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ASSESSING THE PERFORMANCE OF DIFFERENT NAPIER HYBRIDS FOR PRODUCTIVITY AND FODDER QUALITY IN CHAMARAJANAGARA DISTRICT OF SOUTHERN DRY ZONE OF KARNATAKA

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ABSTRACT

Chamarajanagara district of Karnataka State possesses a substantial population of crossbred dairy cows (102,523 animals), making animal husbandry a principal subsidiary occupation. However, severe regional deficits in green fodder availability and crop nutritional quality present critical constraints to livestock productivity, causing depressed milk yields and deficient Solid-Not-Fat (SNF) percentages. To resolve this nutritional bottleneck, ICAR-KVK Chamarajanagara initiated a participatory on-farm testing framework across the 2021-22 and 2022-23 production cycles at Doddatuppuru and Bettadamadahalli villages in Gundlupet taluk. This study evaluated the localized agronomic performance, morpho-structural attributes, nutritional quality, fodder palatability, and production economics of four Hybrid Napier (Pennisetum purpureum × Pennisetum glaucum) cultivars: Co-3 (local check), Co-5, BNH 10, and PBN 342.

The experimental results revealed that the advanced hybrid PBN 342 significantly outperformed all other evaluated varieties. PBN 342 achieved the highest cumulative annual green fodder yield (179.6 t/ha) and a superior Benefit-Cost (B:C) ratio of 3.0, followed by BNH 10 (173.60 t/ha; B:C: 2.9) and Co-5 (163.3 t/ha; B:C: 2.7), while the local check Co-3 recorded the lowest values (154.95 t/ha; B:C: 2.6). Structurally and biochemically, PBN 342 displayed an optimized leaf-to-stem ratio (0.78) and an elevated crude protein content (6.21%). Its smooth, non-hairy leaves (low trichome density) and succulent stems drove a high livestock palatability coefficient of 89.5%. Participatory farmer evaluations confirmed strong cattle preference for PBN 342, corresponding directly to a measurable daily lactation increase of 1.00 to 1.25 L/cow/day along with enhanced milk quality. Based on these findings, PBN 342 is recommended for targeted upscaling, large-scale block demonstrations, and district-wide popularization to ensure sustainable regional forage security.

KEYWORDS: Crude protein, Green fodder yield, Hybrid Napier, Leaf-to-stem ratio, Palatability.

INTRODUCTION

Animal husbandry is an integrated cornerstone of smallholder agricultural systems across semi-arid regions of India, generating essential secondary income, building livelihood resilience, and providing nutritional security. Within the Chamarajanagara district of Karnataka, dairy farming represents a crucial buffer against crop failures driven by erratic monsoonal precipitation. The district maintains a significant crossbred dairy cattle infrastructure, with a recorded population of 102,523 crossbred cows. Despite this substantial production capacity, the local dairy sector faces a chronic, systemic challenge: the severe deficit of high-quality green fodder.

Forage availability in Chamarajanagara is characterized by high seasonal volatility, forcing smallholders to rely heavily on low-quality crop residues, native wild grasses, or legacy varieties that lack the macro- and micronutrient profiles required to maintain peak lactation. This nutritional deficit directly suppresses animal performance, manifesting in low daily milk outputs and deficient Solid-Not-Fat (SNF) content. The primary cause is the low palatability, rapid lignification, and low crude protein content of prevailing regional forages, which limit dry matter intake and digestible nutrient consumption in cattle.

For reducing this regional forage gap, introducing improved perennial forage crops is a priority.

