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COMPARATIVE STUDIES ON EFFECT OF DIFFERENT FORAGE BASED CROPPING SEQUENCES ON DRY MATTER AND CRUDE PROTEIN

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SUMMARY

The experiment was conducted during 2016-17 at Crop Research Centre of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (U.P.) to evaluate the effect of different forage based cropping sequences on total dry matter yield, crude protein content and protein yield. The field experiment was consisted of six treatments as cropping sequences and they were tested in Randomized Block Design with four replications *viz.* Sorghum (F)–Berseem- Maize (F)+Cowpea (F), Sorghum (F)+Guar (F)-Oat (F)-Maize (F)-Cowpea (F), Sorghum (F)+Cowpea (F)-Barley (F)-Maize (F)+Cowpea (F), Rice-Wheat-Maize (F)+Cowpea (F), Rice–Berseem-Sorghum (F), Sorghum (F)+Cowpea (F)–Wheat-Sorghum (F)+Cowpea (F). Among six crop sequences tested total dry matter yield was found maximum under Sorghum (F)–Berseem-Maize (F)+Cowpea (F) (420.60 q/ha) which was recorded in treatment T_1 and minimum dry matter yield was found in crop sequence Sorghum (F)+Cowpea (F)–Wheat-Sorghum (F)+Cowpea (F) (250.66 q/ha) which was obtained in the treatment T_6. Total protein yield was recorded highest in crop sequence of Sorghum (F)-Berseem- Maize (F)+Cowpea (F) (38.40 q/ha) which was recorded in crop sequence T_1, whereas lowest in Sorghum (F)+Cowpea (F)–Barley (F)-Maize (F)+Cowpea (F) (19.40 q/ha) was recorded in the crop sequence T_3.

Key words: Cropping sequences, protein content, dry matter

Livestock population is the largest in India comprising 182.50 million cattle, among these, 61.30 million buffaloes, 76.65 million goats, 41.30 million sheep, 10.0 million pigs and 3.04 million other animals. (Jat *et al*., 2014). India is having the largest livestock population, 15% of the world's livestock population (Neelar, 2011). Livestock contributing 7% to national GDP and source of employment and ultimate livelihood for 70% population in rural areas. Deficiency in feed and fodder has been identified as one of the major components in achieving the desired level of livestock production (Devi *et al.,* 2014). The patterns of deficit values are different in different parts of the country. At present, the country faces a net deficit of 63% green fodder, 24% dry crop residues and 64% feeds (Kumar *et al.,* 2012) as against the requirement of 1025, 570 and 123 million tonnes and state faces a deficit of 46.5, 32.4 and 69.3% green fodder, dry fodder and concentrates, respectively as against the requirement of 313, 62.6 and 14.3 million tonnes, respectively for current livestock population. The deficit and supply in crude protein (CP) and total digestible nutrient (TDN) are 34.18 and 262.02 million tonnes as against the 47.76 and 344.93 million tonnes in India, which is not economical to transport over long distances. It reveals a huge deficit of green fodder prevailing 390 million tonnes and is expected to raise 1025 million tonnes (MOA, 2011). The productivity of our livestock often remains low due to inadequate and nutritionally unbalanced supply of feed and fodder.

The data/estimates of fodder production in the country vary widely. Fodder production and its utilization depend on the cropping pattern, climate, socio-economic conditions and type of livestock. The cattle are normally fed on the fodder available from cultivated areas, supplemented to a small extent by harvested grasses and top feeds. The three major sources of fodder supply are crop residues, cultivated fodder and fodder from common land resources like forests, permanent pastures and grazing lands. The situation is further aggravated due to increasing growth of livestock particularly that of genetically upgraded animals. The available forages are poor in quality, being deficient in available energy, protein and minerals. To compensate for the low productivity of the livestock, farmers maintain a large herd of animals, which adds to the pressure on the land and fodder resources.

India is one of the agricultural country where livestock plays an important role in its economy. Indian agriculture is oriented towards mixed farming in which livestock rearing forms an integral part of rural living. Livestock are not only looked for their role in providing livestock products (milk, meat, wool) for human food and their needs, but also as a major energy source of draft power in agricultural operations. The principal use of forages is as feed for livestock. Forages provide approximately 80% of all the feed units consumed by livestock. Livestock productivity directly depends upon the nutritious, balanced and adequate feeding. Some of major feed resources are the herbages from cultivated forages, grazing materials from grasslands and crop residues/by products i.e., straw, karbi etc.

