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PRODUCTIVITY AND ECONOMICS OF DIFFERENT FORAGE PRODUCTION SYSTEMS IN SOUTH GUJARAT CONDITIONS OF INDIA

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SUMMARY

A Field experiment was carried out at BAIF's KVK Chaswad in Bharuch district during 2014 to 2016 with an objective to study the various forage cropping systems for green fodder production and find out the best remunerative year round fodder production system suitable to the South Gujarat conditions. The experiment was conducted with five cropping systems replicated four times in randomized block design. The cropping systems comprised of the combination of annual and perennial cereals and legumes crops. The three years pooled data revealed that the combination of Hybrid Napier variety BAIF Napier Hybrid-10 with *Desmanthus* (Hedge Lucerne) in 1:5 proportion has given significantly higher green fodder yield of 1701.41 q/ha, gross monetary returns of Rs. 294,872/ha, net monetary returns of Rs. 228,977/ha and benefit: cost ratio of 4.47. The soil fertility status was also maintained over a period of three years due to this cropping system.

Key words : Fodder production systems, green fodder yield, net monetary returns, soil fertility

India has the largest cattle population in the world but the land available for fodder cultivation is limited (4 % of the cropped area). The accessibility of green fodders from different sources is only 40% of the basic requirement and there is 60 % shortage of green fodder. Considering the huge gap between the demand and supply of green nutritious fodder and quality dry matter along with the static or decreasing land availability, it is essential to bridge this gap through intensifying forage production per unit area per unit time, which can be achieved through improved high yielding crops and better management practices. Dairy animals producing up to 12-15 liters milk per day can be maintained by feeding green fodders. Inclusion of green fodders in ration of dairy animals decreases amount of concentrate feeding and thus increases profit (Anonymus, 2017).

The south Gujarat region is not only gifted with highest rainfall in the state but also have good network of irrigation systems. This results into cultivation of cash crops by majority of farmers by replacing food and fodder crops. Sporadically, to overcome the shortage of fodder, dairy farmers tried for other seasonal fodder crops, but it was not found economical and sustainable as well as insufficient in bridging the gap between demand and supply of fodder for ever increased animal population. The replacement of cereal crops, one of the main sources of crop residues, by commercial crops is another factor for scarcity of fodder.

Competent crop sequence in intensive agriculture promotes productivity per unit area per unit time and provides more economic remuneration to the farmers. The present cropping sequences could be adapted with addition of high yielding varieties of perennial crops and inclusion of protein rich legume fodders. Kauthale *et al.* (2017) revealed that green fodder, dry matter and crude protein yields were significantly increased with suitable planting method of perennial grass and legume combination. Although cereal-based forage has a high energy content and low crude protein (CP), legumes have long been recognized as a good source of CP. Instead of growing these crops separately, the possibility exists to grow them together in intercrops to retain soil fertility. With this background a field experiment was conducted to study the production potential and economics of different forage cropping systems under irrigated conditions of South Gujarat which could provide a viable option to dairy farmers for growing year round fodder crops.

MATERIALS AND METHODS

A field experiment was undertaken at BAIF's Krishi Vigyan Kendra, Chaswad, District Bharuch,

Gujarat, India during a period of 2014 to 2016 in *Kharif, Rabi and Summer* seasons. The study area is located at an altitude of 104 m above the sea level at 21.34ºN 73.21ºE. The rainfall mostly received during monsoon season during June to September with the average of 1100 mm with average 45 rainy days. The mean temperature ranges in summer 35ºC and winter temperature 17ºC. The soil of the experimental field was medium black with initial nutrient status for pH (7.72), EC (0.38 dS/m), Organic Carbon (0.52 %), available nitrogen (213 kg/ha), available phosphorus (44.53 kg/ha) and available potassium (161.42 kg/ha). The experiment was laid out with five cropping systems replicated four times in Randomized Block Design having gross plot size of 4.2 m × 3 m. Each treatment plot was separated by a spacing of 60 cm as a buffer zone. The line sowing method in different row proportions was adopted for establishment of all crops (Table 1). The recommended agronomic package of practices was followed for growing all the fodder crops in the experiment. The seasonal crops were harvested at 50 % flowering stage and perennial crops at recommended intervals. The green fodder yield was recorded at harvesting. Cost of cultivation, gross and net returns and benefit cost ratio was worked out for different fodder cropping systems on current market price basis. The soil was analyzed for fertility status after completion of the experiment. The season wise fodder cropping sequences along with fodder crops and varieties are depicted in Table 1 and 2, respectively.