Pandey and Roy (2011) opined that among all fodder crops Napier Bajra hybrid is multicut perinnial grass with profuse tillering and high tonnage of green fodder throughout the year. As Hybrid Napier (Pennisetum purpureum × Pennisetum glaucum), a sterile interspecific hybrid grass, serves as an excellent option due to its rapid biomass accumulation, aggressive tillering capacity, exceptional ratoonability, and water-use efficiency under semi-arid conditions (Ndikumana, 1996; Premaratne & Premalal, 2006). Though there are several agricultural research programs continue to develop advanced Napier cultivars designed for enhanced structural softness, disease resistance and superior nutritional profiles the regional adoption of new forage technologies depends heavily on localized agro-climatic adaptability and direct verification by end-users (Gomez & Gomez, 1984). Genetic potentials recorded under controlled research station conditions do not always translate accurately to smallholder environments, where soil quality, moisture access, and crop management vary widely. Recognizing this implementation gap, the Indian Council of Agricultural Research (ICAR) - Krishi Vigyan Kendra (KVK), Chamarajanagara falling under Southern dry zone of Karnataka initiated a participatory On-Farm Testing (OFT) framework. This research was designed to evaluate the local suitability, morpho-agronomic attributes, nutritional quality, nutrient uptake and economic returns of four distinct Hybrid Napier varieties under actual field conditions, aiming to establish an empirically validated recommendation for regional fodder development.

MATERIALS AND METHODS

The participatory On-Farm Testing (OFT) trials were conducted during two consecutive agricultural years (2021-22 and 2022-23). The experimental blocks were located in the representative farming clusters of Doddatuppuru and Bettadamadahalli villages, situated within the Gundlupet taluk of Chamarajanagara district, Karnataka, India. The region is positioned within the South Dry Zone (Zone-6) of Karnataka, characterized by a semi-arid climate with an irregular rainfall pattern and a mean annual precipitation ranging between 650 mm and 750 mm. The soils across the selected experimental plots were classified as uniform red sandy loams featuring neutral to slightly alkaline pH values, low organic carbon status, and moderate water-holding capacity with Low to Medium fertility for Nitrogen, Phosphorous and Potassium availability.

Experimental layout and treatment details: The field evaluation studied four perennial Hybrid Napier (Pennisetum purpureum × Pennisetum glaucum) cultivars, comprising three newly introduced lines and one regional check variety. The genetic treatments included four fodder hybrids as detailed below:

1. **Co-3:** The regional check variety, widely grown but showing standard yield and palatability characteristics.
2. **Co-5:** An advanced selection known for wide leaf laminae, high tillering capabilities, and lower structural fiber components.
3. **BNH 10:** A high-yielding hybrid optimized for rapid ratoon recovery.
4. **PBN 342:** A premium hybrid line bred for high succulence, high leaf-to-stem ratios, increased crude protein, and a notable absence of leaf-surface trichomes (non-hairy phenotype).

The trials used a participatory action-research framework, directly involving local dairy smallholders in field management to mirror local farming conditions. Prior to planting, the experimental fields underwent uniform primary tillage to establish a fine tilth. Rooted slips of the respective varieties were planted during the early monsoon window at a standardized spacing of 90 cm × 60 cm. Nutrient management was applied uniformly across all treatment blocks, aligning with the recommended package of practices from the University of Agricultural Sciences (UAS), Bangalore. Basal applications included well-decomposed Farmyard Manure (FYM) incorporated at a rate of 25 t/ha, combined with an inorganic chemical fertilizer dose of Nitrogen, Phosphorus and Potassium at (72:48:32 kg/ha, respectively). Nitrogen top-dressing was applied at a rate of 30 kg/ha immediately following each ratoon harvest cycle. The crop blocks were maintained under a protective, uniform irrigation schedule designed to supplement natural rainfall during dry periods. Standard hand-weeding was performed at 30 and 60 days post-planting to manage early weed competition Observation and analysis for green fodder yield, quality parameters, nutrient uptake and the economics involved are recorded timely for drawing valuable conclusions by considering the following methods.

Biometric observation: Plant height (cm) and number of tillers: plant height from the ground level to basal tip of the fully emerged leaves was recorded and number of tillers in each clump was counted. Green Fodder Yield (GFY, t/ha): Measured by cutting the above-ground biomass exactly 10 cm above ground level and weighing it immediately on-site. Cumulative annual yields were calculated by summing the weights across all sequential ratoon harvests over the 12-month period.

