Ranking of Four Types Fodder as Sole Diet Considering Biological Characteristics and Growth of Local Growing Bulls

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Authors' contributions

This work was carried out in collaboration among all authors. Author KSH designed the study and wrote the protocol, author BKR performed the feeding trial and statistical analysis, author NH associated to perform the feeding trial, managed the literature searches and wrote the manuscript. All authors read and approved the final manuscript.

Original Research Article

ABSTRACT

Aims: In this experiment, evaluation of intake, digestibility and growth performances of local growing bulls by feeding Jumbo-green, Para and German grass based on Index (M_f) of Maize are considered and ranked this fodder accordingly.
Study Design: Completely randomized block design.
Place and Duration of Study: Bangladesh Livestock Research Institute (BLRI), Savar, Dhaka, between July 2016 and September 2016.
Methodology: Biomass production efficiency (Xddm), animal production efficiency (Xap), CH_4 emission deduction efficiency (X_{CH4}) and benefit to cost efficiency (Xbc) was considered to identify the biological characteristics of four fodders. Statistical analysis was done through SPSS-17 to evaluate the intake, digestibility and growth of animal. Rank of each fodder was calculated through the equation of Maize index (Mi) = (Xddm + Xap + X_{CH4} + Xbc)/4.
Results: Aggregation of four arithmetic average efficiency; Jumbo-green, Para and German got 0.42, 0.40 and 0.72 point out of 1.0 point of Mi, respectively. Among four fodders German grass

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performed best in terms of average daily gain (107 gm/d) and feed conversion ratio (46.9) compared to maize silage (64 gm/d & 58.4, respectively). Weight loss of bulls fed Jumbo and Para has occurred unexpectedly.

Conclusion: In combination of mathematical calculation and statistical evaluation, the rank of four fodders measured as Maize>German>Jumbo-green>Para.

1. INTRODUCTION

Nowadays with the advancement of science and sincerity of farmers, fodder production practices recognized as a profitable business. In context of this ground, different varieties of fodder crops or cultivars, known or unknown to farmers or hails from exotic origins through different sources is available in the country markets [1]. Capitalizing the market demand, without considering comparative nutritional benefits to animals or comparative production performances with existing fodder crops, only having certification of the Seed Certification Agency (SCA), new fodder crops are being introduced and cultivated by the farmers. Most of the cases in farming systems; the efficiency of on-farm biomass production, it's response to growth & milk production and the reduction of enteric methane emission and the cost-effectiveness of particular fodder is somewhat unknown [2]. That's why, sometimes it becomes inefficient to the farmers because of the variation of climate, topography, physiography, altitude, cultivating technology or other animal production related factors which are influential for the production of fodder both qualitatively and quantitatively. It has a great impact on livestock enterprises because 55 to 75% of the total costs associated with milk or meat productions are feed cost [3,4,5]. Increasing competition of feed availability and cost with an ever increasing demand for safe and high quality beef or dairy products may be minimized to some extent by improving feed efficiencies of animals. However, the shortage of feeds and fodder both in terms of availability and nutritional quality are the major concern to the producers and also considered a major constraint to animal productivity [6]. Fodder crops may play a momentous role in the agricultural economy by providing cheapest source of feed for livestock. At present, on dry matter basis Bangladesh produced 56.08 million tons of roughage which is 3.77% more over the actual demand but 44.6% production deficiency is observing because of losses or otherwise uses. On 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 [7]. In the web portal named Banglapedia, Alam & Sarker stated that, the deficit of green grasses now in the country is 66% and production of grasses becomes challenging and arable land become unavailable. Moreover, fodder production practices have been increasing recently even having limitations of land. So, major concern should have on careful screening of the available fodder crops in the country. In this case, introduction of new fodder with ensuring seed quality have to consider for measuring the production and productivity of fodder. Enforcing of legal authoritative power of the Department of Livestock services (DLS) in the authorization/certification system has to be developed [2]. At first, evaluation of available roughages both in terms of chemical composition and feeding values to animals for ranked them accordingly based on their production efficiency, utilization efficiency and cost benefit efficiency is truly required. But, the fact is, scaling or ranking of available roughages based on their yield, utilization, nutritive value and costing is not completely developed yet in the country. So, ranking of fodder crops based on their production efficiency of fodder biomass and animals, the reduction efficiency of enteric CH_4 emission in the rumen and benefit to cost efficiency are important to select a fodder crop for on farm cultivation. This requires development of database on the above biological and mathematical traits of different fodder crops available in the country. In this experiment, biometrical ranking based on Maize Index (M_f) of Maize with the objectives of evaluating intake, digestibility and growth performances of local growing bulls by feeding Jumbo-green, Para and German grass are considered to be ranked.

