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Intensive Forage Production through *Sesbenia* (*Sesbania grandiflora*) Based Cropping System for Livelihood of Farmers under Protective Irrigated Situation

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B. G. SHEKARA : Selection of research problems, plan of work, statistical analysis;
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ABSTRACT

The experiment was conducted at Zonal Agricultural Research Station, V.C. Farm, Mandya during the year 2017 to 2019 with an objective of identifying sustainable *Sesbenia* based forage cropping system under irrigated situation. The experiment consisted of seven treatments, laid out in randomized block design with four replications. The treatments included were T_1 : *Sesbenia* + Congo signal grass (2:2), T_2 : *Sesbenia* + Rhodes grass (2:2), T_3 : *Sesbenia* + Guinea grass (2:2), T_4 : *Sesbenia* + Bajra Napier hybrid (2:1), T_5 : *Sesbenia* + *Seteria* grass (2:2), T_6 : *Sesbenia* + Perennial fodder sorghum (2:6), T_7 : *Sesbenia* (Sole). Pooled data of three years revealed that intercropping of perennial fodder sorghum with *Sesbenia* (2:6) recorded significantly higher green forage (625.8 q/ha), dry matter (111.4 q/ ha,) crude protein yield (13.1 q/ha), gross and net returns (100470 and 49620 Rs./ha, respectively). Whereas, the higher benefit cost ratio was observed with *Sesbenia* + Bajra x Napier hybrid (2.23).

Keywords : *Sesbania grandiflora*, Green fodder yield, Dry matter yield, Crude protein yield

THE livestock is the vital component of rural economy and backbone of the Indian agriculture with a contribution of 25.6 per cent to agricultural gross domestic product and improving the livelihood of farmers (Anonymous, 2017). Livestock sector is the primary source of energy for agricultural operations and major source of animal protein for masses. As per 20th livestock census conducted during 2019, total livestock population in the country increased with 4.6 per cent over livestock census of 2012. Whereas, available land for green fodder production has remained static (Roy *et al.,* 2019). Hence, the supply of feed and fodder resources has invariably remained deficit of normative requirement resulting in non-realization of the actual production potential of livestock sector. Generally there is no common practice of fodder production in rural areas of the country and animals are fed with naturally grown grasses, shrubs and weeds in agricultural lands, which are of low quality in terms of protein, minerals and available energy. Thus, they are relying more on seasonal fodder resources, which cause fluctuation in continuous fodder supply throughout the year and affect the milk production. On the other hand, sole feeding of green forages to dairy animals is much cheaper than feeding concentrates. Hence, the green fodder is considered as a critical input as it provides nutrients for livestock to meet the current level of green fodder demand by livestock and its annual growth rate in population either by increasing productivity. The cropping system with forage crops provide viable options to over come the fodder deficit as this utilize the resources more efficiently and promote productivity per unit area and time, provide more economic returns to the farmers and also provides balanced nutrition to the animals with inclusion of legumes and cereal fodder crop together. On the other hand the grass-legume mixture forage based feeding system incurred 40 per cent of total expenditure of milk production as compared to concentrate based feedings which fetches 80 per cent of cost. Hence by providing sufficient quantities of green fodder containing grass legume mixture instead of costly concentrates and feeds to the milch animals, the cost of milk production can be considerably reduced. Apart from this the efficient cropping systems have potential to sequestrate carbon dioxide into the soil and legume component also helps to fix atmospheric nitrogen and improve soil fertility and sustaining the crop and livestock productivity. An ideal cropping system should use natural resources efficiently, provide stable and high returns and do not damage the ecological balance and attained great significance in intensified agriculture in India. Fodder from tree legumes often used as a buffer to overcome gaps that arise from seasonal fluctuations in the productivity of other feed sources. The grasses and other herbs may not survive under low soil moisture situation and provides poor quality straw but deep rooted fodder tress exploit moisture from deeper soil and provides green forage rich in protein, minerals and vitamins (Uday *et al.,* 2017). *Sesbania grandiflora* also known as vegetable humming bird, Agati or humming bird tree, is a small tree belong to genera *Sesbania*. It is a multipurpose leguminous tree used for fodder in humid tropical regions. The perennial species of *Sesbania* can establish easily, grown in adverse sites and not require complex management to maintain productivity. It is rich in protein, minerals and vitamins. On dry weight basis it contains 18-20 per cent dry matter, 20-22 per cent crude protein, 18-20 per cent crude fibre, 9-10 per cent Ash, 1.5-2.0 per cent Calcium, 13.60 K. cal/kg dm metabolizable energy, NDF and ADF Values (33.01 and 28.44%, respectively) (Reji and Alphonse, 2013). Keeping these things in view, the present investigation was undertaken to study the performance of different grasses as intercrop in *Sesbenia* and to identify the sustainable and economical *Sesbenia* based grass intercropping system in southern dry zone of Karnataka under protective irrigated situation.

