Legume Research, 42(6) 2019: 812-817
Print ISSN:0250-5371 / Online ISSN:0976-0571

AGRICULTURAL RESEARCH COMMUNICATION CENTRE
www.arccjournals.com

Productivity and Profitability of Cereal-Legume Forages Vis-a-Vis Their Effect on Soil Nutrient Status in Indo-Gangetic Plains

P.S. Hindoriya, R.K. Meena, Rakesh Kumar, Magan Singh, Hardev Ram, V.K. Meena*, D. Ginwal and S. Dutta

ICAR- National Dairy Research Institute,
Karnal-132 001, Haryana, India.
Received: 02-04-2019 Accepted: 26-06-2019 DOI: 10.18805/LR-4147

ABSTRACT

The present study was conducted to evaluation of production potential of different forage crops commonly gown by farmers. The experiment was carried out in randomized complete block design with eight treatments and three replications at research farm of Agronomy Section, ICAR-NDRI, Karnal (Haryana). Among eight treatments, two perennial forage crops napier bajra hybrid(NBH), guinea grass cultivated sole as well as intercropping with cowpea and four seasonal fodder crops (cowpea, sorghum, baby corn and maize) were tested for their physio-morphological, biomass yield responses and economic efficiency. Experimental results showed that among the different forage crops significantly highest green as well as dry fodder yield were revealed from NBH intercropped with cowpea 63.79 and 11.95 t/ha green biomass fodder yield (GBY) and dry fodder yield respectively;which were found at par with sole NBH treatment (60.69&11.68 t/ha GBY and DFY). Amongs the different forage crops lowest GBY and DFY 33.1and 5.68 t/ha was produced by baby corn and cowpea respectively. The magnitude of the yield advantage was observed maximum and in the tune of 20.69% with guinea intercropped with cowpea against sole guinea. Highest net return was obtained from dual purpose baby corn (`1.60 lakh/ha) with B: C ratio (5.26) and economic efficiency (`2471/ha/day), followed by in NBH intercropped with cowpea. Based on the study, it is clearly indicated that dual purpose baby corn followed by NBH + cowpea intercropping could be feasible option for increasing the overall productivity of dairy farmers in Indo-Gangetic plains and elsewhere similar conditions prevails.

Key words: Baby corn, Economic efficiency, Forage crops, Green biomass yield, Napier grass.

INTRODUCTION

About 20.5 million peoples in our country are depend upon livestock for their livelihood. Therefore this sector has also an important contribution in Indian economy with 28.6% of total agricultural GDP (GoI, 2017-18). Presently India is holding number one position in livestock population as well as in milk production but the productivity point of view we are harvested only 987 kg/lactation yield; which has wide gap in per lactation yield as compared to world average (2038 kg/lactation yield) and European countries (6941 kg/lactation yield). Behind this poor productivity and performance of Indian animals so many factors are responsible, among these factors one important factor is unavailability of sufficient quality feed and fodder to animal timely for getting best performance. At present India is having only 5.4% (8.4 Mha) of the cultivated area under forage crops, which has resulted in a severe deficit of green fodder (36%), dry crop residues (11%) and concentrate feed ingredients (44%) (Annual Report, ICAR-IGFRI, 2016). To maintain or raise the performance of current available livestock population and its productivity, we need to enhance the quality forage production and its productivity to achieve minimum optimum balanced feeding of livestock's. Feeding in dairy farming is the utmost important management factor because it is attributed to around 65-70% of the total input cost of animals (Makkar, 2016).

