http://dx.doi.org/10.22161/ijeab/2.4.43 *ISSN: 2456-1878*

Study of Intake, Growth and Nutrient Utilization of Growing Bulls Fed Forages as Sole Diets

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***Abstract*— *The study was conducted to rank Napier, jumbo, maize and rice straw on the basis of their yield, production cost, nutritional value and productivity of native growing bulls. Thirty native bulls (Bos indicus) of 135 (±28) kg live weight (LW) were randomly allocated to five treatments in a completely randomized design and fed silage of maize (Zea mays; Hybrid, PG-1000), jumbo (Sorghum bicolor; Hybrid Sugar graze), Napier (Pennisetum perpureum; hybrid) and urea molasses straw of whole straw (UMS-WS) and UMS of stover (UMS-S) for a period of 90 days. The dry matter (DM) intake of Napier, jumbo, maize, UMS-WS and UMS-S was 2.08, 1.79, 2.01, 1.92 and 2.08 % LW, respectively which differed significantly (P<0.01). The DM digestibility of UMS-WS or UMS-S (45.49 and 44.37 %) was significantly (p<0.01) lower than that of Napier, jumbo and maize (50.22, 53.01 and 58.75 %, respectively). The LW gain was greater (p<0.01) in bulls fed maize silage (273.3 g/d) followed by Napier silage (81.4 g/d), UMS-S (75.3 g/d), jumbo silage (39.9 g/d) and UMS-WS (39.6 g/d). Considering the cost of beef production, maize may be ranked on the top followed by Napier, jumbo, UMS-S and UMS-WS, respectively which may be taken in profitable beef production system.*

***Keywords*— Feed efficiency, jumbo, maize, Napier, UMS.**

I. INTRODUCTION

The efficiency of a fodder to animal production performance is important as about 55 to 75 % of the total costs of farming are associated with feed costs (1, 2 and 3). Feed evaluation systems are used to match the dietary nutrient supply with animal requirements for a specific level of production (4). These systems are important in order to optimize the efficiency of feed utilization, to improve animal performance and to reduce nutrient losses to the environment (4). Thus, the efforts aimed at improving the efficiency of feeding forage will have a large impact on reducing input costs associated with beef production.

Livestock is recognized as an integral component of rice based agricultural production system in Bangladesh and make multifaceted contributions to the growth and development in the agricultural sectors. Cattle fattening or beef enterprise is an important avenue for income generation for subsistence farmers as well as entrepreneurs. The shortage of feeds and fodder both in terms of biomass availability and nutritional quality are major concern to the producers and also considered a major constraint to animal productivity (5). An average 56.2% deficit of roughage DM and 80.0% of concentrate DM results in a very poor plane of nutrition for farm animals in the country (6). Any effort that i) explores quality feeds and fodders ii) generate production technologies for making their biomass available using agro-ecosystem sustainably and economically, and iii) value addition technologies for production and marketing of cost effective premixed feeds using available biomass may boost milk and meat production in the country. This requires qualitative evaluation of available roughages, and development of comparative nutritional weights of different roughages fed to ruminant animals. Moreover, scale of ranking available roughages (Napier, jumbo, maize and rice straw) based on their yield, production cost, nutritional value and productivity in the country is not developed yet. Such scale may help farmers feeding their animals cost effectively. Thus, the objectives of this study are to determine the effect of feeding different types of available straws and green fodders on the nutrition and growth performances of local bulls.

II. MATERIALS AND METHODS

2.1 Fodder cultivation

The seeds of jumbo grass (*Sorghum bicolor*; Hybrid Sugar graze) and maize (*Zea mays*; PG-1000; hybrid) were procured from BRAC Adventa Company, Dhaka, Bangladesh and, Progreen Seed Company, Hyderabad, India from their local authorized sources. Napier (*Pennisetum perpureum*; hybrid), jumbo and maize were grown under the recommended and identical agronomical management condition at Fodder Research Plot, Bangladesh Livestock Research Institute, Savar, Dhaka, Bangladesh.

2.2 Biomass production and cost of production

The annual fresh biomass yield per hectare land of Napier, Jumbo and Maize were determined under identical agronomic management condition. Napier was cultivated once and the number of harvest per year was considered 5 times. Similarly, there was a single cultivation of Jumbo and considered 3 harvest in a year. However, maize was cultivated separately 3 times in a year while calculating annual biomass yield.