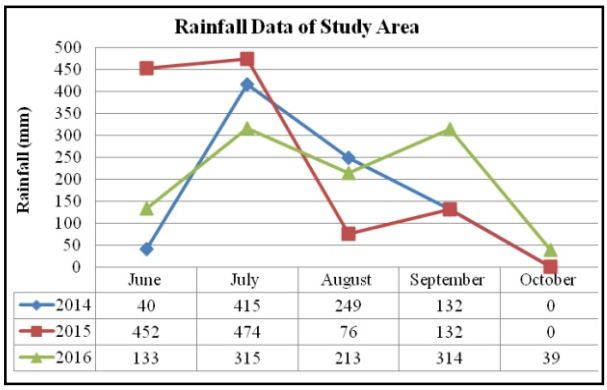

Fig. 1. Rainfall data of study area

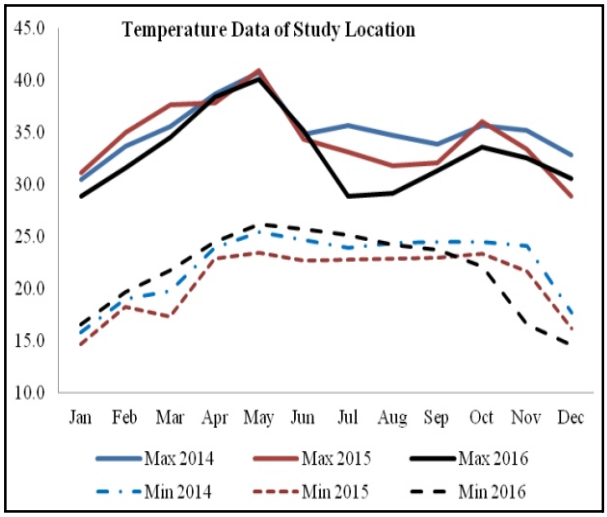

Fig. 2. Temperature data of study location

TABLE 1
Season wise fodder cropping systems adopted

Treat #	Kharif	Rabi	Summer
T_1	Maize + Cowpea (2:1)	Oat + Berseem (2:1)	Pearl millet + Cowpea (2:1)
T_2	Hy. Napier + Desmanthus (1:5)	Hy. Napier + Desmanthus (1:5)	Hy. Napier + Desmanthus (1:5)
T_3	Hy. Napier + Lucerne (1:5)	Hy. Napier + Lucerne (1:5)	Hy. Napier + Lucerne (1:5)
T_4	Fodder Pearl millet	Fodder Sorghum	Grain Pearl millet
T_5	Soybean (Straw)	Grain Sorghum	Green gram (Straw)

TABLE 2
The details of fodder/grain crops and varieties

#	Crops	Variety	#	Crops	Variety
1	Berseem	Wardan	7	Hybrid Napier	BAIF Napier Hybrid-10
2	Cowpea	EC 4216	8	Oats	Kent
3	Desmanthus	Local	9	Fodder Pearl millet	BAIF Bajra-1
4	Lucerne	RL 88	10	Fodder Sorghum	CSV21F
5	Green gram	Meha	11	Grain Pearl millet	GHB558
6	Soybean	NRC-37	12	Grain Sorghum	Dadar Goti

TABLE 3
Forage Yield and Economics of Different Year Round Forage Crop Models

Treatment	Kharif	Rabi	Summer	Forage yield (q/ha/year)	Gross Monetary returns (Rs./ha/year)	Cost of cultivation (Rs./ha/year)	Net Monetary returns (Rs./ha/year)	Benefit : cost ratio
Pooled mean of 3 years (2014-16)								
1	Maize + Cowpea	Oat+Berseem	Pearl millet+Cowpea	842.63	188625.95	70286.00	118339.95	2.68
2	Hybrid Napier+ Desmanthus	Hybrid Napier+ Desmanthus	Hybrid Napier+ Desmanthus	1701.41	294871.75	65895.00	228976.75	4.47
3	Hybrid Napier+ Lucerne	Hybrid Napier+ Lucerne	Hybrid Napier+ Lucerne	1415.59	232910.50	64977.00	167933.50	3.58
4	Fodder Pearl millet	Fodder Sorghum	Grain Pearl millet	1043.12	232923.21	69376.00	163547.21	3.36
5	Soybean (Straw)	Grain Sorghum	Green gram (Straw)	306.42	99928.21	67631.00	32297.21	1.48
			SE(m)+	24.90	4875.18		4875.14	0.07
			CD at 5%	77.59	15188.13		15023.09	0.22
			CV %	4.69	4.64		6.84	4.57
Sale price	Maize	Cowpea	Oat	Berseem	Pearl millet	Hybrid Napier	Desmanthus	Lucerne
(Rs/q)	220	260	210	250	220	150	250	260
Sale price	Fodder Pearl millet	Fodder Sorghum	Grain Pearl millet	Soybean (Straw)	Grain Sorghum	Green gram (Straw)		
(Rs/q)	220	230	220	750	230	750		

