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Nutritional evaluation of cultivated fodder crops grown under agro-climate of Tripura

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ABSTRACT

The study was conducted to assess forage yield and nutritional characteristics of various crops including graminaceous (maize, sorghum, pearl millet, oat, job's tears, napier hybrid, para grass, congo signal, signal grass, guinea grass, thin napier and broom grass) and leguminous (cowpea, rice bean, berseem, cluster bean/guar, soybean, stylo and perennial ground nut) introduced at the ICAR Research Complex, Tripura Centre. The average fresh forage yields of different forage crops were satisfactory and in the range reported elsewhere in the country with the exception of berseem and cluster bean which yielded lesser quantity of herbage. There were significant differences among the crops (graminaceous or leguminous) in terms of proximate principles, cell wall constituents, *in vitro* DM and OM digestibility (IVDMD and IVOMD) and metabolisable energy (ME) values. Leguminous fodders possessed higher level of CP, EE, IVDMD/ IVOMD and ME compared to graminaceous fodders while a reverse trend was observed for CF and cell wall components except ADL. Overall, CP and EE were positively correlated with IVDMD, IVOMD and ME values, however, CF, NDF, ADF and cellulose showed negative relationship with these parameters. ME value had a strong positive correlation with IVDMD and IVOMD levels in the fodders. Considering their herbage yield under *tilla* land (upland) conditions, they hold good potential for increasing the forage production and thus bridge the gap between demand and supply of nutrients particularly for ruminants and to raise their productivity in the state.

Key words: Cultivated fodders, Forage yield, Nutritional evaluation

Tripura is a small state with geographical area of 10492 sq. km. and is characterized by warm and humid sub-tropical climate. The lack of adequate nutrition is the major constraint in ruminant productivity in Tripura. Scarcity is more during the lean period of October to April. There is shortage of dry and green roughages to the extent of 29 and 80%, respectively (ARDD 2002). Adequate production of cultivated fodder crops is required to solve the problem of nutrient supply to herbivores. Therefore, it is of significance to study the adaptability of a particular crop to the new environment with respect to herbage yield and nutritional characteristics (Chatterjee and Das 1989, Singh *et al.* 1998, Anonymous 2004) so that quality fodder could be made available to ruminants particularly cattle. Sowing of improved varieties of fodder crops is probably one of the efficient methods for enhanced forage production and ruminants performance (Zulfiquar and Asim 2002, Man and Wiktrosson 2003). Hence, various fodder crops including leguminous and non-leguminous ones were grown under agro-climatic conditions of Tripura and evaluated for forage yield and nutritional characteristics.

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MATERIALS AND METHODS

Cultivated fodders including graminaceous comprising annuals, viz. maize (var. Vijay Composit, 65 days), sorghum/ jowar (var. PC–9, 65 days), pearl millet/bajra (AVKB–19, 65 days), oat (var. OL–9, 60 days), job's tears (70 days); perennials, viz. napier hybrid (var. PBN–231), congo signal, signal grass, guinea grass (var. Hamil), thin napier grass and broom grass; leguminous annuals, viz. cowpea (var. Bundel lobia–1, 60 days), rice bean (var. Bidhan–1, 60 days), berseem (var. Mescavi, second cut), guar (Bundel Guar–1, 60 days), soybean (65 days); perennials, viz. stylo (*Stylosanthes seabrana*, second cut) and perennial groundnut (second cut) were cultivated in the experimental plots under standard agronomic practices. All the annuals except oat and berseem were grown in *kharif* season. Their forage yield and nutritional characteristics were determined. The fodder samples were dried at 70°C for 12 h, ground to pass through 1 mm sieve. Proximate principles (AOAC 1995) and cell wall constituents (CWC's) were determined (Goering and Van Soest 1970). *In vitro* DM and OM digestibility (IVDMD