Leaf-to-Stem Ratio (L:S): Evaluated by sampling five representative tillers per treatment block, separating the green leaf blades from the central stalks, drying the components, and calculating the dry-weight ratio: L:S Ratio = {Total Dry Weight of Leaves(g)}/Total Dry Weight of Stems (g)

Nutritional Quality Analysis: Representative plant tissue samples from each cultivar cut were processed, oven-dried at 60°C until achieving a constant weight, and pulverized. Nutritional profiles were verified via standard biochemical assays (AOAC, 2005):

Crude Protein Content (%): Quantified by estimating total nitrogen content using the micro-Kjeldahl digestion and distillation method, applying the standard conversion factor:

Crude Protein (%) =Total Nitrogen (%)x 6.25
Crude Fiber Content (%): Determined through sequential acid and alkali digestion protocols to isolate the structural carbohydrate fraction.
Palatability and Participatory Livestock Assessments: Palatability evaluations were carried out using a cafeteria-style feeding matrix. Equal, pre-weighed portions (10 kg each) of fresh, chopped green fodder from Co-3, Co-5, BNH 10, and PBN 342 were presented simultaneously to selected lactating crossbred dairy cows in individual feeding mangers. Total voluntary feed consumption was monitored over a fixed two-hour exposure window.
The palatability coefficient was calculated using the formula:
Palatability (%) = left fraction of Fresh Fodder Consumed (kg)/ Total Fresh Fodder Offered kg) x 100
Qualitative data regarding animal preference, ease of handling, and daily milk output response (measured in L/cow/day) were documented through structured farmer interview schedules.
Economic Analysis: To establish economic viability, accurate cost accounting was maintained for all input resources, labor requirements, and field operations under local market conditions:
Gross Returns (Rs/ha): Calculated based on prevailing local market values for premium green forage crops.
Net Returns (Rs/ha): Derived by subtracting the total operational cost of cultivation from the gross economic returns.
Benefit-Cost Ratio (B:C) is calculated as B:C Ratio = Gross Financial Returns (Rs/ha) / Total Cost of Cultivation (Rs/ha)
The data of two years were statistically analyzed and discussed on pooled basis. The profitability was assessed intermesh of gross economic returns and B:C ratio.

RESULTS AND DISCUSSION

The field trials conducted over the 2021-22 and 2022-23 production seasons demonstrated substantial variation in plant height and number of tillers recorded in each fodder hybrids where PBN 342 recorded higher number of tillers with more plant height which intern reflected in green fodder yield accumulation among the evaluated Hybrid Napier varieties followed by BNH 10. The cumulative annual green fodder yields (GFY) across the experimental zones are summarized in Table 1 and pooled data represented the trend in Figure 1.

Table 1: Growth parameters and green fodder yield as differentiated by distinct fodder hybrids

Treatments	Plant height (cm)			No. of tillers			Green fodder yield (t/ha)		
	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
Co-3	138.40	159.80	149.10	34.40	33.80	34.10	154.50	155.40	154.95
BNH-10	160.20	161.40	160.80	44.80	45.40	45.10	174.60	172.00	173.30
PBN342	166.20	163.40	164.80	48.80	44.60	46.70	181.80	177.40	179.60
Co-5	154.40	158.30	156.35	44.00	42.60	43.30	161.60	165.00	163.30
SEm±	2.04	1.93	1.44	1.38	1.35	1.22	2.68	2.07	2.06
CD (p=0.05)	6.38	5.96	4.44	4.25	4.17	3.74	8.27	6.40	6.36

The fodder hybrid PBN 342 produced the highest annual biomass output, yielding 179.60 t/ha of fresh green fodder. This performance represents an 18.80% yield increase over the established regional check variety, Co-3 (154.95 t/ha). BNH 10 also performed well, generating 173.30 t/ha, while Co-5 recorded a moderate output of 163.30t/ha. Similar findings were recorded by Soumya et al, 2024 and Manidar Kaur and Ashlesha, 2022 indicating yield potential of PBN 342 attributed to higher plant height, ratoonability and better regeneration ability. The enhanced yield performance of PBN 342 is primarily attributed to its superior morphological architecture. Field observations indicated that PBN 342 exhibited aggressive crown tillering, shorter inter-nodal lengths, and broader leaf laminae. These characteristics allowed for more rapid canopy recovery and enhanced ratoon development immediately following each harvest cycle. This growth pattern aligns with findings from similar forage trials, which show that the yield efficiency of advanced Napier accessions under multi-cut regimes depends directly on the structural rate of new tiller emergence and sustained metabolic activity in the basal crown (Aruna et al., 2024 and Ndikumana, 1996).