2. MATERIALS AND METHODS

2.1 Experimental Design and Preparation for Feeding Trial

A three month feeding trial including 7 days of digestibility was conducted as CRD manner having 24 bulls (*Bos indicus;* RCC & BCB-1) of

1-1.5 years of age of average 161.5±18.2 Kg in four groups randomly at Bangladesh Livestock Research Institute (BLRI), Savar, Dhaka. All the animals were de-wormed with Endex ® (Levamesol BP 600 mg per bolus) and housed them individually. Feed was *ad libitum* but amount was adjusted continuously with requirement and fresh water was available all the time. Maize and Jumbo fodder were cultivated and ensiled at the same place. Mature German and Para grass were collected from the field of BLRI periodically where it was available. Harvest index was determined at each harvesting time. Animals were weighed at 10 days interval and all the data which was related to feed and growth were collected properly.

2.2 Mathematical Calculations

To serve the mathematical purpose all the secondary data were generated from collected raw data by using Microsoft Excel software.

2.3 Biomass Production Efficiency (X_{ddm})

Dry matter yield (DMY) per hectare was calculated as $DMY = \frac{fodder\ biomass\ yield\ (kg) \times \%fresh\ DM\ of\ the\ biomass \times 10000}{Area\ of\ Land\ m2}\ kg/ha$. Harvest loss (HL) was calculated as $HL = \frac{\{(DM\ harvested - DM\ ensiled) + (\%\ loss\ of\ ensiled\ fodder \times DM\ ensiled) \times 100\}}{DM\ harvested}\%$. Digestibility of fodder (D, %) was determined with the concern of refused feed by animal as $D = \frac{(DM\ offered - DM\ refused - DM\ voided\ in\ feces) \times 100}{DM\ offered}\%$. Then, digestible dry matter (DDM) yield per hectare (Y_{ddm}) was determined through the equation of $Yddm = (DMY - DMY \times \%HL) \times \%D$ kg/ha. Finally, DDM production efficiency of other fodders (X_{ddm}) was determined by using Yddm as denominator and expressed as $Xddm = \frac{Yddm\ of\ a\ fodder}{Yddm\ of\ maize}$.

2.4 Animal Production Efficiency (X_{ap})

Digestibility (D) and DM intake (DMI) are responsive factors for daily live weight gain (LWG) of animal. The yield of LW against per hectare of maize yield was determined as $Yap = \frac{LWG\ (kg) \times DDM\ (kg)}{DMI\ (kg) \times D\ \%}$ kg/ha. The other fodders was compared through the equation of $Xap = \frac{Yap\ of\ fodder}{Yap\ of\ maize}$.

2.5 Rumen Enteric CH4 Emission Reduction Efficiency (X_{CH4})

Following [8], enteric methane emission of different fodder was calculated through daily gross energy intake (GEI) of animal which previously derived from DMI and GE content (MJ/kgDM) of a particular fodder. Following the equation of IPCC, 2006 emission factor; $EF = \frac{GE\left(\frac{Ym}{100}\right)}{55.6\ 5}$ Kg CH4/head/day; where Ym is 6.50% was determined. Then amount of methane emitted for LWG/kg was determined as $YCH4 = \frac{CH4\ emission\left(\frac{kg}{d}\right)}{LWG\left(\frac{kg}{d}\right)}$. Value of YCH4 always considered positive even if animal lost its body weight. The reduction efficiency of enteric methane emission of other fodders (XCH4) was then determined by comparing with maize as $XCH4 = \frac{YCH4\ of\ maize}{YCH4\ of\ fodder}$.