The analysis of cost of cultivation of fodders included various components of costs. Here, only variable cost components such as cost of seed per cutting, land preparation, sowing cost, fertilizer, irrigation harvesting, silage preparation etc. were considered. The fixed cost such as rental value of land, depreciation of implements, interest on fixed capital, land revenue etc. are ignored.

2.3 Silage making

After harvesting, fodder was chopped into 6-8 cm using a chaf cutter machine and then ensiled in earthen pit. The silos were filled rapidly and compacted properly by hammering to remove air for maintaining a good anaerobic condition. Each pit was covered with 2 inches thick layer of rice straw, followed by covering with a plastic sheet. The plastic sheet was then plastered with mud to avoid any cracking. The silage was kept into the pit for 30 days.

2.4 Preparation of urea molasses straw (UMS)

Straws were procured from local sources and they were of two different types: one was the whole straw containing bottom and the top portion (WS) and the other was with only the bottom portion (stover). Both the straws were used for producing UMS (UMS-WS and UMS-S) according to the method described by Huque and Chowdhury (7).

2.5 Experimental design, animals and diets

Thirty local growing bulls (*Bos indicus;* Pabna & Red Chittagong Cattle) of 135 (±28) kg live weight were randomly allocated to five dietary treatments in a completely randomized design, having six animals in each treatment. The diets of the five treatment groups were maize, jumbo and Napier silage, and UMS-WS and UMS-S, respectively. At the onset of feeding trial, animals were dewormed according to the recommended doses of Endex ® (Levamesol BP 600 mg per bolus) at a rate of 20 mg per kg live weight. The animals were housed individually and fed the roughage diets *ad libitum* for a period of 90 days including a 7 days digestibility trial after 60 days of feeding. No supplementation was provided during the whole feeding trial. Fresh and clean water was made available in the sheds for the whole experimental period. The live weight gain (LWG) of bulls was calculated by measuring the live weight (LW) every ten days interval at 7 am in fasting condition during the whole experimental period.

2.6 Digestibility trial

The diets of bulls were supplied by morning (9 am) and evening (4 pm) meals by dividing the total amount into two equal amounts. The amount of daily feed supply and refusals found in each bull was recorded properly. Fresh samples of feed and refusals were analyzed in the laboratory to determine the daily dry matter (DM) intake of bulls. After 60 days of feeding, experimental bulls were transferred into metabolic stall, where faeces were collected separately for seven days. Records were kept on amount of feed offered, residue left and faeces excreted. During the collection period, composite samples of feed residue and faeces of individual bull were stored at -20 ^{0}C for further laboratory analysis.

2.7 Chemical analysis:

The samples of feeds, residue left and faeces were analyzed for DM, organic matter (OM) and crude protein (CP) following the method of AOAC (8). The acid detergent fibre (ADF) and neutral detergent fibre (NDF) was determined according to van Soest *et al* (9). Dietary metabolizable energy (ME) concentration was estimated from the digestible organic matter (DOM) intake as DOM kg x 15.58 = Mj ME (10)

2.8 Statistical analysis

The response to dietary treatments on intake, digestibility, nutritional quality and growth rate were compared statistically in an ANOVA of a Completely Randomized Design (CRD) using General Linier Model Procedures of SPSS, 11.1 for Windows (11) computer software packages.

III. RESULTS AND DISCUSSION

3.1 Chemical composition of experimental diets

Chemical composition of the roughages is shown in Table 1. Among the five different roughages the highest DM content was found in UMS-WS (67.65 %) followed by UMS-S, Napier, jumbo and maize silage (64.92, 22.95, 21.41 and 15.63, respectively) and the values differed significantly ($P<0.05$) except Napier and jumbo silage. In case of OM content, the highest values were found in maize and Napier silage (90.96 and 89.54 %, respectively) which varied significantly ($P<0.01$) with the values of jumbo silage, UMS-WS and UMS-S (86.48, 87.75 and 85.66 %, respectively). Maize silage (CP 9.65%) and UMS-WS (CP 8.75 %) had higher ($P<0.05$)