Since area under cultivated forages cannot be increased, however, the possibilities exist for improved land productivity through appropriate management practices. The heavy livestock pressure on the limited land resources in the country calls for increasing the fodder production. The area under cultivated fodder is 8.33 million hectares (2.9% of total geographical area) which is not going to increase tangibly, rather it may decrease due to competition with other agriculture crops and mounting pressure and preferential need for food crops (Singhal and Rai 2001).

MATERIALS AND METHODS

The field experiment was conducted for one year during 2016-17 at Crop Research Centre of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (90^0 04' N latitude and 77^0 42' E longitude and 237 meter above mean sea level) located in western part of Uttar Pradesh (India). The experimental soil was sandy loam with pH 7.8 and low organic carbon content (0.42). Available nitrogen, phosphorus and potash of surface soil was 205.00, 12.50 and 170.50 kg/ha, indicating low nitrogen content and medium in phosphorus and potassium in experimental soil. The experiment comprised of seven crop sequences viz., Sorghum(F) – Berseem - Maize(F) + Cowpea(F), Sorghum(F) + Guar(F) - Oat(F) - Maize(F) + Cowpea(F), Sorghum(F) + Cowpea(F)-Barley(F)-Maize(F) + Cowpea(F), Rice - Wheat - Maize(F) + Cowpea(F), Rice – Berseem - Sorghum(F), Sorghum(F) + Cowpea(F) - Wheat - Sorghum(F) + Cowpea(F) was conducted in randomized block design with four replications. The variety used for rice was 'Pusa Basmati-1', sorghum 'Pant Chari (single cut)', guar 'Cluster bean-1', cowpea 'EC 4216' during *kharif*, wheat 'PBW 343', berseem 'Berseem Ludhiana-10', oat 'Kent', barley 'Azad Barley' during *rabi,* maize 'Meerut local', cowpea 'EC 4216', sorghum 'Pant chari (single cut)' during *summer* respectively. The data so obtained on various parameters were analysed as per standard statistical procedures. The crude protein content was determined using Kjeldhal Method.

RESULTS AND DISCUSSION

Total dry matter yield

The data pertaining to total dry matter yield are presented in Table 1. In *Kharif* season the highest dry matter yield (167.30 q ha^{-1}) was recorded in T_1 *i.e.* Sorghum(F)–Berseem-Maize(F)+ Cowpea(F), which was significantly superior than all the treatments and the lowest dry matter yield (77.90 q ha^{-1}) was recorded in the crop sequence T_6 *i.e.* Sorghum(F)+Cowpea(F)-Wheat-Sorghum(F)+Cowpea(F). The treatmentT_2–Sorghum(F)+Guar(F)-Oat(F)-Maize(F)-Cowpea(F) (82.90 q ha^{-1}), T_3–Sorghum(F)+Cowpea(F)-Barley(F)-Maize(F)+Cowpea(F) (78.90 q ha^{-1}) and T_6–Sorghum(F)+Cowpea(F)-Wheat-Sorghum(F)+Cowpea(F) (77.90 q ha^{-1}) was at par to each other. In *Rabi* season the highest dry matter yield (152.70 q ha^{-1}) was recorded in T_1 *i.e.* Sorghum(F)–Berseem-Maize(F)+Cowpea(F), which was at par to treatment T_5-Rice-Berseem-Sorghum(F) (148.20 q ha^{-1}). The treatment T_5-Rice-Berseem-Sorghum(F) (148.20 q ha^{-1}) and T_2–Sorghum(F)+Guar(F)-Oat(F)-Maize(F)-Cowpea(F) (139.60 q ha^{-1}year^{-1}) was at par to each other. The minimum dry matter yield (74.20 q ha^{-1}) was recorded in T_3 *i.e.* Sorghum(F)+Cowpea(F)-Barley(F)-Maize(F)+Cowpea(F). In *Summer* season the highest dry matter yield (158.24 q ha^{-1}) was recorded in T_5 *i.e.* Rice-Berseem–Sorghum (F), which was significantly superior than all the treatments. The lowest dry matter yield (82.40 q ha^{-1}) was recorded in T_6 *i.e.* Sorghum(F)+Cowpea(F)-Wheat-Sorghum(F)+Cowpea(F). Among all the tested cropping sequences the highest dry matter yield (420.60 q ha^{-1}year^{-1}) was recorded in treatment T_1 *i.e.* Sorghum(F)–Berseem-Maize(F)+Cowpea(F), which is significantly higher than other treatments. The lowest dry matter yield (250.66 q ha^{-1}year^{-1}) was obtained in the treatment T_6 *i.e.* Sorghum(F)+Cowpea(F)–Wheat-Sorghum(F)+Cowpea(F). In total dry matter yield the treatment T_1 *i.e.* Sorghum (F)-Berseem-Maize(F)+Cowpea(F) recorded best due to higher photosynthesis and growth rate, similar findings was also reported by Iqbal *et al.,* 2012 and Pachauri *et al.,* 2020.