Surve *et al.* (2011) also reported that availability of green fodder with good quality is the key to success of dairy enterprises and without supply of quality fodder it is difficult to maintain the health and milk production level of the animals. Green fodder production is only single and cheap component in order to reduce the total input cost of milk production and make the dairy enterprises more profiTable. In respect to enhance the availability of fodder and forage, area intensification is difficult task because it faces severe competition with other commercial enterprises and food crops. Therefore, only one and one suiTable and feasible alternative remained under present context is to boost up the productivity of fodder and forage crop per unit area as well as per unit time. In many study it has well established that perennials grasses (like Napier, guinea, paragrass etc.) have more yield advantage in comparison to annual forage crops because it require lower input and it also uniformly supply high green biomass in continuous manner for long time periods. Napier bajra hybrid (NBH) and guinea grass

*Corresponding author's e-mail: kumar.ladla@gmail.com

are important forage grasses of the tropics and well known for its higher biomass potential, palatability, persistence and for quality fodder. In most cases the nutritional quality of cereal fodder is lower as compared to legume. The nutritional quality of cereal fodder or grasses can be enhanced either by mixing legume or growing of legume as inter/mix crop in field condition itself. Another major advantage of inclusion of legume with grasses is to sustain the soil health Halli *et al.* (2018). Baby corn (*Zea mays* L.) is also important dual purpose crop grown for premature cob as well as green fodder near to peri-urban and urban areas dairy farmers. Its dual importance and fast growing habit, high biomass yield potential, better nutritional quality and palatability, absence of any anti-quality compound all these characteristics are make it farmer choice for dairy enterprises. It is therefore, imperative to evaluate the best forage crop or crop combination which are maximize the productivity as well as profitability of dairy farmers in Indo-Gangetic Plains. Hence, keeping these things in view the present investigations was undertaken.

MATERIALS AND METHODS

The present study was carried out during *kharif* 2017 at Agronomy research farm of ICAR-National Dairy Research Institute, Karnal (Haryana) located at 29º45' North latitude, 76º58' East longitudes and at an altitude of 245 m above mean sea level (MSL). The region witnesses sub-tropical, sub-humid climate with hot summers. The meteorological phenomenon occurred during study period (July, 2017- September, 2017) are furnished in Table 1, rainfall and evapotranspiration also furnished in Fig 1. The maximum temperature was recorded 34°C in 29th standard week, while minimum temperature remained 31.7°C during the study period.

The soil of experimental plot was sandy clay loam in texture with chemically neutral reaction 7.2 pH, medium in Walkley-Black C (0.63%), EC (1:2) (0.30 dS/m), low in $KMnO_4$ Oxidizable N (196 kg/ha) and 0.5 M $NaHCO_3^-$ extracTable P (18.15 kg/ha), and medium 1N NH_4OAC extracTable K (213.34 kg/ha). The experiment was laid out in randomized complete block design (RCBD) with two

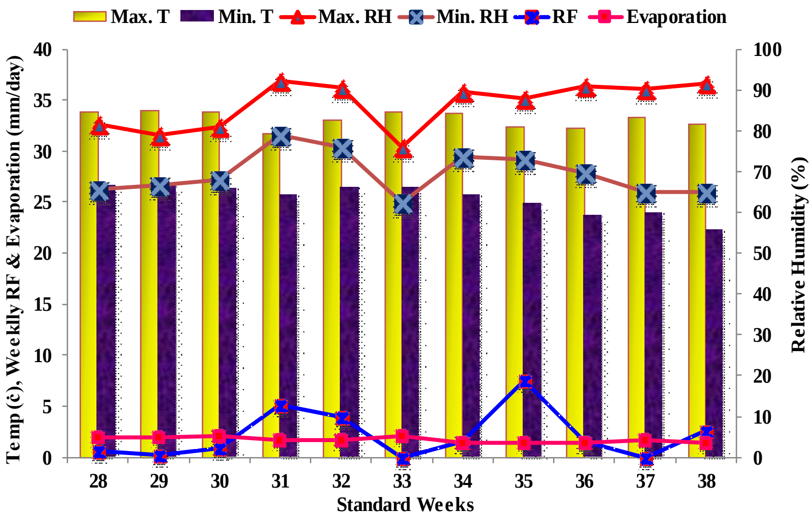

Fig 1: Weekly average meteorological observations chart during study period.

Table 1: Weekly average meteorological observations during study period.