2.6 Benefit to Cost Efficiency (X_{bc})

Annual gross cost of each fodder (GCf) was determined through the equation of $GCF = \sum_{Fi}^{Pi} 1(Pi \times Qi)$; Where Pi = the price of ith input; Qi = the quantity of ith input. The gross return of each fodder (GRf) was determined through the equation of $GR = Qf \times Pf$; where Qf is the quantity of product and, Pf is the price of the product/hectare. Then GRf was divided by GCf to found the benefit to cost ratio of each fodder as $ybc = \frac{GRf}{GCf}$. At last, benefit to cost efficiency of any fodder (Xbc) was calculated by comparing with benefit to cost ratio of maize (Ybc) following the equation of $Xbc = \frac{Ybc\ of\ fodder}{Ybc\ of\ maize}$. All the cost was converted into US dollar (1US$= 78.0 BDT).

2.7 Maize Index (Mi)

For measuring different production parameters, the efficiency of biomass production of a fodder (Xddm), animal production (Xap), reduction of enteric CH4 emission (XCH4) and the benefit to cost of a fodder (Xbc) are the arithmetic ratio of Maize and a fodder. The arithmetic average of these four efficiencies was termed as the maize index (Mi) of available fodder in the particular region of production. So, Mi of a fodder was calculated through the equation of $Mi = \frac{Xddm + Xap + XCH4 + Xbc}{4}$. On the basis of digestibility and DM intake (%LW), the relative feed value of each fodder was determined through [9].

2.8 Statistical Analysis of Data

Nutritional comparison of fodders was done by an ANOVA of a Completely Randomized Design (CRD) using SPSS, 17 computer software packages. DM, OM, CP and ash were examined through the guideline of AOAC [10] and ADF & NDF through [11] as well. Gross energy was

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determined through Bomb calorimeter. The enteric CH_4 emission was calculated using the equation of IPCC [8]. The correlation and regression of M_f of all the tested fodder crops with their i) DM or digestible DM yield/hectare, ii) Kg LW/ha or daily weight gain of growing bulls, iii) Kg CH_4/Kg gain, or with iv) Benefit to Cost were determined and the significance of r values were compared with the tabulated r values at 5.0% level of significance [12].

3. RESULTS

The dry matter and organic matter percentage of maize (20.9 & 93.2, respectively) was found higher among the fodders followed by Jumbo-green, Para and German (19.2, 15.2 and 10.8 & 89.6, 86.3 and 83.1, respectively). The crude protein percentage of German fodder was higher (13.4) than others followed by Para, jumbo and maize (10.3, 9.8 & 9.1, respectively). The highest ADF was found in Jumbo silage (62.7%) and highest NDF was found in Para grass (87.6%). Gross energy (MJ/ kg DM) of maize was highest (16.3) among four fodders followed by jumbo, German and Para (16.2, 15.0 & 14.7, respectively) as mentioned in Table 1.

Nutrient intake of different fodders showed that, intake of jumbo-green silage was significantly higher in all the aspects of intake except CP intake. The DM intake, OM intake and DM intake (kg; % LW) were significantly higher (P = 0.05) in jumbo-green silage fed group (3.12, 2.81 & 1.94, respectively) than all other treatments followed by maize, German and Para (2.99, 2.90 & 1.91; 2.83, 2.35 & 1.70 and 2.43, 2.09 & 1.55, respectively). But, in case of CP intake, German fed animal group performed (0.38 Kg/d) significantly (P = 0.001) best among the treatments followed by jumbo-green, maize and Para (0.31, 0.28 & 0.25 kg/d, respectively). DM digestibility was higher in maize fed group (67.25%) at 1% level of significance followed by German, Para and Jumbo-green fed group (64.23, 54.18 & 53.81%, respectively). Maize also showed the highest OM digestibility (69.84%) at 1% level of significance followed by

German, Jumbo-green and Para (64.48, 57.79 & 53.74%, respectively). In case of CP digestibility German fed group performed significantly best (64.14%) among the treatments followed by Maize (60.24%), Para (55.03%) and Jumbo-green (43.51%). Digestible DM intake had significantly higher (P = 0.05) with maize fed bulls (2.01 kg/d) than others followed by German, jumbo & Para (1.82, 1.69 & 1.33, respectively) and digestible CP intake had significantly higher (P = 0.001) with German fed bulls (0.25 kg/d) than others followed by German, jumbo & Para (1.82, 1.69 & 1.33, respectively) as shown in Table 2.