level of CP compared to others (varied from 8.08% to 8.57%). The ADF content of UMS-WS and UMS-S was similar (47.42 and 47.53 %, respectively) and differed significantly (P<0.01) with Napier, jumbo and maize silage (65.09, 69.05 and 56.31 %, respectively). Similarly, the NDF contents of UMS-WS and UMS-S did not differ, but significantly (P<0.01) less than the values of Napier, jumbo and maize silage (87.19, 75.56 and 75.39 %, respectively. The results with lower levels of CP in Napier (12) and Jumbo silage and higher levels of CP in maize silage is agreement with statements of Harris et al., (13) and Adewakun, et al. (14). Harris et al. (13) and Adewakun, et al. (14) also reported that Jumbo silage (Sorghum) had more structural polysaccharide than in Maize silage.

Table.1: Chemical composition of experimental diets (g/100 g DM)

Nutrients (% DM)	Experimental diets					SED	P-values
	Napier silage	Jumbo silage	Maize silage	UMS-WS	UMS-S		
DM (% fresh)	22.95^{d}	21.41^{d}	15.63^{a}	67.65^{b}	64.92^{c}	0.48	<0.01
OM	89.54^{a}	86.48^{bc}	90.96^{a}	87.75^{b}	85.66^{c}	0.30	<0.01
CP	8.08^{b}	8.53^{b}	9.65^{ac}	8.75^{bc}	8.57^{b}	0.18	<0.05
ADF	65.09^{a}	69.50^{b}	56.31^{c}	47.42^{d}	47.53^{d}	0.75	<0.01
NDF	87.19^{a}	75.56^{b}	75.39^{b}	65.81^{c}	67.29^{c}	0.66	<0.01

Means within the same row bearing different superscripts differ significantly; P>0.05, not significant

3.2 Nutrient intake

Nutritional responses of different roughages are presented in Table 2. The daily DM intake of Napier silage, maize silage and UMS-S was 2.68, 2.70 and 2.77 kg, respectively, or 2.08, 2.01 and 2.08 % LW, respectively. The daily DM intakes of jumbo and UMS-WS were 2.25 and 2.52 kg, or 1.79 and 1.92 % LW, respectively. The former three roughages had significantly (P<0.01) higher intake than that of the later two roughage. A similar trend in CP intake was also found among the roughages. The OM and CP intake were significantly (P<0.01) higher in bulls fed maize silage than bulls those fed other diets. Among the dietary groups jumbo silage fed group consumed significantly (P<0.01) lower OM and CP content. Bulls fed UMS-WS and UMS-S diets consumed significantly (P<0.01) lower ADF then bulls those fed other three diets. The intake of both ADF and NDF were significantly higher in bulls fed Napier silage diet. Keady and Gordon (15) reported that relative to grass silage as the sole forage, feeding maize silage as the sole forage increased (P<0.001) forage intake by 31 %. Similarly, Keady et al. (16) reported that relative to good quality grass silage as the sole forage, inclusion of average quality maize silage (28 % DM and 23 % starch) at 40% of the forage component of the diet (on a DM basis), increased (p<0.05) forage DM intake by 14%. Significantly higher DM intake in continental crossbred steers (424 kg LW) fed whole crop maize silage (9.54 kg DM/d) was also observed by Walsh et al. (17) compared to steers those offered grass silage only (7.41 kg DM/d).

Table.2: Nutritional responses of different roughages fed experimental animals

Parameters	Experimental diets					SED	P-values
	Napier silage	Jumbo silage	Maize silage	UMS-WS	UMS-S		
DM intake (kg/d)	2.68^{ac}	2.25^{b}	2.70^{ac}	2.52^{a}	2.77^{c}	0.05	<0.01
DM intake (% LW)	2.08^{ad}	1.79^{c}	2.01^{bd}	1.92^{bc}	2.08^{d}	0.03	<0.01
OM intake (kg/d)	2.35^{ac}	1.97^{b}	2.46^{a}	2.23^{c}	2.37^{ac}	0.04	<0.01
CP intake (kg/d)	0.25^{b}	0.22^{c}	0.28^{a}	0.23^{c}	0.25^{b}	0.004	<0.01
ADF intake (kg/d)	1.87^{b}	1.77^{b}	1.47^{a}	1.12^{c}	1.22^{c}	0.03	<0.01
NDF intake (kg/d)	2.37^{a}	1.71^{b}	2.06^{c}	1.63^{b}	1.93^{c}	0.03	<0.01

