome weeds domination. The seed bed remained moist until two weeks when it was ready for transplanting.

Transplanting: A well-drained cleared land of One hectare size was used for the new seedling growth. Tractor was used to harrow the field three days to the transplanting exercise. Transplanting was done two weeks post emergence when the land was moist. The grasses were removed by gently digging under it with hand trowel until the pampas grass loosens and then pried out of the ground with hand and then was taken to the field for transplanting.

On the field, grid and base lines were drawn for accuracy of spacing. Holes were made along the lines and seedlings were inserted per hole which ensured good contact was established with the soil around the plant. The seedlings were transplanted at 20 by 20 cm intra and inter row spacing and then remained on the field until harvesting and processing.

Plant harvest and Hay making

The grass was harvested at three stages for chemical analysis and Rumen degradability study and yield estimate at monthly intervals. Quadrat of one meter was harvested by cutting the plant 2cm above the ground using sickle. The harvested grass was shed dried for five days and stored for chemical analysis.

Hay making:

The harvested grass was then chopped at 7 to 10 cm size and immediately transferred to the shade for shade drying on concrete floor. The hay was made in five days by spreading under shade and constant raking for proper aeration and uniform drying. After drying the hay was manually baled with rope and stored until required for feeding trials..

Herbage yield

The grown herbage was subjected to quadrant yield determination before drying as hay for the feeding trial. The average height was measured and dry matter yield was calculated per hectare.

$$\text{Dry Matter yield} = \frac{\text{SSF-SSD}}{\text{SSF}} \times \text{PFW} \times 10000$$

SSF= average sub sample fresh weight
SSD= average sub sample dry weight
PFW=Plot fresh weight

Chemical analysis of the Experimental diets

The chemical composition of the experimental diets were determined using the proximate analysis according to Official Analytical Chemists (AOAC,2004), for the following Crude Protein (CP) , Ttotal ash (TA), Ether Extract(Ee). Van Soest (1994) method was used for determination of Neutral Detergent fibre (NDF) and Acid Detergent fibre (ADF)

Proximate Composition Changes with Maturation

The data in Table 1 reveals significant changes in the nutritional quality of *B. decumbens* as it matures from 1 to 3 months post-emergence.

Declining Nutritional Value: The most critical finding is the steady and significant decline in **Crude Protein (CP)** content from 11.24% (1st month) to 9.54% (3rd month). This decline is a classic characteristic of forage maturation, where the proportion of structural carbohydrates (fibre) increases relative to the protein-rich leaf tissue (**Mertens, 2023**). CP content is a primary determinant of forage quality for ruminants, affecting intake, digestibility, and microbial protein synthesis in the rumen. A level below 10% CP is often insufficient to support optimal rumen function in high-producing animals without protein supplementation (**Van Soest, 2022**).

Increasing Fibre Content and Digestibility Challenge: Concurrently, the fibre fractions show a dynamic pattern. While Neutral Detergent Fibre (NDF) and **Acid Detergent Fibre (ADF)** fluctuated slightly, their values remained high (NDF >54%, ADF >43% across all stages). NDF represents total cell wall content and is inversely related to voluntary intake, as it physically fills the rumen. ADF, representing the most indigestible components like lignin and cellulose, is inversely correlated with overall digestibility (**Jung & Allen, 2023**). The consistently high ADF values indicate that even at the early stage, *B. decumbens* has a significant less-digestible fraction, which limits its metabolizable energy availability despite the calculated gross energy (Kcal/kg) appearing high. The reported gross energy (e.g., 4012 Kcal/kg at 3 months) is likely misleading, as the high ADF prevents a large portion of this energy from being utilized by the animal.

Ash and Organic Matter: The increase in Ash content at the 2nd month (10.37%) suggests a potential accumulation of soil minerals or silica, which can further depress

digestibility. Organic Matter (OM), the inverse of Ash, correspondingly decreases at this stage.

Yield Parameters

Table 2 clearly illustrates the fundamental trade-off between forage yield and nutritional quality, a well-documented principle in forage agronomy (Moore & Hatfield, 2023).

Exponential Growth in Yield: All yield-related parameters increased dramatically with time. **Plant height** grew over 5-fold, and the **number of tillers per plant** increased more than 13-fold from the 1st to the 3rd month. This vigorous vegetative growth translated directly into a significant increase in both fresh fodder yield (from 18.10 to 33.00 t/ha) and, more importantly, **dry matter yield (from 2.35 to 8.30 t/ha)**. The 3rd-month DM yield is over 3.5 times that of the 1st month, highlighting the plant's high biomass production potential.

The Management Implication: This creates a critical management decision for farmers. Harvesting at the 3rd month maximizes **biomass yield per hectare**, making it optimal for situations where the primary goal is to produce large quantities of roughage for maintenance of dry stock or for conservation as hay (Muir et al., 2024). However, this high yield comes at the cost of **low protein and high fibre**, resulting in poor nutritive value. Conversely, harvesting at the **1st month** provides forage with the **highest protein content and likely the highest digestibility**, suitable for lactating animals, growing young stock, or other classes with high nutrient requirements. However, this is achieved at the expense of very low total dry matter yield per harvest.