Material and Methods

Study Location : A field experiment was conducted for three consecutive years from 2017 to 2019 at Zonal Agricultural Research Station, Vishweshwaraiah Canal Farm, Mandya, Karnataka to assess the feasibility of growing perennial grasses as intercrop in *Sesbenia*. The experimental site is situated between 12° 45' and 13° 57' North latitude and 76° 45' and 78° 24' East longitude at an altitude of 695 meter above mean sea level and comes under Southern Dry Zone (ACZ-VI) Karnataka.

Soil Characteristics : The soil of the experimental site is sandy loam texture, neutral in soil reaction (7.13), low in organic carbon (0.43%), available nitrogen (243.0 kg/ha), medium in available phosphorus (46.3 kg/ha) and potassium (159.0 kg/ha).

Experimental Design and Field Management : The experiment was laid out in randomised complete block design with seven cropping systems *viz.,* T_1: *Sesbenia* + Congo signal grass (2:2), T_2: *Sesbenia* + Rhodes grass (2:2), T_3: *Sesbenia* + Guinea grass (2:2), T_4: *Sesbenia* + Bajra Napier hybrid (2:1), T_5: *Sesbenia* + *Seteria* grass (2:2), T_6: *Sesbenia* + Perennial fodder sorghum (2:6), T_7: *Sesbenia* (Sole) and replicated four times. The 45 days aged seedlings of *Sesbenia* raised in polybags were transplanted to main field and planted at a row spacing of 2 ×1 m apart from plant to plant. In between two rows of *Sesbenia* two rows well developed root slips of signal grass, rhodes, guinea grasses and one row B x N hybrid, 4 rows of *Setaria* grass were planted following recommended spacing. The perennial fodder sorghum variety CoFS-29 seeds were sown with a row of spacing's of 30 cm apart. The recommended production packages were followed for establishment of crops. The crops were harvested separately each time. The data for individual years were pooled and analysed statistically for interpretation of results and draw conclusion. The economics was calculated with prevailing market price and input costs.

Fodder Quality Analysis : A random sample of 1000g of green fodder was taken from each plot at the time of harvesting and the samples were dried under sun for few hours and later in electric oven at a temperature of 60°C till they attained constant weight. The known quantity of powdered samples was taken for analysis of nitrogen content in plant by following micro-Kjeldahl method (Jackson, 1973). On the basis of dry matter content of the samples, the green fodder yield was converted into dry matter yield (q/ha) and same samples were also used for determining crude protein content and yield. The total digestible crude protein yield was calculated according to equation adopted by Iqbal *et al.* (2013).

