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PRODUCTIVITY AND PROFITABILITY OF FORAGE CROPPING SYSTEMS UNDER IRRIGATED CONDITIONS OF SOUTHERN DRY ZONE OF KARNATAKA

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SUMMARY

Quality green fodder production throughout the year is the major drive for increasing the livestock productivity in the country. In this regard, a filed investigation was conducted at Zonal Agricultural Research Station, Vishweshwaraiah Canal Farm, Mandya, Karnataka during 2018-19 and 2019-20 to identify the suitable cropping system for year round quality green fodder production under irrigated condition. The experiment was conducted with fifteen different cropping systems involving both annual and perennial cereal and legume fodder crops in randomized complete block design and replicated thrice. The pooled data revealed that, the perennial B×N hybrid + Lucerne system at 2:8 proportion recorded higher green fodder yield (1636 q/ha/year), dry matter yield (321 q/ha/year), crude protein yield (60.2 q/ha/year), gross returns (₹3,02,440/ha/year), net returns (₹2,14,232/ha/year) and benefit cost ratio (3.4) followed by B×N hybrid + Cowpea (2:8) and B×N hybrid + Sesbania (2:8) perennial systems and proved as viable systems for obtaining higher quality fodder.

Key words : Cropping systems, green fodder, crude protein, Bajra Napier hybrid, Lucerne

Livestock is considered as backbone of Indian agriculture as crops and animals are main components of farming in the country. As per 20th livestock census conducted during 2019, the total livestock population in the country is 535.78 million, which is 4.6 per cent increase over livestock census 2012. This increasing livestock population together with less area under fodder crops (8.4 m ha) is creating huge gap between supply and demand of feed and fodder resources in the country and resulting in non-realization of the actual production potential of livestock sector. At present, the availability of green fodder, dry fodder and concentrates are 734.2, 326.4 and 61 million tonnes in the country against the requirement of 827.19, 426.1 and 85.78 million tonnes with a net deficit of 11.24, 23.4 and 28.9 per cent, respectively (Roy *et al.,* 2019). On the other hand, the feed cost alone accounts to 65-70 per cent of the total milk production due to higher cost of concentrate feeds and use of naturally grown grasses, weeds and shrubs as a fodder which are of low quality interms of nutrients. In this juncture, there is a need to meet the current demand of quality green fodder for sustaining livestock sector through increasing productivity.

The adoption of cropping systems with perennial fodder crops will play an important role in enhancing the productivity of fodder through efficient utilization of available resources and provides more economic benefits to the farmers. The cereal fodder crops are rich source of energy while legume fodder crops are rich in protein, thus instead o f growing as sole crops inclusion of perennial cereal fodder crops as main crops and legumes as components crops under intensive cropping systems with high yielding varieties and hybrids enhances the productivity per unit area and time (Patil *et al.,* 2018). Also addition of legumes as components crops helps to fix atmospheric nitrogen and retain the soil fertility. In this background current study was conducted to identify the sustainable fodder cropping system for year round quality green fodder production under irrigated condition.

MATERIALS AND METHODS

The Field experiment was conducted during *kharif, rabi* and *summer* seasons of 2018-19 and 2019-20 at Zonal Agricultural Research Station, Vishweshwaraiah Canal Farm, Mandya, University of Agricultural Sciences, Bengaluru, which is situated in southern dry zone (ACZ-VI) of Karnataka between 12º 45 and 13º 57 North latitude and 76º 45 and 78º

TABLE 1
Details of different fodder cropping systems

S. No.	Treatments
T_1	Fodder Maize + Cowpea (3:1) - Fodder Oat + Cowpea (3:1) - Pearlmillet + Cowpea (3:1)
T_2	Fodder Sorghum + Cowpea (3:1) - Fodder Maize + Cowpea (3:1) - Pearlmillet + Cowpea (3:1)
T_3	B×N hybrid + Cowpea (2:8) perennial system
T_4	B×N hybrid + Lucerne (2:8) perennial system
T_5	B×N hybrid + Desmanthus (2:8) perennial system
T_6	B×N hybrid + Sesbania (2:8) perennial system
T_7	Fodder Maize - Fodder Maize - Fodder Maize
T_8	Fodder Sorghum - Fodder Sorghum - Fodder Sorghum
T_9	Fodder Cowpea - Fodder Cowpea - Fodder Cowpea
T_{10}	Desmanthus perennial system
T_{11}	Sesbania perennial system
T_{12}	B×N hybrid perennial system
T_{13}	Lucerne perennial system
T_{14}	Fodder Oats - Fodder Oats - Fodder Oats
T_{15}	Fodder Pearlmillet - Fodder Pearlmillet - Fodder Pearlmillet

