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Effect of fodder resources on nutrient dynamics in perennial fodder sorghum based fodder pellets

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Abstract
The experiment was conducted at Glass House farm, Department of Forage crops, Tamil Nadu Agricultural University Coimbatore. The treatments consist of twenty four combinations of fodder sorghum with six legumes and four crop residues. The treatments have recorded various quality parameters *viz.,* ash content, crude protein and crude fat range from 8.43 - 12.4%, 52.57 - 61.64 g/kg and 19.77 - 22.33 g/kg respectively. Mineral nutrients like Ca, P, Mg, K and Na ranges between 323.89 - 475.5, 92.80 - 149.03, 268.97 - 338.26, 1264.127 - 1824.81 and 272.24 - 539.04 mg/100g respectively. Lower ash of 8.43 percent was recorded in $G_5L_1D_2$ treatment and it was on par with $G_5L_3D_2$ (8.52%). Significantly higher crude protein of 61.64 g/kg was recorded in $G_5L_2D_3$ and maximum crude fat content 22.33 g/kg was observed in $G_5L_4D_3$ treatment. $G_5L_5D_3$ registered higher Ca, Mg and K content of 475.25, 388.26 and 1824.81 mg/100g respectively. Maximum P and Na were recorded in $G_5L_5D_2$ (149.03 mg/100g) and $G_5L_3D_1$ (539.04 mg/100g) treatments respectively.

Keywords: Livestock, fodder sorghum, pellet, quality and storage

Introduction
The ruminant livestock production especially in developing countries have been used as a pillar for food security, human nutrition and economic growth of the country (Shapiro *et al.*, 2015) [9]. To meet the requirements of growing human population, it is necessary that the production of milk, meat and other products to be increased quickly and it can be achieved by increasing the fodder production. In India, 193.46 millions of cattle and 109.85 millions of buffaloes in addition to 74.26 millions of sheep and 148.88 millions goats are present (20th livestock census, 2019) [7]. At present only 6.9 million (4.4%) of the country's cropped area is under fodder crops and there is hardly any scope of expansion because of pressure on agricultural land for food and cash crop. In Indian livestock farming, a chronic shortage of quality feed and a fodder resource has been the foremost limiting factor in enhancing livestock performance (Birthal and Jha, 2005) [3]. A year-round supply of quality green fodder become very challenging due to various reasons like high land and labour requirement, scarcity and poor quality of water, more growth period of about 60 days, lesser shelf life and crop failure by natural calamities (Naik *et al.*, 2012) [8].
In order to ensure healthy and nourishing animal feed throughout the entire year it is necessary to find ways to preserve green fodder in order to maintain its quality and nutritional properties. In this juncture, production of fodder pellets is a state of art technology that has revolutionized the availability of quality livestock feed in the 21st century. This operation helps to maintain homogeneity and store fodder in better conditions. The fodder pelleting process is largely influenced by the physico-chemical properties of the feed. Pelleted feed has been noted to prevent selective feeding of palatable feedstuffs by animals, and it prevents separation of constituents due to varying size and density and improves nutrient utilization and acceptability (Manasri *et al.*, 2012) [6]. Keeping these in view, this research mooted to know the nutrition changes in different fodder combination of pellets.

Materials and Method
The experiments were conducted at Glass House farm, Department of Forage Crops, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu during December 2020 to November 2021.

This treatments consist of six legumes and four crop residues *viz.*, L_1 - *Desmanthus*, L_2 - Lucerne, L_3 - *Desmanthus* + Gliricidia (3:1), L_4 - *Desmanthus* + Agathi (3:1), L_5 - Lucerne + Gliricidia (3:1), L_6 - Lucerne + Agathi (3:1), D_1 - Paddy straw, D_2 - Sorghum straw, D_3 - Maize stover and D_4 - Wheat straw, in combination with fodder sorghum (G_5). The experiment was laid out in completely randomized design (CRD) with twenty four treatments and each treatment was replicated thrice.

