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Evaluation of Perennial Grass-legume Cropping Systems for Year-round Supply of Fodder for Dairy Farms

Bellamkonda Murali, R. Susheela, M. Shanti, K. Shailaja, T. Shashikala

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ABSTRACT

Background: Long-term and stable livestock productivity could be possible only through a year-round supply of quality green fodder and it is essential for the sustainability of dairy farms. The year-round supply of quality green fodder is challenging to livestock farmers; however, it is possible by adopting perennial grass-legume intercropping systems.

Methods: A field experiment with eight treatments consisting of two perennial grasses (Napier- bajra hybrid grass and guinea grass) alone or in combination with three fodder legumes (Lucerne, Hedge Lucerne and Sesbania) was conducted for 3 years (2016-17, 2017-18 and 2018-19) in a sandy loam soil at the Agricultural Research Institute, Professor Jayashankar Telangana State Agricultural University, Hyderabad. The treatments were replicated thrice in a randomized block design. Perennial grasses were raised in paired row method (row to row 120 cm and plant to plant 60 cm. The legume intercrops were grown with their respective spacing within 120 cm row. Sesbania inter crop was allowed to grow for 6 months and later trimmed to a height of 1 meter in the establishment year. Growth parameters were measured only for grasses at each harvesting and green fodder, dry matter and crude protein yields were recorded for both grasses and legumes at each cut and accumulated annually (total 6 cuts/year) for statistical analyses.

Result: The results indicated that among the grasses, Napier-bajra hybrid recorded significantly higher green fodder, dry matter and crude protein yields; in case of leguminous inter crops, Sesbania recorded highest green fodder, dry matter and crude protein yields followed by Hedge Lucerne. About total productivity of the system, Napier-bajra hybrid + Sesbania (2:1) cropping system recorded highest green fodder, dry matter and crude protein yields. Highest net returns and B:C ratio was also noted with Napier bajra hybrid +Sesbania (2:1) cropping system and proved to be the best perennial fodder system for year-round supply fodder to the livestock.

Key words: Crude protein, Dry matter, Economics, Green fodder, Livestock, Perennial grasses, Perennial legumes, Year-round fodder.

INTRODUCTION

Farmers are facing several challenges in crop production due to the occurrence of biotic and abiotic stresses. Practicing agriculture alone is not a profitable enterprise anymore because of low yields in some years and total crop failures sometimes. In this scenario, dairy farming enterprise appeared to be an attractive option for farmers in addition to agriculture for stabilizing their farm income. These two enterprises are mutually beneficial and help farmers in obtaining higher income. India's milk production was 43 million tonnes in 1983 and increased to198.4 million tonnes by 2019-20 (Madhvi Sally, 2021). The increased milk production in India is due to two reasons: 1) Increased demand for milk by the ever-growing population, 2) Increased consumption of dairy products by the people in the recent past. Dairy farmers spend 60% of the total cost of milk production on the purchase of fodder and feed only. Therefore, the availability of green forage is the key to the profitable production of livestock (Kumar *et al*., 2012). However, the productivity of cultivated fodder crops is low in India due to the least attention and minimal allocation of inputs, unawareness about forage crop species and varieties and non-availability of the improved production techniques to the stakeholders in forage resource development. The situation is still worst regarding small and marginal dairy farmers in India in well-planned year-round cheap forage crop production. But they are the major players in the total milk production in India. Small and marginal dairy farmers are highly dependent on the external supply of green and dry fodder particularly during the winter or summer seasons. Hence, to address this problem educating the farmers about the improved fodder crop production packages: selection of appropriate forage species, suitable varieties and efficient management techniques to sustain forage yields and soil fertility is the best solution.

The association of cereal and legume forages maintains a similar level of herbage yield and their combination also nearly doubles the crude protein production (Menhi Lal and Tripathi, 1987). Epifanio *et al*. (2019) reported that grass-legume intercropping had a

AICRP on Forage Crops and Utilization, Agricultural Research Institute, Professor Jayashanakar Telangana State Agricultural University, Rajendranagar, Hyderabad-500 030, Telangana, India.