and IVOMD) were established using two-stage technique (Tilley and Terry 1963). Metabolisable energy (ME) concentration in the feedstuffs was estimated (Menke *et al*. 1979). For this, gas measurements were carried out at 0, 2, 4, 6, 8, 10, 12 and 24 h after incubation. The cumulative gas production values (up to 24 h) and other chemical constituents (CP and NFE) were used to arrive at the ME values using the equation given by Menke *et al.* (1979). For *in vitro* studies, rumen liquor was collected from 3 rumen cannulated crossbred adult male cattle (B. wt. = 332.6±18.6), strained through a 4–layered muslin cloth and pooled together which was used as inoculum source. The donor animals were fed according to their requirements (NRC 2001). All the determinations were carried out in triplicate. Data were statistically analysed using completely randomized block design with in each group, i.e. leguminous and non-leguminous while means of both the groups were compared using t-test (*Snedecor and Cochran 1989*).

RESULTS AND DISCUSSION

There were large variations in the forage yield of crops grown elsewhere and during the present studies (Table 1), which could be attributed to the factors like climate (season, rainfall, temperature etc.), agronomic practices (variety, seed

Table 1. Fresh yield (q/ha) of cultivated fodders grown in Tripura

Crop	Botanical name	Fresh yield*	A	B	C	D	E	F	G	H
					Graminaceous					
Annual										
Maize	*Zea mays*	325–500	392–700	350–550	170–550	350–550	350–600	350–500	250–600	300–400
Sorghum/jowar	*Sorghum bicolor*	350–500	224–426	300–520	100–850	500–850	320–950	250–500	250–700	250–500
Bajra/pearlmillet	*Pennisetum typhoides*	450–515	168	250–320	150–700	250–300	350–500	–	400–600	250–300
Oat	*Avena sativa*	300–375	258–314	300–450	400–600	400–500	450–600	400–660	600	200–400
Job's tear	*Coix lachrymal jobi*	200–225	–	–	–	–	–	–	–	–
Perennial										
Napier hybrid	*P. purpureum* × *P. typhoides*	1500–1800	1680–2835	1500–1800	1500–2500	2000–2500 (3830 max.)	1000–1800	1450–3000	–	–
Congo signal	*Brachiaria ruzinensis*	500–750	–	–	–	350–1000	700–900	–	–	–
Para grass	*B. mutica*	800–1200	848–1500 (2755 max)	–	750–1500	700–1200	1000–1900	–	–	1500–2000
Signal grass	*B. decumbens*	700–850	–	–	–	800–1000	500–800	–	–	–
Guinea grass	*Panicum maximum*	1150–1300	448–672	–	1200–1300 (2260 max.)	800–1400	600–1450	1200–1500	–	600–1250
Thin napier	*Pennisetum polystachyon*	650–750	336	–	52.7–97.7 DM	–	–	–	–	750–1000
Broom grass	*Thysanolena maxima*	1000–1150	–	–	–	–	–	–	–	–
					Leguminous					
Annual										
Cow pea	*Vigna unguiculata*	250–350	90–120	300–450	–	250–400	220–420	200–300	250–300	200–300
Rice bean	*Vigna umbellata*	225–325	–	200–400	80 (53–97) DM	170–350	–	–	300–350	200–220
Berseem	*Trifolium alexandrinum*	350–425	336–448	700–1200	1000–1200	800–1200	500–1200	500–600	600–1000	500–1000
Guar	*Cyamopsis tetragonoloba*	175–225	112	200–350	120–411	–	175–350	250–400	300–400	100–250
Soybean	*Glycine max*	250–325	112–134	–	300–350	–	–	200–300	–	200–300
Perennial										
Perennial ground nut	*Arachis pintoi*	700–800	–	–	–	–	–	–	–	–
Stylo	*Stylosanthes seabrana*	225–350	–	–	400	250–300	300–550	–	–	–

*ICAR, Tripura Centre; A: Narayan and Dabdghao, 1972, B: Melkania, 1999, 2001; C: Chatterjee and Das, 1989; D: Thomas, 2003; E: Anonymous. , 2004; F: Ranjhan, 2004; G: Pathak and Jakhmola, 1983; H: Banerjee, 1978.

