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Article

Multiplication and adaptation of BLRI Napier-3 fodder at farmer's level

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Abstract: In Bangladesh, feed costs account for 70% of dairy farming expenses. High-yielding fodder (HYF) varieties, such as the Bangladesh Livestock Research Institute (BLRI) developed Napier variety 3 (BN-3), offer significant potential for reducing these costs. This study conducted two agronomical trials, one on-station at the Experimental Plot of BLRI, Regional Station, Baghabari, Shahjadpur, Sirajganj, and one on-farm at the Experimental Plot in the village of Tiar Bondor shahjadpur, Sirajganj during the economic year of 2018-2019. The objectives of this study were to assess the production performance and proximate composition of BN-3 at both the on-station and farmer community levels. Each trial plot measured (20×10) square feet and was prepared according to BLRI's fodder cultivation guidelines. Data from five consecutive harvests over approximately one year were collected and analyzed using SPSS 17.0 software. Results indicated a higher fresh biomass yield was (57.66±4.68 tons/ha/harvest) at on-station compared to the farmer community level (54.89±1.20 tons/ha/harvest), though the difference was not statistically significant (P>0.05). On-station trial also showed superior tiller numbers (30.72±4.27 per hill) and stem perimeter (6.68±0.06 cm). Leaf length and plant height were significantly better (P<0.05) at on station trial. The nutrient composition of BN-3 exhibited non-significant variations between on-station and on-farm conditions. These findings suggest that, while on-station cultivation of BN-3 may provide slight advantages in specific growth parameters, its nutrient composition remains consistent across different farming conditions, highlighting its potential as a cost-effective feed option for Bangladeshi dairy farmers.

Keywords: BLRI napier-3; biomass yield; nutrient composition; adaptation; famers community

1. Introduction

Bangladesh is a densely populated country facing significant competition for concentrate feed between humans and livestock. Feed scarcity is a major obstacle to smooth livestock production. Consequently, fodder cultivation, especially high-yielding fodder (HYF) varieties, is gaining popularity in livestock rearing. Over the past decade, the rapid expansion of the livestock and dairy sectors has increased the demand for nutritious green grass as fodder, attracting more farmers to cultivate it. There is a significant shortage of green fodder for livestock, and minimal efforts have been made to raise awareness among farmers about cultivating high-yielding varieties (HYV) of fodder. The primary factors contributing to this shortage include limited availability of land, insufficient agricultural extension services, and the lack of a dedicated seed bank for fodder crops (Sarker *et al*., 2016). The continuous changes in cropping patterns and HYV rice production have further limited the scope for fodder production. Commonly used grasses in Bangladesh include Pangola (*Digitaria eriantha*), Napier (*Pennisetum purpureum*), Ruzi (*Brachiaria ruziziensis*), German (*Echinochloa polystachya*), Splendida (*Setaria splendida*), and Para (*B. mutica*). Among these, Napier grass (*P. purpureum*) plays a crucial role in livestock feeding. Napier grass, also known as Elephant grass (*P. purpureum*), is commonly found across tropical and subtropical regions worldwide. It thrives in environments with rich soil and abundant rainfall, performing well at elevations of up to 2000 meters above sea level or slightly lower (Kesang *et al*., 2015; Mengistu *et al*., 2016; Umer and Usmane, 2020). Elephant grass is appreciated in a wide range of climates, not just tropical areas, due to its advantageous properties. It is notably drought-resistant, capable of thriving in diverse soil conditions, and demonstrates high efficiency in both water use and photosynthesis (Anderson *et al*., 2008). Recently, Bangladesh Livestock Research Institute (BLRI) has developed a new variety, BN-3. Though BN-3 fodder variety showed better production performance at BLRI head office in confined experimental trials. Evaluating the adaptation and multiplication of BN-3 outside the BLRI head office is crucial to understanding its actual production performance under different soil conditions. This study aims to assess the growth and production performance of BN-3 both at regional station and within farmers' communities, considering the growing importance of this fodder in meeting the nutritional needs of livestock.

2. Materials and Methods

2.1. Ethical approval

This article does not include any research involving animals conducted by the authors, and therefore, ethical approval was not required for this study.

2.2. Site of the experiment

The experiment was carried out at the BLRI Regional Station in Baghabari, Shahjadpur, Sirajganj, Bangladesh, as well as within the farming community of Tiar Bondar village in Shahjadpur, Sirajganj, during the 2018-19 agricultural year. The geographic coordinates of the study locations range from 24˚14'N to 24˚16'N latitude and from 89˚30'E to 89˚40'E longitude (Figure 1). The region experiences an annual average temperature that peaks at 33.19 °C and drops to a minimum of 23.45 °C, with total annual rainfall measuring 1,610 millimeters.