Corresponding Author: Bellamkonda Murali, District Agricultural Advisory and Transfer of Technology Centers, Kamareddy-503 108, Telangana, India. Email: muralibellamkonda1@gmail.com

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positive effect on the total productivity and nutrition of the forage crops. It also increased dry matter production, crude protein yield and *in vitro* dry matter digestibility and decreased the fiber fractions. Mclennon *et al*. (2020) reported that grass-legume mixture at 75:25 produced greater herbage than 25:75 grass-legume mixture and legume monoculture. Forage species mixtures (grass + legume) have showed increased total forage biomass production including nutrient content when compared to growing single species (Belanger *et al*. 2014; Cardinale, *et al*. 2007; Foster *et al*. 2019). Kauthale *et al*. (2017) reported that cultivating *Cenchrus ciliaris* + *Desmanthus virgatus* in 1:1 proportion on ridges and furrows has produced significantly higher green fodder, dry matter and crude protein yields and net returns than *Cenchurus ciliaris* + *Stylosanthus seabrana* cropping system. One ha of Subabul (*Leucaena leucocephala*) + perennial Napier bajra hybrid produced 1.09 ha equivalent green fodder yield and 1.45 ha equivalent dry matter yield including fuel wood of sole Napier bajra hybrid. Sesbania can be grown widely in various agricultural and agroforestry systems for providing green manure, forage and firewood. Being a fast-growing legume, it can help in soil improvement and also controlling soil erosion (Chanda *et al*. 2021). Takawale *et al*. (2016) reported that leaf meal prepared with Sesbania leaves (Sesbania block) has significantly high crude protein content than other legume blocks. Subabul-based silvi-pastoral system produced 55.03 per cent more protein yield with perennial Napier bajra hybrid than sole fodder crops (Chauhan *et al*. 2014). Patil *et al*. (2018) found that Hybrid Napier bajra (Napier Hybrid 10 variety) + Hedge Lucerne at 1:5 ratio has significantly produced highest green fodder yield, gross and net returns and benefit-cost ratio. Bhatt *et al*. (2006) reported that *Acacia tottilis*/*Leucaena leucocephala* -forage crop-based systems produced 1.5-2.25 times higher dry matter yield than pure pasture land use system. The silvi-pastoral systems maintain higher soil moisture and organic carbon for sustainable biomass production for longer period. Saharan *et al*. (1989) also reported that the positive association of Subabul with forage crops like Napier hybrid, Lucerne, oat and other cereal forage crops. Long term economical milk production along with the maintenance of better health and fertility of the dairy animals can only be achieved through feeding of quality green fodder. Thus, the need of the hour is not only to enhance the fodder production, but also to make the fodder accessible round the year to all types of dairy animals adequately. Perennial grasses and legumes besides providing quality fodder to the livestock, they also prevent soil erosion and ameliorate soil health. The main objective of this investigation is to identify the suitable and sustainable perennial grass-legume cropping systems for providing higher fodder yield (green and dry), quality fodder (crude protein and crude fiber), better soil fertility maintenance and higher profit to the livestock/ dairy farmer.

MATERIALS AND METHODS

Field experiments were carried out in the fields of AICRP on Forage Crops and Utilization Scheme at the Agricultural Research Institute, Professor Jayashankar Telangana State Agricultural University, Hyderabad in the three years of 2016-17, 2017-18 and 2018-19 in sandy loam soil for identifying efficient perennial grass-based cropping system. The experimental location is situated at 17°19′ 18′′ N latitude, 78°24′ 18′′ E longitude and at an altitude of 527m above mean sea level in the Southern Telangana Agroclimatic Zone in Telangana State India. The average annual rainfall of the area was 750 mm and maximum and minimum temperatures ranged between 24.6 to 34.1°C and7.6 to 18.6°C respectively during the crop growth period. Experimental site was well drained moderately deep sandy loam soil with pH of 7.8 and EC of 0.22 dS m^{-1}. Soil texture analysis was carried out with Bouyoucos hydrometer method and soil pH and EC were measured using pH meter and EC meter respectively. The experimental field was low in available N (152 kg ha^{-1}), medium in phosphorus (26.0 kg ha^{-1}) and high in potash (293.0 kg ha^{-1}). Available nitrogen, phosphorus and potassium in soil were measured using Kjeldahl, Olsen and Spectrophotometer methods respectively. The experiment was laid out with eight treatments replicated thrice in a randomized complete block design having gross plot size of 5.0 m × 4.0 m. The treatments were composed of two types of perennial grasses (Napier- bajra hybrid grass and guinea grass) alone or in combination with the three fodder legume intercrops (Lucerne, Hedge Lucerne and Sesbania). The treatments are as follows: Napier bajra hybrid (NB hybrid) at 60 × 60 cm spacing (T1), Guinea grass at 60 × 60 cm spacing (T2), NB hybrid in paired rows (60/120 cm) + Lucerne (T3), NB hybrid in paired rows (60/120 cm) + Hedge Lucerne (*Desmanthus virgatus*) (T4), NB hybrid in paired rows (60/120 cm) + Sesbania/Agati (*Sesbania grandiflora*) (T5), Guinea grass in paired rows (60/120 cm) + Lucerne (T6) and Guinea grass in paired rows (60/120 cm) + Hedge Lucerne (T7) and Guinea grass in paired rows (60/120 cm) + Sesbania (T8). Each perennial grass was grown in a paired row method (row to row 120 cm and plant to plant 60cm and the spacing between two rows was 60 cm within each pair. The legume intercrops were sown with their respective spacing between two adjacent paired rows. Spacing between two adjacent paired rows was 120 cm. Four rows of Lucerne were sown with 30 × 10 cm spacing; two rows of Hedge Lucerne were sown with 60 × 10 cm spacing and one row of Sesbania was sown between two adjacent paired rows at 100 cm plant to plant spacing *i.e*., at 240 × 100 cm spacing. Sesbania intercrop was allowed to grow for six months and later trimmed to a height of 1 meter in the establishment year (2015-16). 50 kg nitrogen, 50 kg phosphorus and 30 kg potash per hectare were applied as basal and 50 kg nitrogen applied after each cut with irrigation.