24′ East longitude at an altitude of 695 m above mean sea level. The soil of the experimental site was neutral in reaction (7.45) with electrical conductivity of 0.38 ds m^{-1}, medium in organic carbon content (0.55 %), low in available nitrogen (265.40 kg ha^{-1}), medium in available phosphorous (21.51 kg ha^{-1}) and available potassium (162.35 kg ha^{-1}). The experiment was laid out in Randomized Complete Block Design with fifteen different cropping systems (Table 1) and replicated thrice. The recommended package of practices was followed in execution of the experiment. The seasonal crops like maize, sorghum, pearlmillet, oats and cowpea were harvested at 75, 70, 70, 55 and 50 days after sowing while, in case of perennial crops like B×N hybrid, lucerne, desmanthus and sesbania first harvest was done at 70, 60, 90 and 180 days after sowing by leaving stubbles of suitable height with subsequent harvests at 45, 30, 45 and 45 days interval, respectively. At the time of harvesting green fodder yield was recorded and known quantity of sample was taken and oven-dried at 70 ± 2°C temperature for dry matter estimation. Later sample was powdered for crude protein estimation. The economics of each cropping system was worked out with prevailing market prices of fodder and computed in terms of gross returns, net returns and B:C ratio to assess the profitability of the system. The data of two years were statistically analyzed and discussed on pooled basis.

RESULTS AND DISCUSSION

Green fodder yield

The cropping systems involving cereal-legume intercropping recorded higher green fodder yield (GFY) compared to sole cropping systems grown all the seasons (Table 2). Among different cropping systems on pooled basis, B×N hybrid + Lucerne (2:8) perennial system recorded significantly higher green fodder yield (1636 q ha^{-1} $year^{-1}$) but found on par with B×N hybrid + Cowpea (2:8) perennial system (1552 q ha^{-1} $year^{-1}$). On the other hand, sole cropping of cowpea, desmanthus, oats and pearlmillet in all three season's recorded significantly lower green fodder yield (778, 796, 827 and 854 q ha^{-1} $year^{-1}$, respectively). The magnitude of decrease was 52.44, 51.34, 49.45 and 47.80 per cent, respectively over B×N hybrid + Lucerne (2:8) perennial system. The same trend was also noticed during both the years of study. The complementary nature of intercropped cereal and legume fodder crops under perennial systems might have resulted in efficient utilization of available resources like nutrients, water and solar energy which ultimately enhanced the fodder yield through better growth parameters like plant height, leaf to stem ratio and dry matter accumulation besides additional nitrogen supply by legume crops through atmospheric nitrogen fixation. These results are in accordance with the findings of Patil *et al.* (2018), Singh and Verma (2018) and Gangaiah and Kundu (2020).

Dry matter yield

Among different cropping systems, B×N hybrid + Lucerne (2:8) perennial system recorded significantly higher dry matter yield (DMY) on pooled basis (321 q ha^{-1} $year^{-1}$) but found on par with B×N hybrid + Sesbania (2:8) and B×N hybrid + Cowpea

TABLE 2
Biomass yield, crude protein content and crude protein yield of different year round fodder cropping systems

Treatments	GFY (q/ha/year)			DMY (q/ha/year)			CP (%)			CPY (q/ha/year)		
	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
T_1	1080	1125	1103	223	232	227	12.01	12.36	12.19	26.6	28.5	27.5
T_2	1125	1182	1154	238	250	244	11.56	11.58	11.57	27.5	29.0	28.2
T_3	1530	1575	1552	304	312	308	17.98	18.42	18.20	54.6	57.4	56.0
T_4	1614	1659	1636	317	324	321	18.54	19.02	18.78	58.8	61.6	60.2
T_5	1292	1329	1310	251	259	255	16.19	16.45	16.32	40.7	42.7	41.7
T_6	1384	1497	1440	301	325	313	19.60	19.90	19.75	58.9	64.7	61.8
T_7	1030	1063	1047	212	217	215	9.90	9.94	9.92	21.0	21.6	21.3
T_8	895	918	906	206	211	208	8.09	8.11	8.10	16.7	17.1	16.9
T_9	765	792	778	152	159	155	20.51	20.50	20.51	31.2	32.5	31.9
T_{10}	772	821	796	152	162	157	18.41	18.64	18.53	27.9	30.2	29.1
T_{11}	930	990	960	205	219	212	22.20	22.43	22.32	45.6	49.1	47.3
T_{12}	1247	1277	1262	244	251	248	9.92	9.91	9.92	24.3	24.8	24.5
T_{13}	937	968	952	187	194	191	20.53	20.71	20.62	38.5	41.1	39.8
T_{14}	803	851	827	162	172	167	10.43	10.29	10.36	17.0	17.7	17.3
T_{15}	825	882	854	172	185	178	8.43	8.59	8.51	14.5	15.9	15.2
S. Em±	59	55	63	12	14	13	0.59	0.67	0.66	2.0	2.6	2.6
C. D. (P=0.05)	173	160	184	36	39	38	1.71	1.95	1.92	5.9	7.4	7.5

Note: Legume fodder - ₹250/q, maize - ₹200/q, other cereal Fodder - ₹150/q.