Standard week	Date of standard week	Temperature (°C)		RH (%)		Weekly Rainfall (mm/day)	Weekly Evaporation (mm/day)
		Max.	Min.	Max.	Min.		
28	9th-15th July	33.8	26.6	81.6	65.7	01.5	04.8
29	16th-22th July	34.0	26.6	79.1	66.7	00.4	04.9
30	23rd-29th July	33.8	26.3	80.9	67.9	02.1	05.2
31	30th-5th August	31.7	25.6	92.1	79.0	12.7	04.2
32	6th- 12th August	33.0	26.5	90.7	75.9	09.9	04.2
33	13th-19th August	33.8	26.4	75.8	62.2	00.0	05.3
34	20th-26th August	33.7	25.6	89.6	73.6	04.0	03.5
35	27th- 2ndSeptember	32.4	24.8	87.9	73.0	18.7	03.7
36	3rd- 9th September	32.2	23.7	90.9	69.6	03.8	03.4
37	10th-16th September	33.3	24.0	90.3	65.0	00.0	04.1
38	17th-23rd September	32.7	22.2	91.4	65.1	06.5	03.6

perennial forage crops Napier bajra hybrid/NBH (NBH-37), guinea grass (Bundel guinea-1) sole and intercropping combination with cowpea (C-152) and four seasonal crops cowpea, sorghum, baby corn and maize varieties (C-152, Sudan chari, HM-4 and J-1006 respectively) in the eight treatments with three replications. The crops were sown as per crop standard agronomical package and practices. A common dose of well decomposed farm yard manure (FYM) @ 10 t/ha has been applied three weeks prior to sowing of the crops. Half dose of nitrogen and full dose of phosphorus and potassium were applied in the form of urea, DAP and MOP respectively as basal application and remaining half dose of nitrogen was supplied as split dose through broadcasting. 20 kg $ZnSO_4$ also uniformly applied in all treatment at the time of basal application. In NBH and guinea grass 25 kg/ha N was top dressed after each cutting.

Observations on biometric growth parameters were recorded at 30 days after sowing (DAS) and at the time of harvest. The 1stcut was taken for fodder at 60 days after planting or DAS in NBH, guinea grass and cowpea, sorghum and maize while baby corn was harvested at 65 DAS. For harvesting of cob 2-3 manual picking is required in 2-3 days intervals. The 2nd cut was taken for the NBH, guinea grass and for multicut sorghum at 30-35 Days after 1st cutting. At each harvesting plant samples (1.0 kg fresh weight) were collected to analyse quality parameters. To assess dry matter (DM) contents, all samples were dried in a hot air oven at 65°C for at least 48 hour until a constant weight was reached. The dried samples were milled to pass through a 2 mm sieve for nutritional quality evaluation. All data were analysed using analysis of variance (ANOVA) technique (Gomez and Gomez, 1984). Test of significance of the treatment differences were done on the basis of t-test. The significant difference between treatment means were compared with critical differences at 5% levels of probability. The net profit per ha was calculated by deducting the cost of cultivation from the gross returns per ha.

RESULTS AND DISCUSSION

Plant heightis a reliable indicator for growth of the plants particularly in forage crops, which represents the infrastructure development for other growth parameters such as number of leaves and leaf length over a period of time. Data pertaining to plant height as influenced by different crops and crop combinations are presented in Table 2. The significantly ($P<0.05$) highest plant height at 30 DAS was revealed in the baby corn maize (98.5 cm) which were at par with maize (91.3cm). At harvesting stage the maximum plant height was recorded in sorghum (250.4 cm) and this was at par with cowpea (232.3 cm) under sole and intercropped stand. However, the lowest plant height was attained by guinea grass at both the stages. These results are in close conformity with the findings of Meena *et al.* (2012) and Rana *et al.* (2013). The maximum leaf length was recorded in baby corn maize (61.9 cm) at 30 DAS and this was at par with fodder maize (55.8 cm) as depicted in Table 2. Fodder maize resulted significantly higher leaf length (83.5 cm) at harvesting which was at par with NBH (78.93 cm) intercropped with cowpea.