At each harvest: Plant height, tiller number and leaf to stem ratio (LS ratio) were measured for grasses on three

plants/hills selected randomly. Whereas, green fodder, dry matter and crude protein yields were recorded for both grasses and legumes at each cut and accumulated annually (total six cuts/year) for statistical analyses. The grasses and legumes were harvested plot-wise separately and fresh green forage yield was recorded in kg/plot and was converted into quintals per hectare. A fresh sample of 500 g taken from each treatment was sundried initially followed by oven dried at 60-65°C to a constant weight and estimated dry matter yield, later dried plant samples were finely ground and subsequently used for quality analysis (crude protein, crude fiber, *etc*.) in the biochemistry laboratory. But, estimation of crude protein is the most common for estimating the fodder quality. Crude protein yield was estimated from crude protein content (%) of dried and powdered plant sample and multiplied with its dry matter in grams and converted into q/ha of crude protein yield. The collected data was statistically analysed by analysis of variance (ANOVA) for randomised complete block design. Critical differences were worked out at five per cent probability level in LSD, if treatments were significantly differed and if not; NS was denoted (Gomez and Gomez, 1984). Three years data was pooled and statistically analysed using INDOSTAT software available with our university (PJTSAU, Hyderabad) for the interpretation of results.

RESULTS AND DISCUSSION

Green fodder yield

Three-year (2016-17, 2017-18 and 2018-19) pooled analysis results (means) indicated that among the grasses, Napier bajra hybrid recorded significantly higher green fodder (1342.1 q/ha) yields whereas, among the leguminous inter crops Sesbania recorded highest green fodder (408.6 q/ha) yields followed by Hedge Lucerne with 80.5 q/ha (Table 1). With regards to total productivity of the system T5: Napier Bajra hybrid + *Sesbania grandiflora* (2:1) recorded highest green fodder yields (1577.6 q/ha) followed by T1: Napier bajra alone (1342.1 q/ha), T3: Napier-Bajra hybrid + Lucerne- (1219.5 q/ha) and T4: Napier Bajra hybrid + Hedge Lucerne (1218.1 q/ha). This may be due to non-interference of intercrops with the main perennial grass crop and legume crops would have helped the system in increasing the productivity and nutritive value of the total (grass-legume) system. Under irrigated conditions, Napier Bajra hybrid produced more biomass than Guinea grass and Sesbania produced more biomass than the other two legumes. Perhaps, the combination of these two species in an intercropping system produced more green fodder yield. The following studies have reported similar results, which are: higher green forage yield produced when forage Sorghum intercropped with Sesbania in the pattern of 45 cm spaced double-row strips (Ahmed *et al*. 2007); Kauthale *et al*. (2017) reported that the perennial Cenchrus + Hedge Lucerne intercropping system produced significantly higher green fodder yield; Chauhan *et al*. (2014) recorded significantly higher green fodder yield and a year-round supply of green fodder yield with Subabul + NB hybrid alley cropping system; NB hybrid intercropped with Hedge Lucerne in 1: ratio has given significantly higher green fodder yield than NB hybrid intercropped with lucerne in the same row ratio (Patil *et al.* 2018). *Leucaena*-forage crop-based systems had 1.5 - 2.25 times higher productivity than pure pasture-based systems (Bhatt *et al.* 2006). A similar trend was observed in the three years (2016-17, 2017-18 and 2018-19) the experiments were conducted. If we consider environmental effects the year 2017-18 proved to be the best in producing higher green fodder among the three years the experiments were undergone (Table 1).