$$\text{Dry matter content (\%)} = \frac{\text{Dry weight of the sample}}{\text{Fresh weight of the sample}} \times 100$$

$$\text{Dry matter yield (q/ha)} = \frac{\text{Dry matter (\%)}}{\text{Green forage yield (q/ha)}} \times 100$$

$$\text{Crude Protein (\%)} = \text{Nitrogen (\%)} \times 6.25$$

$$\text{Crude protein yield (q/ha)} = \frac{\text{Crude protein (\%)}}{\text{Dry matter yield (q/ha)}} \times 100$$

$$\text{Total digestible crude protein (q/ha)} = \{0.97 \times \text{Crude protein yield (q/ha)}\} - 0.67$$

Economics :

$$\text{Benefit: Cost ratio} = \frac{\text{Gross returns (Rs. ha}^{-1})}{\text{Total cost of cultivation (Rs. ha}^{-1})}$$

Gross returns (Rs.ha^{-1}) = Quantity of green fodder (q ha^{-1}) X selling price (Rs.q^{-1})

Net Returns (Rs.ha^{-1}) = Gross returns (Rs.ha^{-1}) - Total cost of cultivation (Rs.ha^{-1})

Results and Discussion

Green Forage and Dry Matter Yield : The pooled data of three years indicated that the intercropping of perennial fodder sorghum with *Sesbenia* (2:6) recorded significantly higher green forage yield (625.8 q/ha of the system), which was on par with B x N Hybrid + *Sesbenia* (2:1) (610.3 q/ha), the tune of 74 per cent to 161.84 per cent improvement in green forage yield with grasses as intercrop compared to sole crop of *Sesbenia*. The increase in total system productivity is due to compatibility of grasses with *Sesbenia*, whose contributing for higher green forage yield. Among the intercrops perennial fodder sorghum recorded higher green forage yield (377.1 q/ha) followed by B x N hybrid (339.0 q/ha) and not much variation in green forage yield of *Sesbenia* was noticed with or without intercropping (248.7 q to 273.6 q ha^{-1}), Thus it is clearly indicated that intercrops doesn't have any adverse effect on *Sesbenia* (Table 1). These results are in confirmation with the findings of Yaragoppa *et al.,* 2003; Desai & Halepyati, 2007a; Desai & Halepyati, 2007b; Yaragoppa *et al.,* 2003; Sarvade, 2014; Sayed *et al.,* 2015; Shekara *et al.,* 2016; Roy *et al.,* 2019 and Kiran *et al.,* 2019. Pooled data of three years revealed that, intercropping of perennial fodder sorghum with *Sesbenia* (2:6) recorded higher dry matter yield (111.4 q/ha) followed by intercropping of B x N Hybrid + *Sesbenia* (84.8 q/ha) with planting ratio of 2:1 as compared to sole crop of *Sesbenia* (29.3 q/ha) (Table 3). The increase in dry matter yield over sole crop is to the tune of 102 to 280.2 per cent. The increase in dry matter yield is mainly due to higher green forage yield, dry matter content and better partitioning of the photosynthates. This is in conformity with the findings of Desai and Prabhakar, 2001; Kulkarni and Dev, 2008; Anantaworasakul *et al.,* 2011; Pramila *et al.,* 2015 and Chanda *et al.,* 2020.

Fodder Quality Parameters : The crude protein yield was significantly influenced by the cropping system. The intercropping of perennial fodder sorghum with *Sesbenia* recorded higher crude protein yield of the system (13.1 q/ha) which was on par with inter cropping of B x N Hybrid + *Sesbenia* (11.9 q/ha) and superior over sole crop of *Sesbenia* (6.7 q/ha) (Table 5). The increase in crude protein yield was to the tune of 40.3 per cent to 95.52 per cent over sole crop of *Sesbenia*. The increase in crude protein yield is due to higher dry matter yield of legume + grass mixture cropping system and crude protein content of the legume component over sole crop of *Sesbenia*. This is in conformity with the findings of Ash, 1992; Reji & Alphonse, 2013 and Uday *et al.,* 2017. The total digestible crude protein yield was significantly influenced by cropping system. The intercropping of perennial fodder sorghum with *Sesbenia* recorded higher total digestible crude protein of the system (12.04 q/ha) which was on par with intercropping of B x N hybrid + *Sesbenia* (10.78 q/ha) and superior