The lowermost values (35.3 and 54.2 cm; at 1st and 2nd stages) for this growth attribute were corroborated with guinea grass. The variation in plant height and leaf length of different forage crop might be due to of having different genetic potential and morphological structure. Johnson and Lenhard, (2011) also revealed that growth of plant is controlled by their genetic potentials. Leaf width is also important growth parameters for higher biomass production of forage crops. The value of leaf width at 30 DAS was found highest in cowpea (7.77 cm) intercropped with guinea grass. Number of leaves is an ideal required parameter for all forage crops because it has more nutritional, digestible and

Table 2: Biometric growth parameters of different forage crops**.**

Treatments	Plant height (cm)		Leaf length (cm)		Leaf width (cm)		Number of leaves/ plant/clump	
	30 DAS	At harvest	30 DAS	At harvest	30 DAS	At harvest	30 DAS	At harvest
NBH Sole	70.01	160.18	45.55	73.47	2.50	4.07	6.47	164.30
Guinea Sole	56.73	131.33	35.33	54.20	1.52	2.43	4.13	124.67
NBH +	65.07	155.80	45.80	78.93	2.42	4.40	5.73	147.5
Cowpea*	(54.93)	(239.33)	(8.85)	(11.23)	(7.13)	(7.74)	(30.13)	(127.27)
Guinea +	55.20	149.07	35.73	61.93	1.53	2.63	3.53	116.2
Cowpea*	(52.80)	(229.40)	(9.04)	(11.33)	(7.77)	(7.96)	(38.13)	(131.97)
Cowpea Sole	53.80	232.33	9.65	11.40	7.73	7.93	43.40	133.33
Sorghum Sole	74.29	250.40	51.50	77.27	5.00	7.13	6.13	37.87
Baby corn Sole	98.45	178.80	61.93	75.40	5.93	7.35	7.87	10.93
Maize Sole	91.27	226.30	55.78	83.47	6.56	7.40	7.37	11.53
SEm(±)	5.17	6.33	2.77	2.00	0.27	0.4	1.13	5.47
LSD (P=0.05)	15.2	18.6	8.14	5.88	0.8	1.17	3.34	16.04

Note: *=Parenthesis values (intercrop cowpea) are statistically not analysed.

Table 3: Number of branches/ tillers, GBY, DFY, Baby cob yield and CPY of different forage crops.

Treatments	**Branch/ number of tillers per clump/ plant**		**GBY (t/ha)**	**DFY (t/ha)**	**Baby cob yield (q/ha)**	**CPY (q/ha)**
	30 DAS	**At harvest**				
NBH Sole	5.42	44.90	60.69	11.68	-	11.43
Guinea grass Sole	2.87	26.87	43.98	10.95	-	9.08
NBH+Cowpea*	6.27 (3.59)	25.10 (8.38)	63.75	11.95	-	14.46
Guinea+Cowpea*	2.90 (3.8)	13.2(8.75)	53.08	10.59	-	11.67
Cowpea Sole	4.43	8.85	33.58	5.68	-	7.93
Sorghum Sole	2.80	3.25	45.12	9.91	-	9.72
Baby corn Sole	-	-	33.16	6.50	7.48	5.84
Maize Sole	-	-	46.51	9.99	-	9.43
SEm±	0.29	2.75	2.65	0.55	-	0.57
LSD (*P*= 0.05)	0.87	10.11	7.79	1.61	-	1.69

Note: *=Parenthesis values (intercrop cowpea) are statistically not analysed, GBY=Green biomass yield, DFY= Dry fodder yield, CPY=Crude protein yield.

Table 4: NR and B: C ratio and Economic efficiency of different forage crops.