The final live weight differed non-significantly among the treatments (Table 2). Significantly (P = 0.001) higher average daily gain (107 gm/day) in German fed group was observed in comparison with Maize fed group (64 gm/day). The animals of Para grass and Jumbo-green silage fed group lost their body weight at -132.0 gm/head/day and -148.0 gm/head/day rate, respectively. The FCR of four groups differed significantly (P = 0.001) where Para grass and Jumbo-green silage fed group showed negative impact, as shown in Fig 1.

In case of production cost, more money was expensed for purchasing of Para grass seed which accounts highest preparation cost among the fodders (111,700 Tk/h/Y) but at the growing time it required less fertilization and irrigation cost. Maize fodder needed highest fertilization and irrigation cost (54700 Tk/h/Y). Most cost was required at harvesting time for German grass among the fodders. Finally, fodder production cost of Maize, Jumbo, Para and German grass per hectare with ensiled or not was 210940, 156532, 162631 & 184450 Taka/hectare/Year, respectively. Although, highest fresh grass production was observed with German grass (181 tons/Yr) but Maize performed best with lowest production cost in case of per kg grass production as dry matter basis (6.93 Tk./Kg DM) followed by Jumbo, German and Para (8.95, 9.41 & 10.33 Tk./Kg DM, respectively), as shown in Table 3.

Table 1. Chemical composition of experimental diets

Diets	DM, % fresh	Chemical composition (%DM)				GE(MJ/ kg DM)
		OM	CP	ADF	NDF	
Maize	20.9	93.2	9.1	56.5	70.3	16.3
Jumbo-green	19.2	89.6	9.8	62.7	85.0	16.2
Para	15.2	86.3	10.3	58.7	87.6	14.7
German	10.8	83.1	13.4	59.4	79.3	15.0

Table 2. Nutritional and growth responses of different roughages

Parameters	Diets				SED	Sig. level
	Maize	**Jumbo**	**Para**	**German**		
DM intake (Kg/d)	2.99[a]	3.12[a]	2.43[bc]	2.83[ac]	0.13	*
CP intake (Kg/d)	0.28[bc]	0.31[b]	0.25[c]	0.38[a]	0.01	***
OM intake (Kg/d)	2.80[a]	2.81[a]	2.09[bc]	2.35[ac]	0.11	*
DM intake (kg; % LW)	1.91[ac]	1.94[a]	1.55[b]	1.70[bc]	0.05	**
DM digestibility	67.25[a]	53.81[b]	54.18[b]	64.23[a]	1.15	***
CP digestibility	60.24[ac]	43.51[b]	55.03[a]	64.14[c]	1.34	***
OM digestibility	69.84[a]	57.79[bc]	53.74[c]	64.48[d]	1.16	***
DDMI (Kg/d)	2.01[ad]	1.69[bcd]	1.33[b]	1.82[ac]	0.08	**
DCPI (Kg/d)	0.17[a]	0.14[a]	0.14[a]	0.25[b]	0.009	***
Initial LW (Kg)	160.9	161.0	162.0	162.1	5.63	NS
Final LW (Kg)	164.8	152.1	154.1	168.5	5.88	NS

*Significant level = (Non-Significant = P = 0.05; *= P = 0.05,significantly different; *** = P = 0.001, highly significant), [abcd] values with different superscripts in the same row differ significantly; SE: Standard error of mean*

	Maize	Jumbo-green	Para	German
Daily gain/loss, g	64	-148	-132	107
FCR	58.42	-24.52	-27.87	46.92
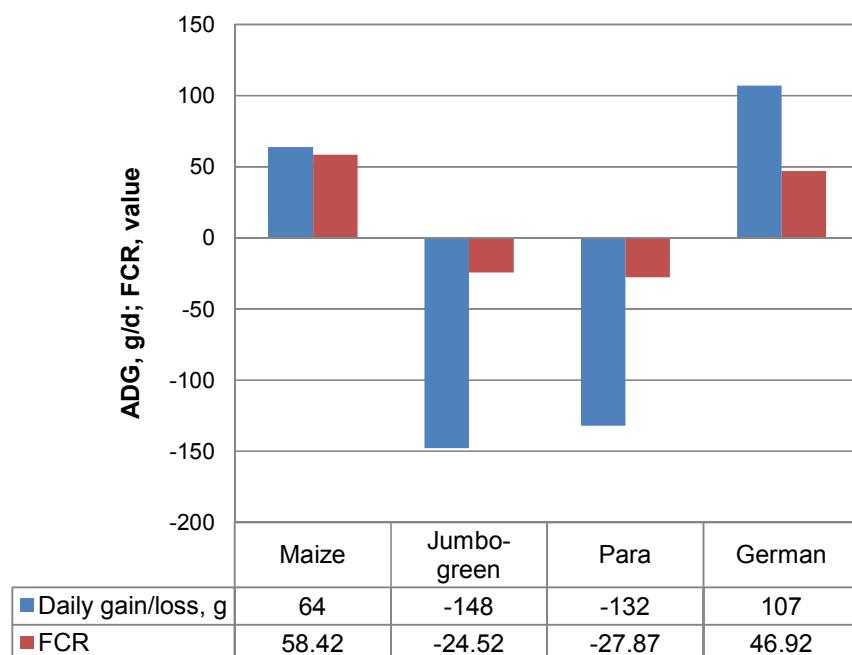
Fig 1. Average daily gain and FCR of different treatments