TABLE 1

Green forage yield (q/ha) as influenced by *Sesbenia* based cropping system

Treatments	Green forage yield (q/ha)											
	Sesbenia (q/ha)			Mean	Intercrops (q/ha)			Mean	Total (q/ha)			Mean
	2017	2018	2019		2017	2018	2019		2017	2018	2019	
T_1- *Sesbenia* + Congo signal grass (2:2)	193.0	366.9	192.5	250.8	109.7	155.2	234.3	166.4	302.7	521.2	426.8	416.9
T_2- *Sesbenia* + Rhodes grass (2:2)	210.1	373.6	198.2	260.6	160.2	210.0	192.8	187.6	370.3	583.5	391.0	448.3
T_3- *Sesbenia* + Guinea grass (2:2)	215.3	374.2	162.6	250.7	178.3	221.3	263.3	221.0	393.6	595.6	425.4	471.5
T_4- *Sesbenia* + Napier bajra hybrid (2:1)	221.3	405.4	187.1	271.3	294.9	353.4	368.7	339.0	516.2	758.8	555.8	610.3
T_5- *Sesbenia* + *Setaria anceps* (2:4)	221.9	397.4	201.3	273.6	169.1	228.7	265.5	221.1	391.1	626.1	466.8	494.6
T_6- *Sesbenia* + Perennial fodder sorghum (2:6)	200.4	389.8	155.9	248.7	329.2	430.1	372.0	377.1	529.6	819.9	527.9	625.8
T_7- *Sesbenia* (Sole)	177.6	362.5	177.0	239.0	-	-	-	-	177.6	362.5	177.0	239.0
S. Em ±	10.8	20.1	9.69	7.70	-	-	-	-	15.85	29.38	16.69	19.3
C.D at 5%	33.3	62.0	29.87	23.9	-	-	-	-	48.84	90.54	51.43	59.3

TABLE 2

Dry matter content (%) as influenced by *Sesbenia* based cropping system

Treatments	Dry matter content (%)											
	Sesbenia (q/ha)			Mean	Intercrops (q/ha)			Mean	Total (q/ha)			Mean
	2017	2018	2019		2017	2018	2019		2017	2018	2019	
T_1- *Sesbenia* + Congo signal grass (2:2)	12.7	11.4	12.3	12.1	15.1	15.9	15.6	15.5	13.9	13.7	14.0	13.8
T_2- *Sesbenia* + Rhodes grass (2:2)	13.1	12.7	12.8	12.9	16.2	14.3	15.2	15.2	14.7	13.5	14.0	14.1
T_3- *Sesbenia* + Guinea grass (2:2)	12.4	11.9	11.9	12.0	14.3	15.1	14.5	14.6	13.3	13.5	13.2	13.3
T_4- *Sesbenia* + Napier bajra hybrid (2:1)	10.7	13.6	12.6	12.3	13.3	14.7	14.2	14.1	12.0	14.2	13.4	13.2
T_5- *Sesbenia* + *Setaria anceps* (2:4)	12.0	11.4	11.5	11.6	14.1	13.6	13.6	13.8	13.1	12.5	12.6	12.7
T_6- *Sesbenia* + Perennial fodder sorghum (2:6)	12.9	12.2	12.8	12.6	21.3	19.8	21.5	20.9	17.1	16.0	17.2	16.7
T_7- *Sesbenia* (Sole)	11.8	11.0	12.8	11.9	-	-	-	-	11.8	11.0	12.8	11.9
S. Em ±	0.5	0.7	0.45	0.40	-	-	-	-	0.50	0.7	0.60	0.39
C.D at 5%	1.6	2.3	1.29	1.40	-	-	-	-	1.60	2.3	1.90	1.21