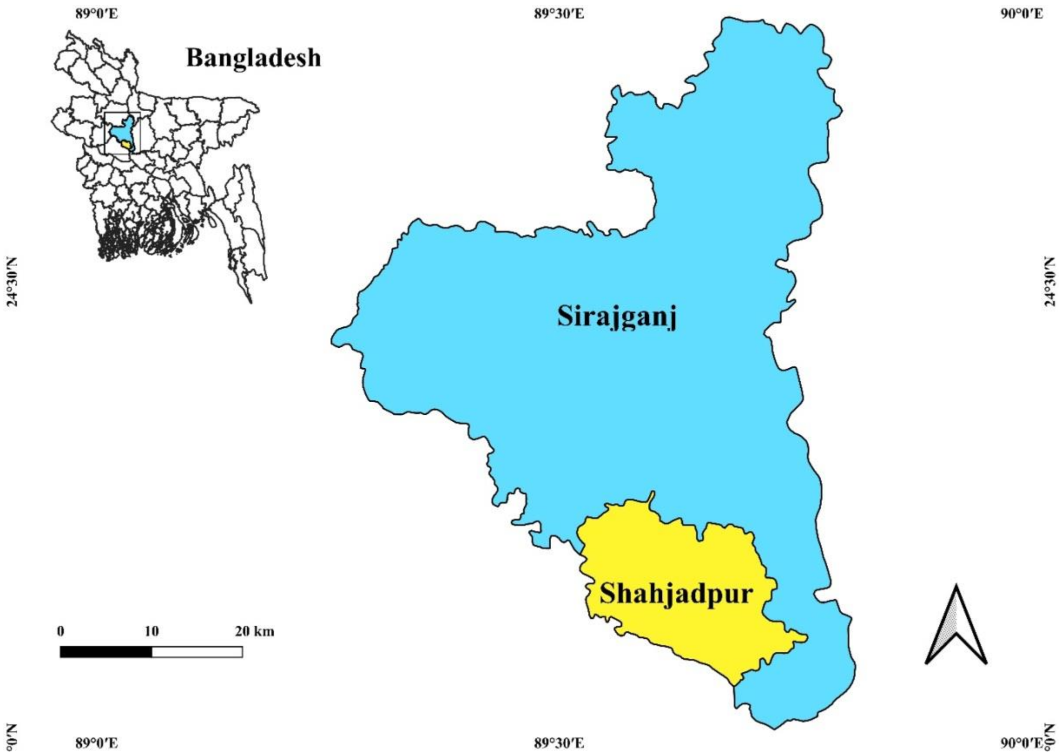

Figure 1. Map of the study area.

2.3. Description of Napier cultivars

BLRI Napier-3 (BN-3) was used for agronomic trials both at research stations and in farmers' fields. BN-3 is a hybrid of Napier grass created by selecting accessions from interspecific crosses between common elephant grass (*P. purpureum*) and pearl millet (*P. glaucum*). It is moderately tall, produces abundant tillers, and has an improved leaf-to-stem ratio. The grass features minimal barbs on the leaves and stems, making it safe for human handling. Its flowering is delayed, and the first harvest can occur 50 to 60 days after planting, with subsequent harvests every 40 to 45 days (Sarker *et al*., 2019).

2.4. Land preparation and cultivation

The cultivar was sown during the Kharif-2 season, following land preparation that included one deep plowing and two rounds of harrowing. During this process, 60 kg of fermented cow dung per decimal was incorporated into the soil. The planting was done using stem cuttings, placed in rows, with standard agronomic practices followed for plot preparation. Each cutting, with two nodes, was planted at a depth of 15-20 cm and angled at 45 degrees. The spacing between rows and plants was maintained at 70 cm and 30 cm, respectively. Regular watering and weeding were carried out, and each cultivar plot measured 200 square feet. After each harvest, deep irrigation was applied along with 50 kg/ha of urea fertilizer.

2.5. Harvesting and yield measurement

Fodder was harvested every 60 days, and the biomass yield was determined by weighing the collected mass. Plant height, hill density (thousands per hectare), and the number of tillers per hill were recorded. From each experiment, one kilogram of fodder was manually separated into three components: leaf blade, leaf sheath, and stem. To calculate the leaf-to-stem ratio (LSR), the combined weight of the leaves was divided by the stem weight. A total of five harvests were conducted throughout the year, with all measurements averaged to represent a single harvest. Representative samples were chopped into 2-3 cm lengths and sent for laboratory analysis to assess nutritional value. Plant height and leaf characteristics were measured from selected tillers to determine morphological traits.

2.6. Soil properties

The physical and chemical properties of the experimental soil were analyzed the previous year at the Central Laboratory of the Soil Resource Development Institute (SRDI), located at Krishi Khamar Sharak, Farmgate, Dhaka. Tests were conducted for pH, nitrogen, organic matter, salinity, and mineral content. The soil at the experimental sites was sandy with a slightly acidic pH of 6.60 and had a low organic matter content, measured at 0.34% (Table 1).