Means within the same row bearing different superscripts differ significantly; P>0.05, not significant

3.3 Nutrient digestibility

The apparent digestibility of different nutrients is presented in Table 3. The DM digestibility of UMS-WS or UMS-S was significantly (P<0.01) lower than that of the three fodders. Maize had the highest DM or CP digestibility (58.8 or 61.4 %), and they were significantly (P<0.01) higher than that of Napier or jumbo. The ADF digestibility of UMS-WS or UMS-S was significantly

http://dx.doi.org/10.22161/ijeab/2.4.43 *ISSN: 2456-1878*

($p<0.01$) lower (55.83 and 39.41 %, respectively) than bulls those fed other three fodders. However, Jumbo had the highest ADF digestibility (81.43 %), and they were significantly ($p<0.01$) higher than that of Napier and Maize (76.85 and 66.56 %, respectively). Similar to ADF digestibility, UMS-WS or UMS-S had the lowest NDF digestibility (56.48 and 59.66 %, respectively) than that of three fodders. However, the NDF digestibility of Napier, Jumbo and Maize did not differ significantly ($P>0.05$).

The digestible DM, OM, CP and NDF intake (DMI, OMI, CPI, and NDFI) was higher ($p<0.01$) in bulls fed Maize silage than bulls those fed other roughages. Similarly, Maize had the highest intake of metabolizable energy (ME) or digestible CP (10.0 MJ/d and 168 g/d) and it differed significantly ($P<0.01$) with that of Napier (8.38 MJ/d and 142 g/d) and Jumbo ((8.42 MJ/d and 105 g/d) or with that of UMS-WS (7.48 MJ/d and 126 g/d) and UMS-S (7.65 MJ/d and 126.0 g/d). Balwani et al. (18) reported that DM, OM and CP digestibility of maize silage was significantly ($P<0.05$) higher than sorghum silages; the values for DM, OM and CP digestibility of maize and forage type sorghum were 68 vs 55; 69 vs 56; and 56 vs 55%, respectively. Garrett and Worker (19) found that sorghum silage were not conducive to higher quality feed. Similar conclusions were made by Owen et al. (20) and Meyer et al. (21).

Table.3: Apparent digestibility of nutrients by growing native bulls fed different roughages

Digestibility of nutrients	Experimental diets					SED	P-values
	Napier silage	Jumbo silage	Maize silage	UMS-WS	UMS-S		
DM	50.22^{ad}	53.01^{d}	58.75^{c}	45.49^{b}	44.37^{b}	0.86	<0.01
OM	52.56^{a}	63.87^{b}	61.72^{b}	50.17^{ac}	48.25^{c}	0.77	<0.01
CP	55.70^{c}	47.79^{a}	61.43^{b}	55.15^{c}	50.98^{d}	0.73	<0.01
ADF	76.85^{a}	81.43^{b}	66.56^{c}	55.83^{d}	39.41^{e}	0.93	<0.01
NDF	61.06^{a}	62.42^{a}	63.71^{a}	56.48^{b}	59.66^{ba}	0.82	<0.01
Digestible DMI (kg/d)	1.37^{a}	1.21^{cd}	1.58^{b}	1.15^{cd}	1.23^{ad}	0.03	<0.01
Digestible OMI (kg/d)	1.26^{c}	1.26^{c}	1.51^{a}	1.12^{b}	1.15^{bc}	0.03	<0.01
Digestible CPI (g/d)	142^{c}	105^{b}	168^{a}	126^{d}	126^{d}±	2.78	<0.01
Digestible NDFI (kg/d	1.46^{a}	1.08^{d}	1.30^{b}	0.92^{c}	1.15^{d}	0.03	<0.01
Digestible ADFI (kg/d	1.44^{b}	1.44^{b}	0.99^{a}	0.63^{c}	0.49^{d}±	0.02	<0.01
ME intake (MJ/kg DM)	8.38^{b}	8.42^{b}	10.05^{a}	7.48^{c}	7.65^{bc}	0.18	<0.01
MP intake (g/d)	45.60^{b}	45.82^{b}	54.68^{a}	40.71^{c}	41.62^{bc}	1.07	<0.01