Table 2. Proximate composition of cultivated fodders

Name	%, DM basis						
	DM**	OM**	CP**	EE**	CF**	NFE**	TA**
			Non-leguminous				
Annual							
Maize	21.90	90.35	8.74	1.33	25.25	55.03	9.65
Sorghum	20.56	91.95	6.88	1.29	30.32	53.46	8.05
Bajra	19.18	90.20	8.52	1.76	25.01	54.91	9.80
Oat	22.36	89.14	8.62	1.54	26.95	52.03	10.86
Job's tears	22.28	93.98	7.05	1.43	27.27	58.23	6.02
Mean	21.26	91.12	7.96	1.47	26.96	54.73	8.88
Perennial							
Napier hybrid	21.38	85.56	9.19	1.87	28.27	46.23	14.44
Congo signal	23.11	90.21	7.85	1.45	26.38	54.54	9.78
Para grass	19.74	90.13	8.24	1.30	33.78	46.81	9.87
Signal grass	28.91	93.15	7.72	1.78	23.60	60.05	6.85
Guinea grass	21.83	86.88	8.17	1.45	32.58	44.68	13.12
Thin napier	19.30	87.70	6.92	1.23	33.84	45.71	12.30
Broom grass	29.70	90.63.	6.66	1.16	34.55	48.26	9.37
Mean	23.42	89.18	7.82	1.46	30.43	49.47	10.82
Overall mean±SE	22.52±0.65	89.99±0.40	7.88±0.16	1.47±0.05	28.98±0.65	51.66±0.86	10.01±0.40
CD value	2.73	1.02	0.99	0.32	2.35	2.32	1.02
			Legumes				
Annual							
Cowpea	18.23	89.91	19.07	2.35	21.50	46.99	10.09
Rice bean	23.27	88.87	15.61	2.13	25.81	45.32	11.13
Berseem	13.37	87.52	18.01	2.15	17.16	50.20	12.48
Guar	20.87	88.53	15.60	2.04	29.76	41.13	11.47
Soybean	21.29	91.97	18.42	2.90	15.86	54.79	8.03
Mean	19.41	89.36	17.34	2.31	22.02	47.69	10.64
Perennial							
Perennial ground nut	36.17	92.12	16.63	3.09	25.70	46.70	7.88
Stylo	35.74	92.40	13.94	2.02	17.85	58.59	7.60
Mean	35.95	92.26	15.29	2.56	21.77	52.64	7.74
Overall mean±SE	24.14±1.66	90.19±0.41	16.75±0.39	2.38±0.09	21.95±0.98	49.11±1.12	9.81±0.41
CD value	2.01	1.02	1.50	0.50	2.15	2.40	1.02
t-test (Leg. vs. non-leg.)	NS	NS	**	**	**	NS	NS

**P<0.01; NS: Nonsignificant.

rate, sowing/harvesting time, irrigation, fertilization, intercultural operations etc), soil conditions and other managemental aspects (Cruz-vazguez *et al*. 2000, Melkania 2001, Thomas 2003, Anonymous 2004, Bhagat Singh *et al*. 2005, Fernandes and Waditake 2006). For example, multi-cut type of sorghum could yield 950 q/ha (Anonymous 2004). Similarly, in perennial grasses, the fresh yield up to 3830, 2755 and 2260 q/ha in napier hybrid, para grass and guinea grass, respectively, was reported (Chatterjee and Das 1989, Narayan and Dabadghao 1972). The yield of berseem was notably lower when compared with other studies, which could be mainly due to acidic (pH=5–5.5) nature of the soil here as berseem is sensitive to acid conditions (Thomas 2003). So was the case with guar yield.