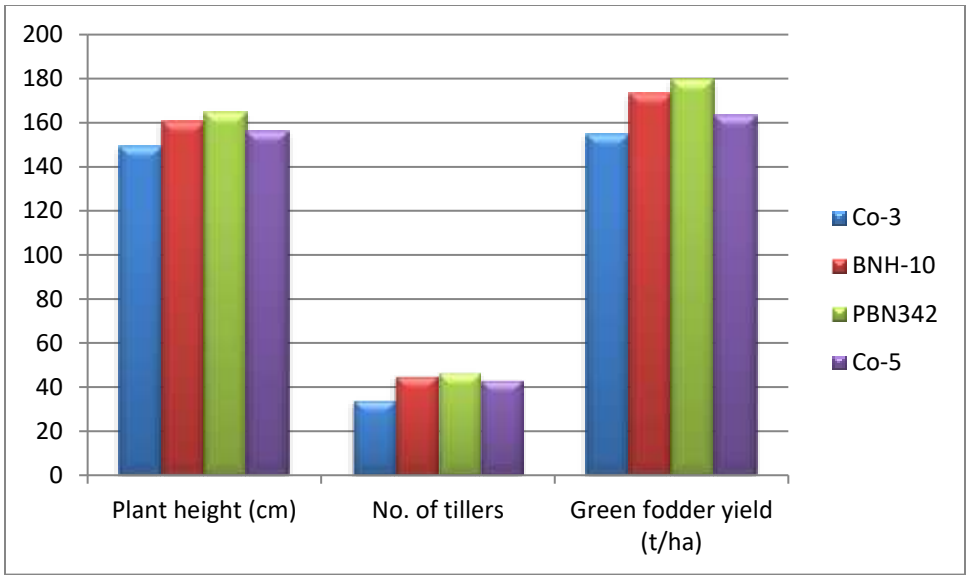

Fig:1 Growth parameters and green fodder yield as differentiated by distinct fodder hybrids (Pooled)

The structural distribution of biomass between high-quality leaves and fibrous stems is a key determinant of overall forage value. The Leaf-to-Stem (L:S) ratios varied noticeably among the cultivars (Figure 2). PBN 342 recorded the highest L:S ratio at 0.76, followed by BNH 10 (0.74) and Co-5 (0.66), while the local check Co-3 exhibited the lowest ratio at 0.63.