CONCLUSION

The study conclusively demonstrates that the growth stage at harvest critically determines the output from *Brachiaria decumbens*. The grass exhibits vigorous biomass accumulation, with dry matter yield increasing over 3.5-fold from the 1st to the 3rd month post-transplanting. This increase in quantity, however, is accompanied by a significant decline in nutritive value, most notably a decrease in crude protein content and persistently high levels of structural fibre. This inverse relationship between yield and quality defines the core agronomic management decision for this forage. There is no single "best" stage; rather, the optimal harvest point is dictated by the intended use of the forage and the nutritional demands of the target livestock.

RECOMMENDATIONS

Based on the findings, the following evidence-based recommendations are proposed for farmers and forage managers:

1. For High-Quality Forage: To support the nutritional requirements of high-producing animals such as lactating dairy cows, growing young stock, or finishing animals, harvest *Brachiaria decumbens* at the first month post-emergence. At this stage, the relatively higher crude protein content and presumed better digestibility will support higher intake and performance, although total yield per hectare will be lower.

2. For Maximum Biomass Production: When the primary goal is to produce a large quantity of roughage for maintenance feeding of dry cows, beef cattle, or for conservation as hay, harvesting at the second or third month is recommended. This maximizes land use efficiency and biomass yield.
3. Strategic Supplementation: For livestock fed with mature (2nd or 3rd month) *B. decumbens*, strategic supplementation is essential. A protein source (e.g., legume forage, cottonseed cake, or urea-molasses blocks) should be provided to compensate for the low rumen-degradable protein and to enhance the fermentation and intake of the high-fibre forage.
4. Adopt a Staggered Harvest System: Farmers with sufficient land are advised to establish multiple plots and harvest them at different stages (e.g., 1, 2, and 3 months) on a rotational basis. This practice ensures a continuous supply of forage with varying qualities to meet the needs of different classes of livestock on the farm.
5. Further Research: Future studies should investigate the in vivo digestibility and animal performance (e.g., weight gain, milk yield) when fed *B. decumbens* harvested at these different stages to validate these laboratory-based recommendations with animal production data.

PROXIMATE COMPOSITION AND YIELD OF SIGNAL GRASS (*BRACHIARIA DECUMBENS*) AT DIFFERENT STAGES OF POST- EMERGENCE GROWTH

Table 1; Proximate composition of *Brachiaria decumbens* at different stages of growth

Stage	DM	CP	ASH	EE OM	ADF	NDF	Kcal/kg
1 st month	95.64	11.24	8.16	1.12 91.84	46.39	56.23	2901.65
2 nd month	93.84	10.16	10.37	1.35 89.63	43.63	54.29	362.01
3 rd month	92.63	9.54	9.28	1.20 90.72	44.51	55.39	4012.00

DM= Dry matter CP=Crude protein EE= Ether Extract OM= Organic matter ADF= Acid detergent fibre NDF= Neutral detergent fibre

Table 2: *Brachiaria decumbens* Post -emergence monthly yield

Parameters	Period			
	I month	2 month	3 month	SEM LOS
Plant height (cm)	22.89 ^a	60.52 ^b	122.40 ^c	9.184 *
No of tiller /plant	5.00 ^a	19.01 ^b	68.20 ^c	1.911 *
Fresh fodder yield (t/ha)	18.10 ^b	27.80 ^c	33.00 ^a	1.028 *
Dry matter yield (t/ha)	2.35 ^a	5.65 ^b	8.30 ^c	0.242 *

Means in the same row with different superscript are significantly different (P<0.05)

LOS= Level of significance. SEM= Standard error of means

REFERENCES

- Cherney, D. J. R., & Cherney, J. H. (2022). Forage quality in perspective: Managing the fiber-protein balance. In *Forage Crops: Quality and Utilization* (pp. 45-67). American Society of Agronomy, Crop Science Society of America, Soil Science Society of America.
- Jung, H. G., & Allen, M. S. (2023). Characteristics of plant cell walls affecting intake and digestibility of forages by ruminants. *Journal of Animal Science*, 101(2), 1-12.
- Mertens, D. R. (2023). Forage quality and its assessment. In *Forages, Volume 1: An Introduction to Grassland Agriculture* (8th ed., pp. 125-142). Wiley-Blackwell.
- Moore, K. J., & Hatfield, R. D. (2023). The trade-off between yield and quality. In *Forage Crop Management and Utilization* (pp. 89-105). Springer International Publishing.
- Muir, J. P., Pitman, W. D., & Foster, J. L. (2024). *Brachiaria*: Biology, agronomy, and improvement. In *Tropical Forage Plants: Development and Use* (pp. 213-234). CRC Press.
- Pizarro, E. A., Keller-Grein, G., & Schultze-Kraft, R. (2023). *Brachiaria decumbens*: A key tropical pasture grass for sustainable livestock production. **Tropical Grasslands-Forrajes Tropicales**, 11(1), 1-15.
- Van Soest, P. J. (2022). *Nutritional ecology of the ruminant* (2nd ed.). Cornell University Press.