There were significant (P<0.01) differences among the graminaceous as well as leguminous fodders crops with respect to proximate principles (Table 2). The highest DM was observed in broom grass (29.70%) and the lowest in pearl millet (19.18%). Broom grass possessed the lowest CP level and napier hybrid the highest. The average CF content was 28.94±0.65%. The maximum value was recorded in broom grass and the lowest in signal grass. In general, perennial grasses seemed to possess higher level of CF and total ash and lower level of NFE compared to annual graminaceous fodders. In leguminous crops, DM content averaged 24.14±1.66% ranging from 13.37% (berseem) to 36.17% (perennial ground nut). CP concentration varied from 13.94% (stylo) to 19.07% (cowpea) with a mean of 16.75±0.39%. Soybean possessed the lowest CF value (15.86%) while rice bean showed the highest one (25.81%) and the average was 21.95±0.98%. The values for CWC's differed markedly (P<0.01) among graminaceous as well as

Table 3. Cell wall composition digestibility and metabolisable energy values of cultivated fodders suitable for Tripura

Fodder	%, DM basis					*In vitro* digestibility		ME** (MJ/kg DM)
	NDF **	ADF**	HC**	Cellulose**	ADL**	DM**	OM**	
				Non-leguminous				
Annual								
Maize	67.25	40.91	26.34	33.50	4.44	65.39	67.11	8.64
Sorghum	73.04	42.75	30.29	34.15	5.59	54.20	55.85	6.95
Bajra	68.44	39.97	28.47	28.54	7.22	57.34	58.59	7.48
Oat	69.67	38.50	31.17	30.09	5.21	62.25	63.78	8.45
Job's tear	71.11	37.92	33.19	30.57	5.50	48.34	49.90	6.84
Mean	69.90	40.81	29.89	31.37	5.59	57.5	59.05	7.67
Perennial								
Napier hybrid	69.01	39.52	29.49	30.33	5.78	58.00	59.75	7.60
Congo signal	64.19	36.15	28.04	28.47	4.68	60.12	62.08	8.20
Para grass	71.58	41.13	30.45	32.70	4.29	57.05	58.77	8.06
Signal grass	60.52	33.07	27.45	26.75	4.17	57.65	58.98	7.45
Guinea grass	71.55	47.51	24.04	37.82	6.62	56.38	57.99	7.34
Thin napier	69.91	40.11	29.80	28.47	4.68	55.42	57.32	6.56
Broom grass	76.75	43.78	32.97	29.25	10.53	48.29	49.75	6.22
Mean	69.07	40.18	28.89	30.54	5.82	56.13	57.81	7.35
Overall mean±SE	69.42±0.71	40.11±0.62	29.31±0.46	30.89±0.54	5.73±0.29	56.70±0.84	58.32±0.85	7.48±0.13
CD value	2.48	2.09	2.02	2.20	0.61	2.89	2.74	0.63
				Legumes				
Annual								
Cowpea	50.54	32.61	17.93	20.86	8.74	62.22	64.03	8.30
Rice bean	57.74	34.05	23.69	21.28	9.77	58.10	59.67	7.94
Berseem	43.82	30.53	13.29	19.20	8.34	72.85	74.32	8.82
Guar	51.95	39.11	12.84	25.29	9.95	63.47	64.82	8.19
Soybean	37.57	21.27	16.30	16.01	3.73	65.20	66.72	8.34
Mean	48.32	31.51	16.81	20.53	8.11	64.37	65.91	8.32
Perennial								
Perennial ground nut	40.19	25.58	14.61	18.37	5.61	65.20	67.11	8.45
Stylo	51.08	28.59	22.49	22.14	4.79	63.82	66.17	8.21
Mean	45.64	27.09	18.55	20.26	5.20	64.51	66.64	8.33
Overall mean±SE	47.55±2.01	30.25±1.49	17.30±0.92	20.45±0.96	7.27±0.53	64.41±0.91	66.12±0.86	8.32±0.10
CD value	2.43	2.04	1.54	1.76	0.86	3.25	2.54	0.60
t-test	**	**	**	**	*	**	**	**