Table 1. Analysis of the physical and chemical properties of the experimental sandy soil.

Components	Amount(s)
pH	6.60
Organic Matter (%)	0.34
Total Nitrogen (%)	0.017
Potassium (Millitulanko/100g)	0.10
Calcium (Millitulanko/100g)	0.78
Magnesium (Millitulanko/100g)	0.39
Sodium (Millitulanko/100g)	0.11
Phosphorus (µg/g)	16.88
Sulfur (µg/g)	1.44
Boron (µg/g)	0.24
Copper (µg/g)	0.44
Iron (µg/g)	19.21
Manganese (µg/g)	0.85
Zinc (µg/g)	0.46

(Source: Islam *et al*., 2017).

2.7. Layout of the experiment

In this study, six farmers from Tiar Bondor village in Shahjadpur Upazila were chosen for on-farm fodder cultivation, with each plot measuring 10 × 20 square feet. Simultaneously, an equal-sized area was set up at the

BLRI regional station to trial the BN-3 fodder. The experiment was conducted using a completely randomized design (CRD).

2.8. Chemical analysis

The dry matter (DM) content of the feed was determined by first drying it in an oven at 105°C for 30 minutes, followed by drying at 65°C until a constant weight was reached. The samples were then stored in a dry container for further analysis of crude protein (CP), ash, and acid detergent fiber (ADF). Chemical analysis followed the methods outlined by AOAC (2005). Nitrogen content was measured using the Kjeldahl method, with crude protein calculated as nitrogen multiplied by 6.25. Crude protein content was determined using wet chemistry analysis with a Kjeltec TM 8400 analyzer (FOSS, Hoganas, Sweden). ADF content was measured using the method described by Van Soest *et al*. (1991) with an ANKOM 2000 Fiber Analyzer (ANKOM Technology, NY, USA).

2.9. Statistical analysis

At harvest, data was collected on various parameters, including plant height, stem length, leaf length, the number of leaves per stem, the number of tillers per hill, yield per hill, and total biomass yield per plot. The gathered data were statistically analyzed using the Compare Means (CM) procedure within a one-way Analysis of Variance (ANOVA), along with Post Hoc Multiple Comparisons, utilizing SPSS 17.0 for Windows (SPSS Inc., 2002).

3. Results and Discussion

3.1. Production performance of BN-3

The results indicated that the fresh biomass yield was numerically greater in the on-station trial (57.66±4.68 t/ha) compared to the yields observed at the community level among farmers, although this difference was not statistically significant (P>0.05) (Table 2). This outcome is consistent with the findings of Islam *et al*. (2017), who also reported no significant differences (P>0.05) in the biomass yield of Napier grass across various soil types. Similarly, Amin *et al.* (2016) found no significant variations in biomass yield, number of hills, or tiller counts, except for plant height, which was higher for Mark Eron and lower for Napier hybrid during the first cutting. Sarker *et al*. (2019) reported a biomass yield of BN-3 fodder at 70 days of cutting to be 50.1 MT/ha, which is comparable to the current findings. However, the biomass yield in this study was slightly lower than the results of Sarker *et al*. (2021), who documented the highest yields for BN-3 at non-drought locations (42.98 t/ha/harvest) and drought conditions (33.32 t/ha/harvest). In terms of leaf length and plant height, the on-station trial demonstrated significantly higher values (P<0.05) with leaf length at 3.59±0.04 ft and plant height at 6.36±0.20 ft, compared to 3.37±0.02 ft and 6.00±0.03 ft, respectively, at the farmers' community level. These results are consistent with the findings of Amin *et al.* (2016), who reported plant heights of 152.71±3.60 cm in normal soil conditions, compared to various sandy soil ratios. Significant differences (P<0.01) were also observed in the tiller number and stem perimeter, with the on-station trial showing higher values (30.72±4.27 tillers/hill and 6.68±0.06 cm, respectively) compared to the farmers' community level (18.21±0.65 tillers/hill and 6.14±0.02 cm, respectively). This contrasts with Amin *et al.* (2016), who found no significant differences in the number of tillers or hills but did observe differences in plant height between Mark Eron and Napier-Hybrid in the first cutting. Leaf number and hill number did not differ significantly (P>0.05) between the on-station and farmers' community levels, although the on-station parameters were comparatively higher.

Table 2. Production performance of BLRI Napier-3 (BN-3) at 60 days of cutting.