Table 1: Green fodder yield of total cropping system, grasses and legumes as influenced by different perennial grass/grass-legume cropping systems.

Treatments	Total system (Grass+ Legume) (Q/Ha)				Grass main crop (Q/Ha)				Legume intercrop (Q/Ha)			
	2016-17	2017-18	2018-19	Mean	2016-17	2017-18	2018-19	Mean	2016-17	2017-18	2018-19	Mean
T1	1306.6	1411.6	1308.1	1342.1	1306.6	1411.6	1308.1	1342.1	0.0	0.0	0.0	0.0
T2	666.6	728.3	856.7	750.5	666.6	728.3	856.7	750.5	0.0	0.0	0.0	0.0
T3	1216.9	1282.4	1159.4	1219.5	1191.6	1263.3	1142.7	1199.2	25.2	19.1	16.6	20.3
T4	1166.6	1310.8	1176.7	1218.1	1106.6	1245.0	1105.2	1152.2	60.1	65.8	71.5	65.8
T5	1599.6	1612.8	1520.5	1577.6	1263.3	1251.6	1169.7	1228.2	336.3	361.1	350.7	349.4
T6	616.4	596.6	754.4	655.8	581.6	573.3	735.1	630.0	34.7	23.3	19.3	25.7
T7	642.5	685.3	794.5	707.4	565.0	607.3	708.2	626.8	77.5	78.0	86.2	80.5
T8	1016.4	1074.3	1079.0	1056.2	626.6	650.6	665.5	647.6	389.7	422.6	413.5	408.6
S.Em(±)	-	-	-	13.4	-	-	-	14.4	-	-	-	6.0
C.D. (0.05)	-	-	-	38.4	-	-	-	41.2	-	-	-	17.0
Environmental means	1029.0	1087.6	1081.1	-	913.5	966.4	961.4	-	115.4	121.2	119.7	-

T1: NB hybrid, T2: Guinea grass, T3: NB hybrid + Lucerne, T4: NB hybrid + Hedge Lucerne, T5: NB hybrid + Sesbania, T6: Guinea grass + Lucerne, T7: Guinea grass + Hedge Lucerne, T8: Guinea grass + Sesbania.

Note: Total 3-year pooled analysis presented in the Table.

Dry matter yield

The three-year pooled analysis means indicated that NB hybrid recorded significantly higher dry matter yields (316.9 q/ha) followed by Guinea grass (239.7 q/ha). NB hybrid produces a higher tonnage of dry matter per hectare with its rapid growth and profuse tillering (Kadam *et al*. 2017). Among the leguminous intercrops, Sesbania recorded the highest dry matter yield (85.7 q/ha) followed by Hedge lucerne (17.6 q/ha). With regards to total productivity of the system T5: NB hybrid + *Sesbania grandiflora* (2:1) recorded highest dry matter yields of 348.9 q/ha (Table 2). These results were supported by the following studies: Chauhan *et al*. (2014) observed that higher dry matter yield with Subabul + NB hybrid alley cropping system; Kauthale *et al*. (2017) reported that Cenchrus + Hedge Lucerne intercropping system produced higher dry matter yield per hectare; Patil *et al.* (2018) recorded significantly higher dry matter yield when NB hybrid intercropped with Hedge Lucerne in 1:5 ratio than NB hybrid intercropped with lucerne in the same row ratio. The environment/year 2017-18 is the best in producing higher dry matter among the three years experiment was carried out (Table 2).

Crude protein yield

The three-year pooled analyses results indicated (Table 3) that among the grasses, NB hybrid recorded significantly higher crude protein yields (20.1 q/ha) whereas; among the

Table 2: Dry matter yield of total cropping system, grasses and legumes as influenced by different perennial grass/grass-legume cropping systems.