Treatments	**Net return (`/ha)**	**B:C Ratio**	**Economic efficiency (`/ha/day)**
NBH sole	27,123	0.56	301.0
Guinea grass sole	21,94	0.04	24.0
NBH+Cowpea*	49,329	1.39	548.0
Guinea+Cowpea*	34,623	0.91	385.0
Cowpea sole	30,694	1.56	511.0
Sorghum sole	33,412	1.45	371.0
Baby corn sole	1,60,609	5.27	2471.0
Maize sole	35,729	1.59	595.0

Note: *=Parenthesis values (intercrop cowpea) are statistically not analysed.

pala Table value compare to other plants parts. The maximum leaves were counted in cowpea (43.4) and lowest in guinea grass (3.53) at 30 DAS. While sole NBH produced highest leaves (164.30) at harvest. Similar types of results were also reported by earlier finding of Hofer *et al.* (2001).

Number of tiller are directly proportion to biomass yield of any forage crops. In general the more number of tiller are producing higher biomass tonnage. Among the forage crops maximum number of tillers (5.42 and 6.27) were recorded in NBH under sole and intercropping stand with cowpea at 30 DAS. However, sole NBH resulted the highest number of tillers (44.9) at the time of harvest. Less no of tillers and branch (legume crop) were recorded in intercropping system which could be due to competition effect of cereal-legume fodder crop for space, light and air as noticed in both grasses guinea and NBH with cowpea. Similar result was also observed by Sarjerao, (2014).

Green biomass yield (GBY) and dry fodder yield (DFY) were significantly influenced due to variable performance of different forage crops as shown in Table 3. The maximum GBY and DFY were recorded in treatment NBH intercropped with cowpea (GBY 63.8 and DFY 11.9 t/ha) which were observed at par with sole NBH (GFY 60.7 and DFY 11.7 t/ha). This might be due to yield advantage of fodder cow pea over sole stand of grass. The lowest GBY and DFY (33.1 and 5.68 t/ha) were produced by baby corn maize and cowpea respectively. However in addition to green biomass yield baby corn maize also produced baby cob (7.48 q/ha). The magnitude of the yield advantage was observed to maximum in the tune of 20.7% with guinea intercropped with cowpea against sole guinea. Intercropped NBH with cowpea also resulted into yield advantage by 5.04 and 2.31% for GBY and DFY respectively over sole NBH. Our findings are in agreement with Zhang *et al.* (2011) suggested that intercropping system shows a greater forage production potential than sole cropping. Anita *et al. (*2015) also revealed that NBH and guinea grass intercropped with cowpea enhanced the total green fodder yield. Among the different fodder crops highest crude protein CP yield (14.5 q/ha) was attained in NBH + cowpea followed by guinea grass intercropped with cowpea (11.6 q/ha). The higher total protein yield was recorded by combination of NBH with cowpea over other treatment due to the higher dry matter yield of this combination. Hindoriya *et al.* (2019) revealed that in Indo-Gangetic plain combination of perennial NBH grass intercropping with cowpea have the greater potential to produce higher dry fodder yield as well as good quality fodder and yearly availability of green fodder. Baghdadi *et al*. (2016) observed that cereal- legume based intercropping produce greater CP yield than sole crop. Strydhorst *et al.* (2008) and Tamta *et al.* (2019) stated that cowpea is usually grown mixed with cereal fodders and grasses to improve the nutritional quality of fodder in terms of CP yield.

Economic analysis (Table 4) is an important component of any study which decide it final acceptability amongs the stakeholders. Economics was computed considering the local price of input and output. The highest net returns was obtained from baby corn maize (Rs. 1.60

Table 5: Nitrogen uptake and soil nutrients status after harvesting of different forage crops.