Parameter	On-station (mean±SE)	Farmers community (mean±SE)	*P* value	Level of significance
Biomass (t/ha/harvest)	57.66±4.68	54.89±1.20	0.568	NS
Leaf length(ft.)	3.59±0.04	3.37±0.02	0.010	*
Leaf number (Leaf No/Plant)	16.24±0.79	17.13±0.18	0.231	NS
Plant height(ft.)	6.36±0.20	6.00±0.03	0.011	*
Tiller number (No/Hill)	30.72±4.27	18.21±0.65	0.000	**
Hillar number (thousand/ha)	58.66±5.15	55.20±1.06	0.425	NS
Stem perimeter (cm)	6.68±0.06	6.14±0.02	0.000	**

NS= Non significant (P>0.05), *=P<0.05 stands for significant; ** =P<0.01 stands for highly significant

3.2. Nutritional status of BN-3

The dry matter content BN-3 of present study at on station and farmers community were 21.24% and 21.02% respectively (Table 3). This result is similar with Sarker *et al.* (2019), who found 20.11% dry matter content in BN-3 fodder though the cutting interval was 70 days. The average crude protein percentage of BN-3 fodder of present study ranged from 7.37% to 7.45%, which showed the similarity with the finding of Ahmed *et al.* (2021), who found that the average crude protein of BN-3 at 60 days of age was 7.63%. But slightly lower than the overall mean crude protein content of 9.96% reported by Sarker *et al.* (2021). Actually, nutritional content of fodder depends on the cutting age of the fodder. Higher cutting age increases the lignin and cellulose content and decreases the dry matter and crude protein content of fodder which makes the fodder less digestible for livestock.

Table 3. Average proximate component of BLRI Napier-3 (BN-3) at 60 days.

Nutrient components	**On-station (mean±SE)**	**Farmers community (mean±SE)**	***P* value**	**Level of significance**
Dry matter (DM) %	21.24± 0.59	21.02±0.11	0.245	NS
Ash%	13.90±018	13.67±0.08	0.355	NS
Crude protein%	7.37±0.10	7.45± 0.08	0.400	NS
ADF%	42.20±0.27	41.51±0.11	0.195	NS

NS= Non-significant (P>0.05).

3.3. Botanical fraction of BN-3

Table 4 shows the biomass yield ratio of botanical fraction for BN-3 fodder in on station and farmers community. Among the three consecutive cutting, higher LSR was found at first cutting compared to others where on station showed higher value than farmer's community. First cutting at 60 days, the portion of leaf was higher in both trials that means vegetative development of leaves was higher than stem. Higher LSR increases the palatability of feed for animals. The ratio of LSR was decreased considerably at the 2nd cutting both on station and farmers community level. The average LSR of the present study at on station and farmers community were 0.66 and 0.60 respectively. This results is compatible with the findings of Ahmed *et al.* (2021), who found that the average LSR of BN-3 were 0.62, 0.53 and 0.46 at 40, 50 and 60 days of cutting interval respectively. Amin *et al.* (2016) stated that LSR of BN-3 at 1st , 2nd and 3rd cutting were 4:3, 2.5:6.5 and 3.3:5.1 respectively which confirmed to our study results. There are some significant differences in growth parameters between on-station and farmers' community trials, the overall biomass yield and nutritional content of BN-3 are comparable. The findings highlight the potential of BN-3 to improve fodder availability and reduce feed costs, thereby supporting the sustainability and growth of the livestock sector in Bangladesh.

Table 4. The biomass yield ratio of botanical fraction for BLRI Napier-3 (BN-3).

Parameter	**Stem wt./kg**	**Sheath wt./kg**	**Leaf wt./kg**	**Leaf-steam ratio (LSR)**
1st cutting				
On station	397.33	158	444.67	1.11
Farmers community	443.33	144	412.33	0.93
2nd cutting				
On station	641.67	134	224.33	0.35
Farmers community	638.67	137	224.67	0.35
3rd cutting				
On station	549.67	156	294.33	0.53
Farmers community	535.67	181	283.67	0.52

4. Conclusions

From the findings of the present experiment, it was observed that the production performance of BLRI Napier-3 grass was almost similar both on the farm and at the farmer's community level. BLRI Napier-3 cultivar performed well in both experimental trial. It can be effectively cultivated to provide high-quality fodder for livestock. Further study with animal feeding is recommended for more precise results.

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Data availability
Data are contained within the article.

Conflict of interest
None to declare.

Authors' contribution
Conceptualization: Md. Yousuf Ali; Methodology: Md. Yousuf Ali and Ummeya Shiha Alam; Experiment management and data collection: Ummeya Shiha Alam; Data analysis: Md. Yousuf Ali and Al-Amin Hossain; Writing-original draft preparation: Ummeya Shiha Alam, Md. Tareq Hossain and Al-Amin Hossain; Writing-review and editing: Md. Yousuf Ali, Md. Hossen Ali and Md. Shamim Hasan; Supervision: Md. Yousuf Ali. All authors have read and approved the final manuscript.

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