Treatments	Total (Grass+Legume) system (Q/Ha)				Grass main crop (Q/Ha)				Legume intercrop (Q/Ha)			
	2016-17	2017-18	2018-19	Mean	2016-17	2017-18	2018-19	Mean	2016-17	2017-18	2018-19	Mean
T1	309.5	336.9	304.3	316.9	309.5	336.9	304.3	316.9	0.0	0.0	0.0	0.0
T2	225.1	238.9	255.2	239.7	225.1	238.9	255.2	239.7	0.0	0.0	0.0	0.0
T3	256.7	272.7	209.1	246.1	251.7	268.9	205.8	242.1	5.0	3.8	3.3	4.0
T4	243.2	279.0	215.3	245.8	228.2	263.2	201.0	230.8	14.9	15.7	14.3	15.0
T5	356.4	359.9	330.5	348.9	281.4	278.3	260.4	273.4	75.0	81.6	70.1	75.5
T6	182.9	169.4	202.2	184.8	176.1	164.9	198.3	179.7	6.8	4.4	3.8	5.0
T7	174.6	184.2	210.1	189.6	156.5	166.5	192.8	171.9	18.1	17.7	17.2	17.6
T8	246.9	267.3	283.3	265.8	163.5	176.3	200.6	180.1	83.4	91.0	82.7	85.7
S.Em(±)	-	-	-	8.0	-	-	-	7.9	-	-	-	1.5
C.D. (0.05)	-	-	-	22.9	-	-	-	22.7	-	-	-	4.3
Environmental means	249.4	263.5	251.2	-	224.5	236.7	227.6	-	25.4	26.8	23.9	-

T1: NB hybrid, T2: Guinea grass, T3: NB hybrid + Lucerne, T4: NB hybrid + Hedge Lucerne, T5: NB hybrid + Sesbania, T6: Guinea grass + Lucerne, T7: Guinea grass + Hedge Lucerne, T8: Guinea grass + Sesbania.

Note: Total 3-year pooled analysis presented in the Table.

Table 3: Crude protein yield of total cropping system, grasses and legumes as influenced by different perennial grass/grass-legume cropping systems.

Treatments	Total (Grass+ Legume) system (Q/Ha)				Grass main crop (Q/Ha)				Legume intercrop (Q/Ha)			
	2016-17	2017-18	2018-19	Mean	2016-17	2017-18	2018-19	Mean	2016-17	2017-18	2018-19	Mean
T1	16.1	26.1	18.1	20.1	16.1	26.1	18.1	20.1	0.00	0.00	0.00	0.00
T2	11.2	15.4	14.2	13.6	11.2	15.4	14.2	13.6	0.00	0.00	0.00	0.00
T3	17.1	18.8	13.2	16.4	16.2	18.3	12.6	15.7	0.86	0.85	0.53	0.65
T4	15.7	21.1	15.0	17.2	13.3	19.2	12.9	15.2	2.30	1.88	2.00	2.06
T5	29.1	30.8	28.4	29.4	16.7	19.2	17.8	17.9	12.46	11.53	10.52	11.50
T6	10.4	10.3	11.7	10.8	9.2	9.7	11.0	10.0	1.14	0.58	0.62	0.78
T7	11.0	13.6	13.8	12.8	8.2	11.6	11.3	10.4	2.83	199	2.41	2.41
T8	23.1	24.7	25.9	24.6	9.4	12.3	13.4	11.7	13.71	12.41	12.40	12.84
S.Em(±)	-	-	-	0.7	-	-	-	0.6				
C.D. (0.05)	-	-	-	2.0	-	-	-	1.9	-	-	-	
Environmental means	16.7	20.1	17.5	-	12.5	16.5	13.9	-	3.62	4.16	3.56	-

T1: NB hybrid, T2: Guinea grass, T3: NB hybrid + Lucerne, T4: NB hybrid + Hedge Lucerne, T5: NB hybrid + Sesbania, T6: Guinea grass + Lucerne, T7: Guinea grass + Hedge Lucerne, T8: Guinea grass + Sesbania.

Note: Total 3-year pooled analysis presented in the Table.

leguminous inter crops Sesbania recorded highest CPY (12.8 q/ha). Jagadeesh *et al.* (2017) reported that NB hybrid variety APBN1 produced significantly higher crude protein yield (11.45 MT/ha) when harvested at 45 days of growth. Higher dry matter producing capacity may be the reason for obtaining the higher crude protein yield in NB hybrid and Sesbania species. Hence naturally, the total productivity of the system T5 - NB hybrid + *Sesbania grandiflora* (2:1) recorded the highest crude protein yields (29.5 q/ha) compared to the other treatments. Njoka-Njiruet *et al.* (2006) also reported when Napier hybrid grass intercropped with legume species improves the nutritive value of the total cropping system than Napier hybrid grass produced alone. Environment prevailed during the year 2017-18 was congenial in producing the higher crude protein yields among the three years the experiment was carried out (Table 3).