The fodder crops are harvested at optimum stage of 75-80 DAP followed by subsequent harvest after 45-50 days. These harvested fodder crops are chopped into small pieces of 1-2 inch with the help of fodder harvester and chaffer. Then the chopped fodder crops are dried in solar drier at 60^0C in order to reduce the moisture content upto 15%. As per the treatment schedule quoted above, each treatment of 5 kg of chopped fodder combination (60% cereal fodder, 20% leguminous fodder and 20% dry fodder on wet basis) are powdered and fed into pelleting machine. After pelleting the pellets are collected and stored for further analysis.

Ash content was determined by using muffle furnace method, by keeping the samples in muffle furnace at 600 ºC for 3 hours according to Chemists and Cunniff (1990) [4]. Ash content was expressed in percentage. Total nitrogen content was estimated by micro kjeldahl's method suggested by Humphries (1956) [5] and it was multiplied by the factor 6.25 to obtain the crude protein content and it was expressed in percentage. Crude fat content was estimated by using the soxhlet extraction method according to Chemists and Cunniff (1990) [4] and it was expressed in percentage. The mineral nutrients in the pellets are analyzed in Inductively Coupled Plasma Mass Spectrometry (ICPMS) suggested by Masson *et al.*, (2010) [6] to determine the nutritional composition of the pellet samples and expressed in percentage.

Results and Discussion

The nutritional quality parameters of pellet are determined by crop residues found in the pellet. Since each treatment have fodder sorghum, lesser proportion of legume fodder and major proportion of crop residues (around 38% fodder sorghum, 11% leguminous fodder and 51% crop residues on DM basis). Nutrient content of the crop residues significantly influence the quality of pellets.

The pellets made with fodder sorghum based combinations showed a marked variation in ash content (Table 1). $G_5L_6D_1$ treatment recorded higher ash content of 13.4 percent and it was on bar with $G_5L_2D_1$, $G_5L_4D_1$ and $G_5L_5D_1$ with 13.2, 13.3 and 13.0 percent respectively. This shows that pellet which contains paddy straw had higher ash content. Similarly higher ash content of paddy straw was also reported by Bakker *et al.*, (2013) [2]. Lower ash content of 8.43 percent was reported in $G_5L_1D_2$ treatment.

Crude protein content of pellet showed significant variation among the treatments (Table 1). Higher crude protein content of 61.64g/kg was recorded in $G_5L_2D_3$ which contains maize stover followed by $G_5L_6D_3$ (61.31g/kg). Similar result of higher crude protein in maize stover among the other crop residues was revealed by Alhassan *et al.*, (1987) [1]. The Crude fat of pellet marked a significant variation among fodder pellet combinations (Table 1). The higher crude fat was found in $G_5L_4D_3$ followed by $G_5L_3D_3$ with 22.33 and 22.31g/kg respectively. This showed that the higher crude fat is due to the presence of maize stover. Xing, (1995) [10] also reported a similar findings of higher crude fat in maize stover.

Mineral nutrients like Ca, P, Mg, K and Na of pellet registered significant variation (Table 2).

$G_5L_5D_3$ treatment recorded higher Ca, Mg and K content of 475.25, 388.26 and 1824.81 mg/100g respectively. The maximum P and Na were recorded in $G_5L_5D_2$ (149.03 mg/100g), and $G_5L_3D_1$ (539.04 mg/100g) treatments respectively. The higher amount of Ca, Mg and K was influenced by the presence of maize stover in that treatment. More phosphorus and sodium content were influenced by sorghum stover and paddy straw respectively.