Table 3. Biomass yield and production cost of fodders and silages (Tk/h/Y)

Inputs	Maize	Jumbo-green	Para	German
Land rent, Sowing and Land Preparation Cost	75,540	54,900	111,700	62,500
Intercultural Operation Cost	54,700	34,700	7,215	14,000
Harvesting and Processing Cost	80,700	66,932	43,716	107,950
Total cost (Tk/Y)	210,940	156,532	162,631	184,450
Product per hectare (fresh; tons/year)	140	75	100	181
Product cost (Tk./kg)	1.51	1.56	1.56	1.02
Cost (Tk./Kg DM)	6.93	8.95	10.33	9.41

In the context of production merits of four fodders, DMY was obtained highest with maize (20700 kg/ha) followed by German, Para and Jumbo-green (19600, 15250 & 14400 kg/ha, respectively) but, German grass performed best (12206 kg/ha) in terms of digestible dry matter

yield (Y_{ddm}) than maize, Para & Jumbo-green (11887, 8018 & 7515 kg/ha, respectively) and thus biomass production efficiency of German grass got highest 1.03 mark followed by maize, Para and Jumbo-green (1.0, 0.67 & 0.63, respectively), as mentioned in Table 4. In the feeding trial, the animal production efficiency against different fodder showed little bit peculiar response. Animal of Jumbo-green silage and Para grass fed group lost their weight during the time of trial even though the highest DMI was observed in Jumbo group, 3.12 kg/d. But, DMI of Para grass fed group was lowest (2.43 kg/d) among the groups. Eventually when production efficiency was calculated the Jumbo and Para fed group got negative marks (-0.33 & -0.40, respectively) where German grass got positive marks (0.36), as shown in Table 4.

Although the negative value was found with Jumbo-green silage and Para grass fed group (-0.148 & -0.132 kg/day, respectively), these values were used as positive value in case of the calculation of enteric methane emission production. Because, biological phenomenon like methane emission always carried positive value. Thus, we got positive value of emission factor (EF) of all the fodders and then enteric methane emission reduction efficiency of all the fodders was calculated accordingly where Jumbo-green silage, Para grass and German grass got 0.52,

0.66 and 0.45 points, respectively, as shown in Table 5.

Calculative value of production cost of different fodder per hectare of land annually showed that, more money was required to produce per ton dry matter of German grass (203.1 US$) followed by maize, Jumbo-green and Para grass (185.7, 156.3 & 145.2 US$, respectively). Side by side annual gross return of these fodders was found as previous manner where German grass showed best performance. Considering the costing and returning factors of these fodders, benefit to cost ratio was figured as 1.60, 1.37, 1.10 & 1.69 for maize, Jumbo-green, Para and German grass, respectively and at last benefit to cost efficiency of German, Jumbo-green and Para grass was marked as 1.06, 0.86 & 0.69, respectively, as shown in Table 6.

All the biological merits of different fodder which found previously were compiled and the actual standard of different fodders was measured against maize index accordingly. Finally, it stands as 0.72, 0.42 & 0.40 for German, Jumbo-green and Para grass, respectively. Along with this result, the relative feed value of these fodders were calculated and values were found as 98, 85, 81 & 65 for maize, German, Jumbo-green and Para grass, respectively, as mentioned in Table 7.