RESULTS AND DISCUSSION

The pooled data over three year's period showed that the year round green forage cropping system of hybrid napier intercropped with *Desmanthus* in 1:5 proportion has recorded highest green forage production of 1701.41 q/ha/year which was significantly superior over rest of the forage cropping systems (Table 3). The same system has also given the highest gross monetary returns (Rs. 294,871.75/ ha/year), net monetary returns (Rs. 228,976.75/ha/ year) and benefit cost ratio (4.47) as compared to other fodder cropping systems. The cropping sequence of lucerne intercropped with hybrid napier was the second best cropping system which has given higher green fodder yield of 1415.59 q/ha/year, gross monetary returns of Rs. 232,910/ha/year, net monetary returns of Rs. 167,933.50/ha/year and benefit cost ratio of 3.58. The net monetary returns in hybrid napier intercropped with *Desmanthus* was four times higher than the regular cropping system of the area (Soybean-grain sorghum-green gram).

The plant height and more number of tillers/ plant has contributed in higher green fodder yield in hybrid napier. These results are in accordance with the findings of Yunus *et al.* (2000). Moreover, inclusion of legumes in cereals have several benefits for intercropping systems such as production of greater yield on a given piece of land by making more efficient use of the available resources, improvement of soil fertility through the addition of nitrogen by fixation and increases soil conservation through greater ground cover than sole cropping. (Dwivedi *et al*., 2015). Menbere *et al.* (2015) reported that intercropping of Napier grass with herbaceous perennial legume has significant advantage than growing Napier grass solely in increasing the dry matter yield harvested.

The green fodder yield in hybrid napier intercropped with *Desmanthus* was higher than hybrid napier intercropped with lucerne due to more biomass obtained from *Desmanthus* (hedge lucerne). *Desmanthus* being a hardy perennial crop which can be grown in poor type of soil with less irrigation (Hegde, 2010) and perform better in good type of soil. These results are in agreement with those of Jayaprakash *et al*. (2016). He noticed that *Desmanthus virgatus* produced 40 t/ha/year biomass yields and thus has the potential to be a good alternate feed source for ruminant animals. It was observed that lucerne is sensitive to soil type and water management as compared to *Desmanthus.*

The data on changes in chemical properties of soil depicted in Table 4 indicated that the soil fertility was maintained over a period of three years, moreover there was slight increase in organic carbon in legume based intercropping system. The rise in organic carbon was found more (0.54 %) in hybrid napier intercropped with *Desmanthus and* was decreased (0.48 %) in cropping system having only cereal crops (Fodder pearl millet-fodder sorghum-grain pearl millet). This was because of cropping of perennial crops paves a way for reducing carbon dioxide emissions and thereby sequestering carbon in agricultural lands. Sivakumar *et al*. (2014) also found hybrid napier and *Desmanthus* had enhanced the organic carbon content in soil.

CONCLUSIONS

Based on the findings of the three years study it could be concluded that perennial fodder cropping sequence of hybrid napier intercropped with *Desmanthus* in 1:5 proportion gave maximum green forage yield throughout the year and highest gross and net monetary returns and benefit cost ratio as compared to all other sequences and it was much higher as compared to the local cropping sequence of Soybean-

TABLE 4
Soil fertility changes after three years of experimentation

Treatment	pH	EC (ds/m)	Organic Carbon (%)	Available nitrogen (kg/ha)	Available phosphorus (kg/ha)	Available potash (kg/ha)
1	7.65	0.43	0.50	211.2	40.16	174.20
2	7.48	0.47	0.54	224.6	41.09	171.02
3	7.60	0.45	0.51	218.0	43.54	167.91
4	7.89	0.40	0.48	201.4	38.33	163.42
5	7.79	0.40	0.51	215.0	40.05	168.00
Initial status	7.72	0.38	0.52	213.0	44.53	161.42

grain sorghum-green gram under South Gujarat conditions. Being a perennial cropping system the cost of cultivation was also comparatively low. The soil fertility was also maintained due to legume combination and quality cereal and legume fodder could be harvested at regular interval to feed the animals.

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