Table 1: Effect of quality parameters of ash content, crude protein and crude fat on pellet quality

Treatments	Ash content (%)	Crude protein (g/kg)	Crude fat (g/kg)
$G_5L_1D_1$	12.80	54.56	20.91
$G_5L_1D_2$	8.43	57.56	21.48
$G_5L_1D_3$	9.75	61.23	22.25
$G_5L_1D_4$	11.05	53.80	20.15
$G_5L_2D_1$	13.20	54.57	20.58
$G_5L_2D_2$	9.00	57.75	21.18
$G_5L_2D_3$	10.70	61.64	21.99
$G_5L_2D_4$	10.95	53.77	19.77
$G_5L_3D_1$	12.55	54.51	20.96
$G_5L_3D_2$	8.53	57.55	21.54
$G_5L_3D_3$	9.66	61.27	22.31
$G_5L_3D_4$	10.21	53.53	20.19
$G_5L_4D_1$	13.30	54.30	20.99
$G_5L_4D_2$	8.94	57.32	21.57
$G_5L_4D_3$	9.85	61.02	22.33
$G_5L_4D_4$	10.40	53.53	20.22
$G_5L_5D_1$	13.00	53.37	20.71
$G_5L_5D_2$	8.69	56.55	21.31
$G_5L_5D_3$	10.30	60.43	22.12
$G_5L_5D_4$	10.20	52.57	19.90
$G_5L_6D_1$	13.40	54.30	20.75
$G_5L_6D_2$	8.87	57.45	21.35
$G_5L_6D_3$	9.70	61.31	22.15
$G_5L_6D_4$	10.62	53.49	19.95
SEd	0.23	1.38	0.43
CD(P=0.05)	0.47	2.77	0.87

Table 2: Effect of nutritional composition of calcium, phosphorus, magnesium, potassium and sodium on pellet quality

Treatments	Ca (mg/100g)	P (mg/100g)	Mg (mg/100g)	K (mg/100g)	Na (mg/100g)
$G_5L_1D_1$	368.01	92.80	268.97	1264.17	510.14
$G_5L_1D_2$	402.23	125.18	323.16	1518.87	313.04
$G_5L_1D_3$	445.95	112.91	360.10	1692.47	368.02
$G_5L_1D_4$	330.61	106.50	307.78	1446.57	457.82
$G_5L_2D_1$	386.91	108.32	285.84	1343.45	534.78
$G_5L_2D_2$	413.08	141.56	332.56	1563.04	273.20
$G_5L_2D_3$	464.00	126.02	373.56	1755.73	377.93
$G_5L_2D_4$	355.04	118.04	311.50	1464.03	408.09
$G_5L_3D_1$	374.16	110.55	288.17	1354.41	539.04
$G_5L_3D_2$	406.31	136.19	341.05	1602.96	272.24

$G_5L_3D_3$	453.97	121.89	380.50	1788.35	384.27
$G_5L_3D_4$	351.11	112.25	319.25	1500.49	415.16
$G_5L_4D_1$	370.62	94.14	278.54	1309.14	532.00
$G_5L_4D_2$	389.14	126.04	328.13	1542.22	339.33
$G_5L_4D_3$	433.62	113.11	363.80	1709.85	384.63
$G_5L_4D_4$	323.89	107.72	309.52	1454.73	411.85
$G_5L_5D_1$	399.28	115.09	299.83	1409.21	533.36
$G_5L_5D_2$	419.29	149.03	349.24	1641.44	275.89
$G_5L_5D_3$	475.25	134.05	388.26	1824.81	390.17
$G_5L_5D_4$	381.60	128.02	333.52	1567.55	411.77
$G_5L_6D_1$	379.00	110.12	287.00	1348.91	519.76
$G_5L_6D_2$	397.99	143.70	335.91	1578.80	330.29
$G_5L_6D_3$	451.11	128.88	374.54	1760.32	369.77
$G_5L_6D_4$	350.26	121.03	315.45	1482.63	466.17
SEd	8.32	2.20	7.15	33.54	7.86
CD(P=0.05)	16.73	4.44	14.37	67.45	15.81

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