Means within the same row bearing different superscripts differ significantly; P>0.05, not significant

3.4 Live weight gain and FCR

The LW gain of bulls fed different forage is presented in Table 4. Feeding maize silage had the highest daily gain of 273.3 g ($P<0.01$) compared to 81.4 g in Napier, 75.3 g in UMS-S, and 39.9 or 39.6 g in jumbo or UMS-WS diet. Except maize, the LW gains of other diets did not vary significantly ($P>0.05$). It had an average feed conversion efficiency of 9.87 followed by 32.9 of Napier, 36.8 of UMS-S, 56.4 of jumbo, and 63.6 of UMS-WS, and the differences among the diets varied significantly ($P<0.01$). Therefore, considering the beef production performances, maize may be ranked on the top of all, followed by Napier, UMS-S, jumbo and UMS-WS based on their coefficient of nutritional response to growth of 1.0, 0.30, 0.28, 0.15 and 0.14, respectively.

The higher DM, CP and ME intake and greater digestibility of DM, OM, and CP could be the reasons for exhibiting higher growth rate and better FCR of bulls fed maize silage than bulls those fed other roughages. Keady and Gordon, (15) in their study reported that feeding maize silage alone increased carcass gain by 31% than bulls those fed other grass silage. Keady et al. (16) also reported that relative to good quality grass silage as the sole forage inclusion of average quality maize silage (28% DM and 23% starch) at 40% of the forage component of the diet (on a DM basis), increased carcass gain by 17%. Keady et al. (16) and Walsh et al. (17)

http://dx.doi.org/10.22161/ijeab/2.4.43 *ISSN: 2456-1878*

concluded that the FCR of the animals affected by the diet; animals those fed maize silage only had more efficient in utilizing energy than animals fed grass silage only. Walsh et al. (17) also reported that steers fed maize silage had a significantly better feed conversion efficiency compared to steers fed grass silage only (12.4kg DMI/kg carcass gain vs. 16 kg DMI/kg carcass gain) and maize silage had significantly higher LWG (1.200 compared to 0.802 kg/day), compared to steers fed grass silage only. Heifers fed maize silage alone had a significantly higher DMI than heifers fed grass silage only, 9.5 compared to 7.8 kg/day (22). Aston and Tayler (23) reported that at least an extra 2 kg of concentrates were required to enable cattle on grass silage to achieve comparable rates of LW gain to those on maize silage.

Table.4: Growth responses and FCR of growing native bulls fed different roughages

Parameters	**Experimental diets**					**SED**	**P-values**
	Napier silage	**Jumbo silage**	**Maize silage**	**UMS-WS**	**UMS-S**		
Initial LW (Kg)	133.9	135.1	134.8	134.7	135.8	8.05	>0.05
Final LW (Kg)	141.2	138.7	159.4	138.3	142.6	8.52	>0.05
Daily gain (g)	81.4^{b}	39.9^{b}	273.3^{a}	39.6^{b}	75.3^{b}	18.5	<0.01
FCR	32.92^{a}	56.35^{b}	9.87^{c}	63.62^{d}	36.78^{e}	0.76	<0.01

Means within the same row bearing different superscripts differ significantly (p<0.01); not significant, P>0.05

3.5 Biomass yield and the coat of production

The biomass yield and production cost of different fodders and silages are presented in Table. 5. The annual fresh biomass yield per hectare land of Napier, Jumbo and Maize were 150, 80 and 105 metric tons, respectively. It shows that the average cost of cultivation (total variable cost) per hectare per year required for Napier, jumbo and maize were 74905, 66545 and 122135 taka, respectively. The production cost per kg fresh and silages of Napier, jumbo and maize were 0.50, 0.83 and 1.16 Taka and 0.67, 1.09 and 1.36 Taka, respectively. The present findings agreed with Jabbari et al. (2011) who reported that the production cost of maize per unit land was higher than production cost of jumbo fodder. The higher cultivation cost of maize is due to use higher amount of seeds, fertilizer and increased cost for separate land preparation. The production cost of Kg.DM UMSs is shown in Table 6. The production cost including price of straw, molasses, urea and processing cost for UMS-WS and UMS-S were 9.98 and 8.98 taka, respectively. The production cost of UMS-WS was relatively higher than cost of UMS-S.