Table 4: Effect of perennial grass-legume intercropping systems on growth parameters of grasses*.

Treatments	Plant height (cm)	Number of tillers/hills	LS ratio
T1	89.6	45.9	0.50
T2	97.2	42.2	0.47
T3	89.1	43.3	0.51
T4	87.5	42.5	0.53
T5	89.5	47.6	0.58
T6	88.3	40.3	0.47
T7	91.7	39.1	0.45
T8	97.1	42.0	0.51
S.Em(±)	5.55	2.63	0.03
C.D. (0.05)	NS	NS	0.10

T1: NB hybrid, T2: Guinea grass, T3: NB hybrid + Lucerne, T4: NB hybrid + Hedge Lucerne, T5: NB hybrid + Sesbania, T6: Guinea grass + Lucerne, T7: Guinea grass + Hedge Lucerne, T8: Guinea grass + Sesbania.

*Total 3-year pooled analysis means only presented in this Table.

Table 5: Effect of perennial grass-legume intercropping systems on economics of total cropping systems*.

Treatments	Gross returns (Rs.)	Cost of cultivation (Rs.)	Net returns (RS.)	BC Ratio
T1	193194	61394	131800	3.14
T2	102274	45394	56880	2.25
T3	182071	59124	122947	3.07
T4	182730	57912	124818	3.15
T5	260299	64419	195878	4.03
T6	96792	44232	52560	2.19
T7	106587	44310	62277	2.40
T8	179421	51281	128140	3.50
S.Em(±)	1699	297	1643	0.03
C.D. (0.05)	4850	849	4691	0.08

T1: NB hybrid, T2: Guinea grass, T3: NB hybrid + Lucerne, T4: NB hybrid + Hedge Lucerne, T5: NB hybrid + Sesbania, T6: Guinea grass + Lucerne, T7: Guinea grass + Hedge Lucerne, T8: Guinea grass + Sesbania.

*Total 3-year pooled analysis means only presented in this Table.

Growth parameters

Results of 3-year pooled data analysis revealed that plant height and the number of tillers per hill did not differ significantly except for the leaf stem ratio among the eight treatments tested (Table 4). Plant height and tiller number of grass species might not be adversely affected by adding legume intercrops in the experiment. In the case of leaf stem ratio: Napier bajra hybrid + Sesbania (2:1) (T5) intercropping system recorded the highest leaf stem ratio of 0.58, followed by Napier bajra hybrid + Hedge Lucerne (2:1) (T4) with 0.53 leaf stem ratio. Ahmed *et al.* (2007) also reported similar results that maximum leaf area per plant was observed in Sorghum where Sorghum was intercropped with Sesbania. The higher leaf stem ratio in T5 followed by T4 might be due to more organic matter added because of higher leaf fall on the soil by Sesbania followed by Hedge Lucerne. The organic matter favored getting more leaf growth in grasses.

Economics

According to three-year pooled analyses results: highest net returns of Rs. 1,95,878 per hectare and B:C ratio was noted with Napier bajra hybrid + Sesbania system followed by Napier bajra hybrid cropping system and Guinea grass + Sesbania cropping system with Rs. 1,31,800 and Rs.1,28,140 respectively (Table 5). Highest BC ratio was also recorded by Napier bajra hybrid + Sesbania (2:1) system with 4.03:1 followed by Guinea grass + Sesbania cropping system and Napier bajra hybrid + Hedge Lucerne cropping system with 3.50:1 and 3.15:1 respectively. These results confirmed the findings of Kauthale *et al.* 2017 and Patil *et al.* 2018. Similar trend was noticed in the three years (2016-17, 2017-18 and 2018-19) the study was undergone.

CONCLUSION

Among the two perennial grasses tested, the Napier bajra hybrid produced significantly higher green fodder, dry matter and crude protein yields whereas; among the leguminous intercrops Sesbania recorded the highest green fodder, dry matter and crude protein yields. With regards to total productivity of the cropping system Napier bajra hybrid + Sesbania (2:1) recorded the highest green fodder, dry matter and crude protein yields. Highest net returns and B:C ratio was also recorded with the Napier bajra hybrid + Sesbania (2:1) cropping system and proved to be the best perennial fodder system for year-round fodder production livestock farmers.

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