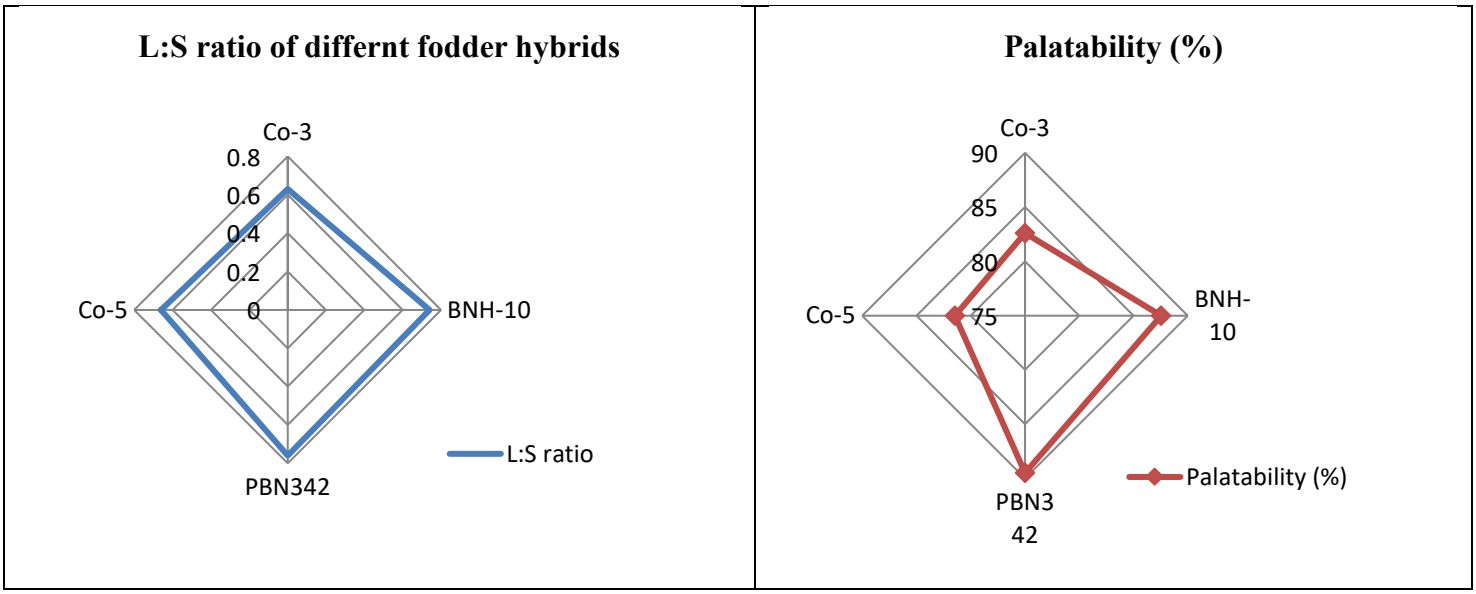

Fig 2: Leaf to stem ratio and Palatability as differentiated by different fodder hybrids type

A higher leaf-to-stem ratio indicates a structurally superior forage canopy. In tropical grasses, plant stems undergo rapid lignification as they mature, which increases the proportion of cell-wall components like neutral detergent fiber (NDF) and acid detergent fiber (ADF). Leaves, by contrast, retain high levels of soluble cell contents, soluble sugars, and metabolic enzymes. The elevated L:S ratio in PBN 342 indicates that a larger percentage of its total harvested biomass consists of highly digestible leaf tissue rather than fibrous, woody stems. This structural feature has positive implications for voluntary dry matter intake and downstream nutrient utilization by livestock (Premaratne & Premalal, 2006).

Quality parameters of different fodder hybrids: PBN 342 contained the highest concentration of crude protein of 6.21%. In comparison, the check variety Co-3 contained 5.33%, while BNH 10 and Co-5 recorded intermediate values of 5.52% and 6.18%, respectively. Concurrently, biochemical analysis indicated that PBN 342 maintained the lowest crude fiber levels (29.05%) relative to Co-3 (30.80%) as depicted in Table 2. These results are in accordance with Digvijay Singh et al., 2018 as studied for various bajra Napier hybrids. The increased crude protein content in PBN 342 is directly linked to its higher L:S ratio, as protein concentrations are naturally higher in leaf tissue than in stem

tissue. Achieving a 6.21% crude protein profile is operationally important for smallholder dairy systems; it meets the minimum dietary threshold required to support stable microbial fermentation within the bovine rumen without requiring expensive concentrated protein supplements (ICAR, 2013). The combination of elevated crude protein and reduced crude fiber in PBN 342 indicates a high-quality forage profile capable of optimizing volatile fatty acid production in the rumen and increased palatability of the fodder (Table3). The cafeteria-style feeding trials revealed clear differences in consumption patterns and livestock preferences among the varieties, as depicted in Table 3.