(2:8) perennial systems (313 and 308 q ha^{-1} year^{-1}, respectively). Whereas, significantly lower dry matter yield (155, 157, 167, 178 and 191 q ha^{-1} year^{-1}, respectively) was recorded with sole cropping of cowpea, desmanthus, oats, pearlmillet and lucerne throughout the year (Table 2). These crops accounts to 48.29, 48.91, 52.02, 55.45 and 59.50 per cent, respectively of total dry matter yield produced by the B×N hybrid + lucerne (2:8) perennial system. The similar trend was noticed during both the years of study. The higher dry matter yield in perennial fodder intercropping system modules might be due to higher green fodder yield of the component crops even with considerable lower dry matter content. These results are confined with the findings of Deore *et al.* (2013) and Shekara *et al.* (2015).

Crude protein content

The cropping system modules which included legume fodder crops recorded significantly higher crude protein (CP) content compared to sole cereal fodder cropping systems (Table 2). The perennial system of sole sesbania on pooled basis recorded significantly higher crude protein content (22.32 %) but found at par with sole lucerne (20.62 %) and cowpea (20.51 %) cropping systems. However, sole fodder sorghum, pearlmillet, maize and B×N hybrid cultivated throughout the year resulted in lower crude protein content (8.10, 8.51, 9.92 and 9.92 %, respectively). The similar trend was also noticed during both the years of study. The higher crude protein content with sole legume fodder crops might be attributed to nitrogen fixation by these crops due to symbiosis between *Rhizobia* present in the soil that led to more availability and uptake of nitrogen resulted

TABLE 3
Economics of different year round fodder cropping systems (Pooled data)

Treatments	Cost of cultivation (Rs./ha/year)	Gross returns (Rs./ha/year)	Net returns (Rs./ha/year)	B : C
T_1	85304	206932	121628	2.4
T_2	84365	212705	128340	2.5
T_3	87531	283885	196354	3.2
T_4	88208	302440	214232	3.4
T_5	91045	223449	132405	2.5
T_6	94598	261126	166528	2.8
T_7	85014	209300	124286	2.5
T_8	78319	135963	57644	1.7
T_9	65049	194500	129451	3.0
T_{10}	76520	199000	122480	2.6
T_{11}	79387	239958	160571	3.0
T_{12}	85808	189225	103417	2.2
T_{13}	79387	238042	158655	3.0
T_{14}	83037	123975	40938	1.5
T_{15}	74487	128000	53513	1.7
S. Em±	-	5863	4118	0.1
C. D. (P=0.05)	-	17073	11990	0.2

better protein biosynthesis. The lower protein content with sole cereal crops was mainly because of their genetic character. These results are in agreement with the findings of Yadav *et al.* (2019) and Mallikarjun *et al.* (2018).

Crude protein yield

The cropping system involving B×N hybrid + Sesbania (2:8) perennial system recorded significantly higher crude protein yield (CPY) (61.8 q ha^{-1} year^{-1}) and it was at par with B×N hybrid + Lucerne (2:8) and B×N hybrid + Cowpea (2:8) perennial systems (60.2 and 56.0 q ha^{-1} year^{-1}, respectively) on pooled basis (Table 2). The lower crude protein yield was noticed with sole fodder pearlmillet, sorghum and oats (15.2, 16.9 and 17.3 q ha^{-1} year^{-1}, respectively) cultivated throughout the year. The trend was similar during both the years of study. The crude protein yield is the function of dry fodder yield and crude protein content of fodder. The higher dry matter yield led to higher crude protein yield even with the considerable lower crude protein content of perennial cropping system modules. These results are in conformity with the findings of Prajapati *et al.* (2019) and Hindoriya *et al.* (2019).

ECONOMICS

Among different cropping systems, perennial system of B×N hybrid + Lucerne (2:8) recorded higher gross returns (₹3,02,440 ha^{-1} year^{-1}), net returns (₹ 2,14,232 ha^{-1} year^{-1}) and benefit cost ratio (3.4) followed by B×N hybrid + Cowpea (2:8) (₹2,83,885 ha^{-1} year^{-1},₹1,96,354 ha^{-1} year^{-1} and 3.2, respectively) and B×N hybrid + Sesbania (2:8) perennial systems (₹2,61,126 ha^{-1} year^{-1}, ₹1,66,528 ha^{-1} year^{-1} and 3.0, respectively) (Table 2). While sole cropping of oats registered lower gross returns (₹1,23,975 ha^{-1} year^{-1}), net returns (₹40,938 ha^{-1} year^{-1}) and benefit cost ratio (1.5). The higher gross returns, net returns and benefit cost ratio with perennial cropping system modules were mainly attributed to higher green fodder yield. These results are in line with Shekara *et al.* (2015), Patil *et al.* (2018) and Hindoriya *et al.* (2019).

The perennial system of B×N hybrid + Lucerne followed by B×N hybrid + Cowpea and B×N hybrid + Sesbania perennial systems in 2:8 proportion resulted in higher biomass yield and protein yield throughout the year. The same perennial systems also proved as profitable systems with higher gross returns, net returns and benefit cost ratio compared to all other cropping sequences.

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