Treatments	N uptake (kg/ha)	pH	EC (dS/m)	OC (%)	N (kg/ha)	P (kg/ha)	K_2O (kg/ha)
Initial	-	7.18	0.29	0.63	196	20.8	289.3
NBH Sole	182.91	7.29	0.35	0.58	179.7	19.54	270.5
Guinea Sole	145.35	7.30	0.36	0.59	180.33	19.67	275.07
NBH + Cowpea	231.31	7.23	0.25	0.60	188.15	19.81	281.57
Guinea grass + Cowpea	193.06	7.21	0.26	0.61	190.23	19.88	284.15
Cowpea Sole	155.55	7.20	0.22	0.63	197.9	20.69	283.49
Sorghum Sole	126.88	7.26	0.36	0.58	184.56	19.74	274.28
Baby corn Sole	93.50	7.27	0.34	0.59	187.13	19.77	275.94
Maize Sole	150.90	7.25	0.34	0.59	189.17	19.86	277.2
SEm±	9.23	0.08	0.03	0.02	7.72	1.04	21.48
LSD (P= 0.05)	27.09	NS	NS	NS	NS	NS	NS

OC=Organic carbon.

lakh/ha) with B:C ratio (Rs. 5.26) and economic efficiency (Rs. 2471/ha/day), followed by NBH intercropped with cowpea. This is might be due to dual purpose potential of crop which generated good amount monetary value through baby cob as well as green biomass yield. Similar findings were reported by Verma *et al.* (2005); Birader *et al*. (2014) and Dar *et al*. (2014).

The highest nitrogen uptake was recorded in NBH + cowpea intercropping (231.3 kg/ha), followed by guinea grass + cowpea (193.1 kg/ha). However, the lowest uptake was observed in sole baby corn crop (93.5 kg/ha). Similar findings was obtained by Adhikari *et al.* (2005) and Sarjerao *et al.* (2014) in maize + cowpea intercropping system. The pH and electrical conductivity (EC) of soil did not differ under different treatments after harvesting of the crops (Table 5). Organic carbon and primary nutrient content (N, P and K) of soil were observed statistically non-significant but all the treatments were declined compare to initials value. The lower value of all the available nutrients compare to initials data showed the mining of nutrients from soil. Comparisons between treatments it was showed that highest mining of N, P and K nutrients were observed in sole NBH cultivation, while lowest was observed in sole cowpea cultivation. This might be due to dense root system and high biomass producing potentials of NBH it became more nutrient exhaustive compare to other fodder crops. Aulakh *et al.* (2012) revealed that performance of different cropping systems did not differ significantly in respect of soil pH, organic carbon, available nitrogen, phosphorus and potassium. Sathiya, (2017) revealed that the nutrient uptake pattern of Napier hybrid grass indicated that N, P and K along with micronutrients were removed heavily from the soil and led to mine of nutrients from the soil.

CONCLUSION

For higher economic efficiency and income generation with in short period's baby corn cultivation could be a best option. But for running the dairy enterprises supply of quality green fodder in a continuous manner with low maintenance cost and high profitability growing of NBH grass with cowpea would be better option to others treatments. Therefore, earning of more profit from dairy enterprises it may be advised to a farmer to grow combination of NBH + cowpea intercropping system for more feasible, low maintenance, high productivity and continuous supply of quality green fodder.

ACKNOWLEDGEMENT

The authors are obliged to Director, ICAR-NDRI, Karnal for providing necessary facilities and financial assistance for carrying out this study.

REFERENCES

Adhikari, S., Chakraborty, T. and Bagchi, D.K. (2005). Bio-economic evaluation of maize (*Zea mays*) and groundnut (*Arachis hypogaea*) intercropping in drought-prone areas of Chotonagpur plateau region of Jharkhand. *Indian Journal of Agronomy*. **50**(2): 113-115.

Anita, M.R., Lakshmi, S. and Rani, T.S. (2015). Effects of row ratios of grass fodder cowpea mixtures on the yield and quality of forages. *International Journal of Forestry and Crop Improvement*. **6**(2): 85-89.

Annual Report, (2016-17). ICAR-Indian Grassland and Fodder Research Institute, Jhansi, India. 1-137.

Aulakh, C.S., Gill, M. S., Mahey, R. K., Walia, S.S. and Singh, G. (2012). Effect of nutrient sources on productivity of fodder cropping systems in Punjab. *Indian Journal of Agronomy*. **57**(2): 200-205.