Table 2: Quality Parameters of different fodder hybrids recorded in the study

Treatments	Crude fibre (%)			Crude Protein (%)			Crude fat (&)		
	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
Co-3	31.08	30.52	30.80	5.43	5.22	5.33	0.98	0.92	0.95
BNH-10	33.04	31.60	32.32	5.57	5.46	5.52	1.04	0.96	1.00
PBN342	29.22	28.88	29.05	6.22	6.20	6.21	1.04	1.00	1.02
Co-5	29.82	29.88	29.85	6.40	5.96	6.18	0.98	0.88	0.95
SEm±	0.64	0.51	0.52	0.16	0.13	0.14	0.04	0.04	0.02
CD (p=0.05)	2.0	1.57	1.61	0.51	0.42	0.45	NS	NS	NS

Table 3: Fodder hybrids distinct features observed in cafeteria feeding trials

Fodder hybrids	Mean Cafeteria Palatability (%)	Key Phenotypic/ Handling Characteristics	On-Farm Lactation Impact (Milk Yield Response)
Co-3 (Local check)	82.60	High trichome density (hairy leaves); stiff stalks.	Baseline standard production values.
BNH 10	87.55	Moderate trichomes; average stalk pliability.	Minor, inconsistent yield variations.
PBN 342	89.50	Smooth, non-hairy leaves; succulent, pliable stalks..	Definitive increase of 1.00 – 1.25 L/cow/day plus enhanced milk thickness (SNF).
Co-5	81.45	Soft broad leaves; low trichome density	Modest improvement in overall yield.

Economics of fodder hybrids as influenced by distinct hybrids: The cost of cultivation for different fodder hybrids studied in distinct location did not vary much but the final gross returns and B:C ratio were greatly influenced by higher green forage yield varied by different fodder hybrids (Table 4). Though the initial cost of cultivation was Rs. /ha 71875, it generated the highest gross returns (**312720** Rs/ha) for PBN 342 and Consequently, achieved the highest Benefit-Cost (B:C) ratio of **3.0**, compared to 2.9 for BNH 10, 2.7 for Co-5, and 2.6 for the control variety Co-3. Similar findings were documented by Singh et al., 2022 where use of bajra Napier hybrids recorded improved profit over traditional cultivars. The elevated net economic returns demonstrate that the initial investment in high-yielding, nutrient-dense planting stock is fully justified by the substantial increase in harvestable biomass over the crop's perennial lifespan.

Table 4: Economics of fodder hybrids as influenced by distinct hybrids

Treatments	COC (Rs/ha)			Gross returns (Rs/ha)			B:C (Rs/ha)		
	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
Co-3	72500	71250	71875	185400	186480	185940	2.60	2.57	2.59
BNH-10	72500	71250	71875	209520	206400	312720	2.94	2.85	2.89
PBN342	72500	71250	71875	218160	212880	215520	3.06	2.94	3.00
Co-5	72500	71250	71875	193920	198000	195960	2.72	2.73	2.73

Note: Economic valuations are derived from local prevailing market rates for high-quality perennial green forage commodities in the region.

CONCLUSION

The two-year participatory on-farm testing conducted by ICAR-KVK Chamarajanagara highlights the importance of cultivar selection in addressing regional fodder deficits. Among the evaluated choices, the Hybrid Napier variety PBN 342 demonstrated clear advantages in agronomic yield, structural canopy composition, nutritional quality, and economic returns under the dryland conditions of Gundlupet taluk. By producing an annual green fodder yield of 179.6 t/ha, maintaining an optimal leaf-to-stem ratio of 0.78, and providing a crude protein content of 6.12%, PBN 342 outperformed the local check variety, Co-3. Its smooth, non-hairy leaves and high palatability improved voluntary

feed intake in cattle, resulting in an additional 1.00 to 1.25 L/cow/day and improving overall milk quality metrics. Financially, the variety achieved a high B:C ratio of 3.0, confirming its economic viability for smallholder dairy farmers.

Based on these findings, PBN 342 is recommended for systematic upscaling and district-wide deployment across Chamarajanagara. It is advised that local agricultural extension networks, department agencies and KVK units initiate large-scale field demonstrations and establish community-managed nurseries to distribute certified PBN 342 planting material widely, thereby supporting regional dairy productivity and fodder security.

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