Table 4. Biomass production and animal production efficiency of fodder crops

Fodder	Biomass production & its quality					Animal production efficiency			
	DMY, Kg/ha	HL %	D, %	Y_{ddm}	X_{ddm}	DMI, Kg/day	LWG, Kg/day	Y_{lw}	X_{ap}
Maize	20700	3.0	59.2	11887	1.0	2.72	0.269	1985.8	1.00
Jumbo-green	14400	3.0	53.8	7515	0.63	3.12	-0.148	-662.6	-0.33
Para	15250	3.0	54.2	8018	0.67	2.43	-0.132	-803.5	-0.40
German	19600	3.0	64.2	12206	1.03	2.83	0.107	718.8	0.36

DMY, dry matter yield; HL, harvest loss; D, digestibility; Yddm, digestable dry matter yield; Xddm, biomass production efficiency of fodder crops; DMI, dry matter yield; LWG, live weight gain; Ylw, live weight yield; and Xap, animal production efficiency of fodder crops; Source: Huque, et al. [25]

Table 5. Enteric CH4 emission reduction efficiency of different fodder crops

Fodder	GE MJ/kgDM	GEI, MJ/d	LWG, kg/d	EF, kg CH4/d	YCH4 (CH4:LWG)	XCH4
Maize	17.6	47.87	0.269	0.06	0.21	1.00
Jumbo-green	16.2	50.54	-0.148	0.06	0.40	0.52
Para	14.74	35.82	-0.132	0.04	0.32	0.66
German	14.98	42.39	0.107	0.05	0.46	0.45

GE, gross energy; GEI, gross energy intake; LWG, live weight gain; EF, emission factor, kg CH4/d; YCH4, ratio of enteric CH4 emission per kg live weight gain; XCH4, enteric CH4 reduction efficiency of fodder crops
Source: Huque, et al. [25]

Table 6. Benefit to cost efficiency of different fodder crops

Fodder	GCf, US$/ha	US$/tonDM	GRf, US$	Ybc	Xbc (Fodder:Maize)
Maize	2402.30	185.70	3843.99	1.60	1.00
Jumbo-green	1641.80	156.30	2250.72	1.37	0.86
Para	2004.80	145.20	2214.30	1.10	0.69
German	2349.50	203.10	3980.76	1.69	1.06

GCf, annual gross cost of production of a fodder crop per ha of land; GRf, annual gross return of the fodder crops; Ybc, benefit to cost ratio of fodder crops; Xbc, benefit to cost efficiency of different fodder crops
Source: Huque, et al. [25]

Table 7. Maize index (Mi) and relative feed value (RFV) of fodder crops

Fodder	Xddm	Xap	XCH4	Xbc	Mi	D%	DMI, %LW	RFV
Maize	1.00	1.00	1.00	1.00	1.00	59.20	2.14	98
Jumbo-green	0.63	-0.33	0.52	0.86	0.42	53.80	1.94	81
Para	0.67	-0.40	0.66	0.69	0.40	54.20	1.55	65
German	1.03	0.36	0.45	1.06	0.72	64.20	1.70	85

X_{ddm}, biomass production efficiency of fodder crops; Xap, animal production efficiency of fodder crops; X_{CH4}, enteric methane emission reduction efficiency of different fodder crops; and X_{bc}, benefit to cost efficiency of fodder crops; Mi, maize index of fodder crops; D, digestibility; DMI, dry matter intake; RFV, relative feed value
Source: Huque, et al. [25]

Table 8. Relations of Mi with different important parameters

Relations with	Equations	r	Significance
Biomass production (kg DM/ha)	Yddm = 7756.6 Mi + 4981.1	0.79	*P* = 0.01, df 15
Animal production (kg LW/ha)	Yap = 2.3173 Mi – 1.314	0.99	*P* = 0.01, df 15
CH4 emission reduction efficiency	XCH4 = 0.4467 Mi + 0.6189	0.59	*P* = 0.01, df 15
Benefit to cost efficiency	Xbc = 0.5637 Mi + 0.2996	0.43	*P* = 0.05, df 15
LWG (Y; kg/d)	Y = 0.7033 Mi - 0.4226	0.99	*P* = 0.01, df 15
Relative feed value (RFV)	Y = 42.6 M_i + 55.199	0.79	*P* = 0.01, df 15

Y_{dm}, digestible dry matter yield; Yap, live weight yield; Y_{CH4}, ratio of enteric CH_4 emission per kg live weight gain; Y_{bc}, benefit to cost ratio of fodder crops; LWG, live weight gain; r = correlation

At last, relationship of Mi with different production parameters was figured out and all the equations showed that, there was a strong correlation in all terms i.e.: biomass production efficiency, animal production efficiency and CH_4 emission reduction efficiency, with 1% level of significance along with benefit to cost efficiency which was correlated with maize index at 5% level of significance.