TABLE 3

Dry matter yield (q/ha) as influenced by *Sesbenia* based cropping system

Treatments	Dry matter yield (q/ha)											
	Sesbenia (q/ha)			Mean	Intercrops (q/ha)			Mean	Total (q/ha)			Mean
	2017	2018	2019		2017	2018	2019		2017	2018	2019	
T_1- *Sesbenia* + Congo signal grass (2:2)	24.3	50.7	34.6	36.5	16.5	24.6	36.5	25.9	41.9	64.7	71.1	59.2
T_2- *Sesbenia* + Rhodes grass (2:2)	27.6	47.5	33.9	36.3	25.9	30.0	30.6	28.8	54.2	77.5	64.5	65.4
T_3- *Sesbenia* + Guinea grass (2:2)	26.6	44.3	28.3	33.1	25.8	33.5	48.6	36.0	52.7	77.8	76.9	69.2
T_4- *Sesbenia* + Napier bajra hybrid (2:1)	23.9	49.4	35.1	36.1	39.2	52.0	62.6	51.3	62.1	94.7	97.7	84.8
T_5- *Sesbenia* + *Setaria anceps* (2:4)	26.8	45.2	43.5	38.5	23.7	30.8	52.0	35.5	50.9	76.0	95.4	74.1
T_6- *Sesbenia* + Perennial fodder sorghum (2:6)	25.9	47.6	33.3	35.6	69.7	84.9	77.9	77.5	90.5	132.5	111.2	111.4
T_7- *Sesbenia* (Sole)	21.0	39.9	37.4	32.8	-	-	-	-	10.5	39.9	37.4	29.3
S. Em ±	1.86	2.20	2.93	2.13	-	-	-	-	3.65	4.21	4.29	4.30
C.D at 5%	5.74	6.78	NS	6.55	-	-	-	-	11.24	12.97	13.23	13.4

TABLE 4

Crude protein content (%) as influenced by *Sesbenia* based cropping system

Treatments	Crude protein content (%)											
	Sesbenia (q/ha)			Mean	Intercrops (q/ha)			Mean	Total (q/ha)			Mean
	2017	2018	2019		2017	2018	2019		2017	2018	2019	
T_1- *Sesbenia* + Congo signal grass (2:2)	17.6	17.5	16.6	17.2	10.8	12.7	8.8	10.8	14.2	15.1	12.7	14.0
T_2- *Sesbenia* + Rhodes grass (2:2)	18.6	18.8	17.5	18.3	8.8	9.2	8.3	8.8	13.7	14.0	12.9	13.5
T_3- *Sesbenia* + Guinea grass (2:2)	17.3	15.8	18.4	17.2	9.5	9.6	9.0	9.4	13.4	12.7	13.7	13.3
T_4- *Sesbenia* + Napier bajra hybrid (2:1)	17.2	15.3	18.8	17.1	10.5	10.5	11.1	10.7	13.9	12.9	15.0	13.9
T_5- *Sesbenia* + *Setaria anceps* (2:4)	17.8	16.6	18.6	17.7	11.8	11.8	11.9	11.8	14.8	14.2	15.3	14.8
T_6- *Sesbenia* + Perennial fodder sorghum (2:6)	16.8	16.2	16.9	16.6	9.8	8.7	11.1	9.9	13.3	12.5	14.0	13.3
T_7- *Sesbenia* (Sole)	16.9	17.1	18.2	17.4	-	-	-	-	16.9	17.1	18.2	17.4
S. Em ±	0.40	0.57	0.80	0.54	-	-	-	-	0.34	0.6	0.8	0.48
C.D at 5%	1.29	1.75	NS	1.63	-	-	-	-	1.01	1.8	0.24	1.49