Table.5: Annual biomass yield and production cost of fodders and silages (Taka/ha)

Inputs	**Napier**	**Jumbo**	**Maize**
Seed/cutting	667	8,000	30,000
Land preparation	5,190	7,400	22,200
Sowing cost	4,167	500	2,000
Fertilizer	18,882	20,645	37,935
Irrigation	16,000	12,000	12,000
Harvesting	30,000	18,000	18,000
Silage preparation (pit, polyethylene, filling, chopping)	25,233	20,800	20,800
Total production cost (fresh, Taka/year/ha)	74,905	66,545	122,135
Total cost (silage, Taka/year)	1,00,138	87,345	1,42,935
Biomass production (Mt/year)	150	80	105
Production cost (fresh, Taka/kg)	0.50	0.83	1.16
Production cost (silage, Taka/kg)	0.67	1.09	1.36

Table.6: Production and preparation cost (Taka/Kg DM) of UMSs*

Inputs	***Production cost (Taka)**	
	UMS-WS	**UMS-S**
Straw	6.00	5.00
Straw processing	1.00	1.00
Molasses	2.50	2.50

Urea	0.48	0.48
Total (Tk/kg)	9.98	8.98

**Market price, 2013*

3.6 Cost of feeding

The cost involvement of LW gain of bulls fed different roughage diets is presented in Table 7. It shows that the cost of per kg DM intake required for Napier, jumbo, aize, UMS-WS and UMS-S were 2.92, 5.10, 8.72, 9.98 and 8.98 taka, respectively. However, the total roughage cost of per kg LW gain required 103.6, 301.2, 87.8, 646.8 and 338.2 taka, respectively for Napier, Jumbo, Maize, UMS-WS and UMS-S diets. Considering diet, refusal, management cost and time or days required for LWG, the maize fed animals required less feed cost (Taka 114.2) for Kg LW gain followed by Napier (Taka134.7), Jumbo (Taka 391.5), UMS-S (Taka 439.6) and UMS-WS (Taka 840.9). Considering the cost of beef production, less cost is involved in maize feeding, followed by Napier, jumbo and UMSs, respectively. The present findings are in agreement with Keady and Gordon (15) who reported that feeding maize silage as the sole forage reduced feed costs by 37 penny/kg carcass gain (P<0.001) than bulls those fed other grass silage. Keady et al. (16) reported that relative to good quality grass silage as the sole forage, inclusion of average quality maize silage (28% DM and 23% starch) at 40% of the forage component of the diet (on a DM basis), reduced (p<0.05) feed costs by 25 penny/kg carcass gain.

Table.7: Costs (Taka) involvement in LW gain of bulls fed different roughage diets

Parameters	Silage/ UMS				
	Napier	Jumbo	Maize	UMS-WS	UMS-S
FCR	32.92	56.35	9.87	63.62	36.78
Cost (Taka/KgDM)	2.92	5.1	8.72	9.98	8.98
Refusal	0.23	0.24	0.15	0.19	0.21
Increase of cost considering refusal (Taka)	3.15	5.34	8.87	10.17	9.19
Cost of roughage diet (Taka)	103.6	301.2	87.8	646.8	338.2
Time (days for one Kg LWG)	12.3	25.0	3.7	25.0	13.3
Cost management	31.1	90.4	26.3	194.0	101.5
Cost per kg LW gain (Taka)	134.7	391.5	114.2	840.9	439.6

IV. CONCLUSIONS

It may be concluded that, considering beef production performances maize may be ranked on top, followed by Napier, UMS-S, jumbo and UMS-WS based on their coefficient of nutritional response to growth of 1.0, 0.30, 0.27, 0.18 and 0.16, respectively. On the other hand, considering the cost of beef production, the top fodder maize may be followed by Napier, jumbo, UMS-S and UMS-WS, respectively. Farmers may use this roughage scale in formulating cost effective diets for making more profit of cattle production.

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