4. DISCUSSION

Fresh biomass of maize harvested at maximum (140 tons/h/year) with 20.9% DM and 9.1% CP in this experiment which was similar to Rahman, et al. [13] (135 tons/h/year with 19.66% DM and 10.94% CP). In this study, when fed maize silage as sole diet, average daily gain of animals was only 64 g/d but up to 162 g/d it could be achievable if used maize silage as sole [14]. The fact is, sometimes it is unable to achieve comparable rates of LWG using maize as sole; according to Aston and Tayler [15]. In case of jumbo grass, 75 tons/year of fresh yield had

gained under this experiment as dissimilar with the findings of Rahman, et al. [16] (145 tons/year). Several Jumbo cultivars are available in local market and among them Sweet Jumbo is best in terms of biomass yield [17]. But, Garrett and Worker [18] reported that, sometimes sorghum silage is not performed as higher quality feed. This may be one of the reasons of losing weight of bulls fed jumbo silage. However, the DM, OM and CP digestibility of maize silage was significantly higher than jumbo silage 67 vs 54, 70 vs 58 and 60 vs 44%, respectively which was similar with the findings of Balwani, et al. [19] in most of the context (68 vs 55; 69 vs 56; and 56 vs 55% respectively). The yield of Para and German grasses was 100 and 181, respectively (fresh; tons/h/year) which was much more in comparison with the achieved yield of Kanak, et al. [20] (70 & 84, respectively; ton/h/Y) and Pikar [21] (slightly higher than the previous). In this experiment, DM intake (kg; % LW) of Para grass was lowest (1.55) among four treatments and resulted with weight loss of bulls. But, Sath, et al. [22] by using Para grass with rice straw got a
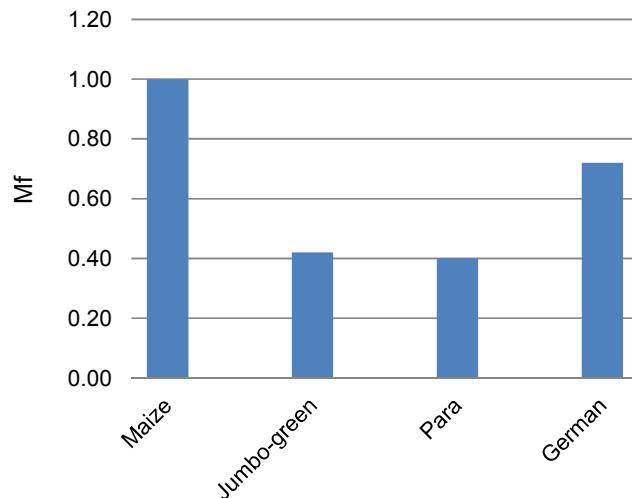
Fig. 2. Ranking of four fodder

result of 155 g/d live weight gain, where total DM intake (% BW) was 2.70. The mineral contents of Para grass especially Ca, may remain low sometimes in fodder which may create deficit intake which found as a recommendations for growing cattle [23]. So, with this matter the low intake rate of DM may be the cause of weight loss of Para feds bulls. On the other hand, in this experiment, the yield of German grass was highest (181 ton/h/Y; fresh) and DM, CP & OM digestibility was mostly similar to maize silage (64 Vs 67, 64 Vs 60 & 64 Vs 70, respectively) with significantly highest average LWG in comparison to maize (107 Vs 64 g/d, respectively). In another findings, [24] also got positive response by fedding German grass to RCC Cattle in terms of intake, digestibility or average daily live weight gain.

5. CONCLUSION

Best performance of German grass was clearly visible all through the feeding trial. Considering Maize (M_f =1.0), the calculated M_f for Jumbo-green silage, Para grass and German grass was 0.42, 0.40 and 0.72. So, these four types of roughages may be ranked as Maize>German>Jumbo-green>Para, as expressed in Fig. 2.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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