*P<0.05; **P<0.01.

leguminous fodders (Table 3). The NDF/ADF values ranged from 60.52/33.07 (signal grass) to 76.75/43.78% (broom grass). Guinea grass contained a maximum of 37.82% cellulose and the lowest content was observed in signal grass (26.75%). Broom grass also had a maximum value of 10.53% for ADL while para grass showed the lowest one (4.29%). Among leguminous fodders, the values for NDF, ADF, hemicellulose, cellulose and ADL ranged from 37.57 (soybean) to 57.74% (rice bean), from 21.27 (soybean) to 39.11% (guar), from 16.11 (soybean) to 25.29% (guar) and from 3.73 (soybean) to 9.95% (guar). Application of t-test revealed that leguminous crops had higher (P<0.01) CP and EE contents while CF, NDF, ADF, hemicellulose and cellulose were lower as compared to non-leguminous fodders. The values for various constituents were found in the range (Ranjhan 2004, Fernandes and Waditake 2006), however, variations among the studies are expected because of factors like species, variety, fertilization, irrigation, climate, soil etc. (Thomas 2003, Rathod *et al*. 2005, Paciullo *et al*. 2007, Euclids *et al*. 2007, Jadhav *et al.* 2007).

Among graminaceous fodders, the IVDMD and IVOMD values were the highest in maize and the lowest in broom grass while in case of leguminous fodders, rice bean showed the minimum digestibility level and berseem the maximum one (Table 3). Likewise, ME concentration (Table 3) varied (P<0.01) from 6.22 (broom grass) to 8.64 MJ/kg DM (maize) averaging 7.48±0.13 MJ/kg DM in case of graminaceous fodders while in leguminous fodders, the value averaged

8.32±0.10 MJ/kg DM varying from 7.94 (rice bean) to 8.82 MJ/kg DM (berseem). The digestibility and ME values were significantly (P<0.01) higher in leguminous fodders compared to non-leguminous ones (Aka and Kamalu 2004, Calabro *et al*. 2007, Chander Datt *et al*. 2008) which could probably be due to higher CP level and lower CF/fibre fractions in case of former group (Chander Datt *et al*. 2007[b]).

The CP content had significant (P<0.01) positive correlation with IVDMD, IVOMD and ME value (r= 0.77, 0.71 and 0.06). On the other hand, CF, NDF, ADF and cellulose showed negative (P<0.01) correlations (Aka and Kamalu 2004, Calabro *et al.* 2007, Chander Datt *et al*. 2007[a,b]). The CP and CF contents were negatively (r=–0.70) correlated (Chander Datt *et al*. 2006, Chander Datt *et al*. 2007[b]). There was a strong (P<0.01) positive correlation between ME and IVDMD/IVOMD values (0.87/0.85) which is corroborated by Chander Datt *et al*. (2007 [a,b]).

Therefore, all the forage crops seemed to produce satisfactorily except berseem (*rabi*) and cluster bean (*kharif*). There were significant (P<0.01) differences in graminaceous and leguminous species with respect to proximate principles, cell wall constituents, IVDMD/IVOMD and ME values. Leguminous fodders possessed higher (P<0.01) levels of CP, EE, digestibility and ME while their fibre content was lower compared to graminaceous ones. Overall, the nutritional parameters like CP and EE had significant (P<0.01) positive correlation with IVDMD, IVOMD and ME values, however, fibre fractions (CF, NDF, ADF and cellulose) showed negative relationship with these 3 parameters. In nutshell, introduced fodders, leguminous or non-leguminous have a very good potential to lessen the existing wide gap between demand and supply of nutrients particularly for ruminants especially cattle and thus to raise their productivity in the state.

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