TABLE 5

Crude protein yield (q/ha) as influenced by *Sesbenia* based cropping system

Treatments	Crude protein yield (q/ha)											
	Sesbenia (q/ha)			Mean	Intercrops (q/ha)			Mean	Total (q/ha)			Mean
	2017	2018	2019		2017	2018	2019		2017	2018	2019	
T_1- *Sesbenia* + Congo signal grass (2:2)	5.6	8.8	3.1	5.8	3.4	3.2	3.1	3.2	9.0	11.9	8.8	9.9
T_2- *Sesbenia* + Rhodes grass (2:2)	5.8	9.0	2.3	5.7	2.8	2.8	2.3	2.6	8.6	11.7	8.3	9.5
T_3- *Sesbenia* + Guinea grass (2:2)	5.3	7.0	3.8	5.4	3.6	3.2	3.8	3.5	8.9	10.2	9.0	9.4
T_4- *Sesbenia* + Napier bajra hybrid (2:1)	6.2	7.6	4.5	6.1	5.2	5.5	4.5	5.0	11.4	13.0	11.1	11.8
T_5- *Sesbenia* + *Setaria anceps* (2:4)	5.8	7.5	3.8	5.7	3.8	3.6	3.8	3.7	9.6	11.2	11.9	10.9
T_6- *Sesbenia* + Perennial fodder sorghum (2:6)	6.4	7.7	5.5	6.6	6.6	7.5	5.5	6.5	13.0	15.2	11.1	13.1
T_7- *Sesbenia* (Sole)	6.4	6.8	6.8	6.7	-	-	-	-	6.4	6.8	6.8	6.7
S. Em ±	0.30	0.33	0.38	0.6	-	-	-	-	0.40	0.44	0.6	0.56
C. D at 5%	0.99	1.00	1.10	2.0	-	-	-	-	1.21	1.32	1.8	1.17

TABLE 6
Total digestible crude protein yield (q/ha) as influenced by *Sesbenia* based cropping system

Treatments	Crude protein yield (q/ha)											
	Sesbenia (q/ha)			Mean	Intercrops (q/ha)			Mean	Total (q/ha)			Mean
	2017	2018	2019		2017	2018	2019		2017	2018	2019	
T_1- *Sesbenia* + Congo signal grass (2:2)	4.76	7.87	2.34	4.96	2.63	2.43	2.34	2.43	8.06	10.87	7.87	8.93
T_2- *Sesbenia* + Rhodes grass (2:2)	4.96	8.06	1.56	4.86	2.05	2.05	1.56	1.85	7.67	10.68	7.38	8.55
T_3- *Sesbenia* + Guinea grass (2:2)	4.47	6.12	3.02	4.57	2.82	2.43	3.02	2.73	7.96	9.22	8.06	8.45
T_4- *Sesbenia* + Napier bajra hybrid (2:1)	5.34	6.70	3.70	5.25	4.37	4.67	3.70	4.18	10.39	11.94	10.10	10.78
T_5- *Sesbenia* + *Setaria anceps* (2:4)	4.96	6.61	3.02	4.86	3.02	2.82	3.02	2.92	8.64	10.19	10.87	9.90
T_6- *Sesbenia* + Perennial fodder sorghum (2:6)	5.54	6.80	4.67	5.73	5.73	6.61	4.67	5.64	11.94	14.07	10.10	12.04
T_7- *Sesbenia* (Sole)	5.54	5.93	5.93	5.83	-	-	-	-	5.54	5.93	5.93	5.83
S. Em ±	0.27	0.26	0.30	0.57	-	-	-	-	0.36	0.42	0.57	0.51
C. D at 5%	0.76	0.75	0.97	1.76	-	-	-	-	1.12	1.24	1.86	1.47

TABLE 7

Economics of *Sesbenia* based cropping system

Treatments	Gross returns (Rs ha^{-1})	Net returns (Rs ha^{-1})	B : C
T_1- *Sesbenia* + Congo signal grass (2:2)	73160	25860	1.69
T_2- *Sesbenia* + Rhodes grass (2:2)	77885	27885	1.69
T_3- *Sesbenia* + Guinea grass (2:2)	81925	32625	1.81
T_4- *Sesbenia* + Napier bajra hybrid (2:1)	103475	52975	2.23
T_5- *Sesbenia* + *Setaria anceps* (2:4)	83730	39130	2.06
T_6- *Sesbenia* + Perennial fodder sorghum (2:6)	100470	49620	2.14
T_7- *Sesbenia* (Sole)	44460	14360	1.39

over sole crop of *Sesbenia* (5.83 q/ha). The higher crude protein yield and content resulted in higher total digestible crude protein yield. These results corroborate with the findings of Bilal *et al.,* 2016, (Table 6).