Baghdadi, A., Ridzwan, A.H., Ghasemzadeh, A., Ebrahimi, M., Othman, R. and Yusof, M.M. (2016). Effect of intercropping of corn and soybean on dry matter yield and nutritive value of forage corn. *Legume Research*. **39**(6): 976-981.

Biradar, S.A., Shreedhar, J. N. and Ubhale, P. (2014). Economics and varietal performance of Hybrid Napier and guinea grass under irrigated conditions of northern Karnataka. *Forage Research*. **40**(2): 95-97.

Dar, E.A., Harika, A.S., Tomar, S.K.,Tyagi, A.K. and Datta, A. (2014). Effect of crop geometry and nitrogen levels on quality of baby corn (*Zea mays* L.) as fodder. *Indian Journal of Animal Nutrition*. **31**(1): 60-64.

Gomez, K.A. and Gomez, A.A. (1984). Statistical Procedure for Agricultural Research. Willey-*Int. Sci. Pub*., New York, USA.

Halli, H.M., Rathore, S.S., Manjunatha, N. and Wasnik, V.K. (2018). Advances in agronomic management for ensuring fodder security in semi-arid zones of India- A *International Journal of Current Microbiology and Applied Sciences.* **7**(2): 1912-1921.

Hindoriya, P.S., Meena, R.K., Singh, M., Kumar, R., Ram, H., Meena, V.K. and Kushwaha, M. (2019). Evaluation of *kharif* forage crops for biomass production and nutritional parameters in Indo-Gangetic Plains of India. *Indian Journal of Animal Nutrition.* **36** (1): 25-29.

Hofer, J.M., Gourlay, C.W. and Ellis, T.N. (2001). Genetic control of leaf morphology: a partial view. *Annals of Botany.* **88**(6): 1129 -1139.

Johnson, K. and Lenhard, M. (2011). Genetic control of plant organ growth. *New Phytologist.* **191**(2): 319-333.

Makkar, H.P.S. (2016). Animal nutrition in a 360-degree view and a framework for future R&D work: towards sustainable livestock production. *Animal Production Science.* **56**(10): 1561–1568

Meena, A.K., Singh, P. and Kanwar, P. (2012). Effect of nitrogen levels on yield and quality of [*Sorghum bicolor* (L.) Moench] sorghum genotypes. *Forage Research.* **37**(4): 238-240.

Rana, D.S., Singh, B., Gupta, K., Dhaka, A.K. and Pahuja, S.K. (2013). Effect of fertility levels on growth, yield and quality of multicut forage sorghum [*Sorghum bicolor* (L.) Moench] genotypes. *Forage Research.* **39**: 36-38.

Sarjerao, D.A. (2014). Intercropping of Maize *(Zea mays* L.*)+Cowpea (Vigna unguiculata)* for higher production of green fodder (Doctoral dissertation, MPKV, University Library Rahuri).

Strydhorst, S.M., King, J.R., Lopetinsky, K.J. and Harker, K.N. (2008). Forage potential of intercropping barley with fababean, lupin, or field pea. *Agronomy Journal.* **100**(1): 182-190.

Surve, V.H., Patil, P.R. and Arvadia, M.K. (2011). Performance of fodder based intercropping of sorghum, maize and cowpea under different row ratio. *Agricultural Science Digest.* **32**(4): 336-339.

Tamta, A., Kumar, R., Ram, H., Meena, R.K., Meena, V.K., Yadav, M.R. and Subrahmanya, D.J., (2019). Productivity and profitability of legume-cereal forages under different planting ratio and nitrogen fertilization. *Legume Research-An International Journal.* **42**(1): 102-107.

Verma, A.K. and Dadheech, R.C. (2005). Yield and economics of fodder oat as influenced by balanced fertilization and legume mixture. *Forage Research.* **31**: 73-74.

Zhang, G.G., Yang, Z.B., Dong, S.T. (2011). Interspecific competitiveness affects the total biomass yield in an alfalfa and corn intercropping system. *Field Crop Research.* **124**: 66-73.