Economics : The cropping system of *Sesbenia* + Perennial fodder sorghum (2:6) recorded higher gross and net returns (100470 Rs./ha and 49620 Rs./ha, respectively) followed by *Sesbenia* + B x N hybrid intercropping system (2:1), which recorded gross and net returns of 103475 Rs./ha and 52975 Rs./ha, respectively. Whereas, the higher benefit cost ratio was observed with *Sesbenia* + B x N Hybrid (2.23) followed by *Sesbenia* + Perennial fodder Sorghum (2.14). The sole crop of Agase recorded lower gross and net returns and benefit cost ratio (44460 Rs./ha, 14360 Rs./ha and 1.39, respectively). The increase in net monetary returns and benefit cost ratio is due to additional green forage yield and marginal increase in cost of production of intercrop over the sole crop of *Sesbenia* (Table 7).

Soil Properties : The soil physical and chemical properties were not much influenced by *Sesbenia* based intercropping system. There was slight increase in soil p^H (7.18 to 7.33) and electrical conductivity (0.39 to 0.44 ds m^{-1}) over initial value (7.13 and 0.38 ds m^{-1}, respectively). The improvement in organic carbon (0.45 to 0.48%), soil available nitrogen (265.90 kg N to 281.25 kg N ha^{-1}) and potassium (159.55 kg to 172.80 kg K_2O ha^{-1}) over initial soil status (0.43%

TABLE 8

Soil properties as influenced by *Sesbenia* based cropping system

Treatments	pH	Organic Carbon (%)	Electrical conductivity (ds m^{-1})	Available Nutrients (Kg/ha)		
				Nitrogen	Phosphorous	Potash
T_1- *Sesbenia* + Congo signal grass (2:2)	7.19	0.46	0.41	271.76	45.05	171.05
T_2- *Sesbenia* + Rhodes grass (2:2)	7.21	0.46	0.44	268.39	44.30	165.70
T_3- *Sesbenia* + Guinea grass (2:2)	7.18	0.47	0.44	278.80	39.70	167.90
T_4- *Sesbenia* + Napier bajra hybrid (2:1)	7.24	0.44	0.39	281.25	41.70	159.55
T_5- *Sesbenia* + *Setaria anceps* (2:4)	7.33	0.48	0.42	274.95	42.90	164.70
T_6- *Sesbenia* + Perennial fodder sorghum (2:6)	7.09	0.45	0.40	267.90	43.85	170.65
T_7- *Sesbenia* (Sole)	7.15	0.46	0.39	265.90	42.55	172.80
Initial	7.13	0.43	0.38	243.00	46.32	159.00

243.0 kg N $ha^{-1,}$ and 159 kg K_2O_5 ha^{-1}, respectively). The slight reduction in soil phosphorous content (39.70 kg to 45.05 P_2O_5 ha^{-1}) was noticed over initial soil phosphorus content (46.32 kg P_2O_5). The improvement in soil properties with intercropping was due to grasses having more root biomass, which resulted luxuriant growth of plant and led to higher sequestration of carbon which supported for improvement in organic carbon, available nitrogen and potassium (Table 8).

Based on the results it can be inferred that perennial fodder Sorghum (2:6) or B x N hybrid (2:1) are most suitable intercrops in *Sesbenia*, recording higher green forage, dry matter, crude protein yield and monetary benefits without impairing the soil fertility under protective irrigation.

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