TABLE 1
Effect of different forage based cropping sequences on total dry matter yield (q/ha/year)

Treatments	Dry matter yield (q/ha)			Total dry matter yield (q/ha)
	Kharif	*Rabi*	*Summer*	
T_1–Sorghum(F)-Berseem-Maize(F)+Cowpea(F)	167.30	152.70	100.60	420.60
T_2–Sorghum(F)+Guar(F)-Oat(F)- Maize(F)+Cowpea(F)	82.90	139.60	99.27	321.77
T_3–Sorghum(F)+Cowpea(F)-Barley(F)- Maize(F)+Cowpea(F)	78.90	74.20	98.68	251.78
T_4–Rice-Wheat-Maize(F)+Cowpea(F)	101.35	85.41	102.00	288.76
T_5–Rice-Berseem-Sorghum(F)	104.80	148.20	158.24	411.24
T_6–Sorghum(F)+Cowpea(F)-Wheat-Sorghum(F)+Cowpea(F)				
S. Em±	3.95	4.92	3.36	13.39
C. D. (P=0.05)	12.62	15.71	10.73	42.76

Total protein yield

The data pertaining to total protein yield are presented in Table 2. In *Kharif* season the highest protein yield (8.46 q/ha/year) was recorded in treatment T_1 *i.e.* Sorghum (F)–Berseem-Maize (F)+Cowpea (F), which was at par to treatment T_2–Sorghum (F)+Guar (F)-Oat (F)- Maize (F)-Cowpea (F) (7.90 q/ha/year). The lowest protein yield (5.99 q/ha/year) was recorded in crop sequence T_5 *i.e.* Rice–Berseem-Sorghum (F), which was at par to crop sequence T_4–Rice–Wheat-Maize (F)+Cowpea (F) (6.10 q/ha/year). In *Rabi* season the highest protein yield (19.08 q/ha/year) was recorded in crop sequence T_1 *i.e.* Sorghum (F)–Berseem-Maize (F)+Cowpea (F), which was significantly superior than other treatments while the lowest protein yield (1.98 q/ha/year) was recorded in the crop sequence T_3 *i.e.* Sorghum (F)+Cowpea (F)-Barley (F)-Maize (F)+Cowpea (F). In *Summer* season the highest protein yield (10.86 q/ha/year) was recorded in crop sequence T_1 *i.e.* Sorghum (F)–Berseem-Maize (F)+ Cowpea (F), which was significantly superior than other treatments whereas the lowest protein yield (7.43 q/ha/year) was recorded in the crop sequence T_6 *i.e.* Sorghum (F)+Cowpea (F)– Wheat-Sorghum (F)+Cowpea (F), which was at par to crop sequence T_5–Rice–Berseem- Sorghum (F) (7.91 q/ha/year). Among all crop sequences under present investigation total protein yield (38.40 q/ha/ year) was recorded in crop sequence T_1 *i.e.* Sorghum (F)–Berseem-Maize (F)+Cowpea (F), which was significantly superior than other treatments. The second highest total protein yield was (32.79 q/ha/ year) recorded in the crop sequence T_2- Sorghum (F)+Guar (F)-Oat (F)-Maize (F)-Cowpea (F) which was at par to crop sequence T_5– Rice–Berseem-Sorghum (F) (32.42 q/ha/year). The lowest protein yield (19.40 q/ha/year) was recorded in the crop sequence T_3–Sorghum (F)+Cowpea (F)-Barley (F)-Maize (F)+Cowpea(F), which was at par to crop sequence T_6–Sorghum (F)+Cowpea (F)–Wheat - Sorghum (F)+Cowpea (F) (21.42 q/ha/year). The highest total protein yield was recorded in the treatment

TABLE 2
Effect of different forage based cropping sequence on crude protein content (%) and protein yield (q ha-1)

Treatments	Crude protein content (%)			Protein yield (q/ha)			Total protein yield (q/ha)
	Kharif	*Rabi*	*Summer*	*Kharif*	*Rabi*	*Summer*	
T_1–Sorghum(F)-Berseem- Maize(F)+Cowpea(F)	5.06	12.50	9.37	8.46	19.08	10.86	38.40
			13.12				
T_2–Sorghum(F)+Guar(F)-Oat(F)- Maize(F)+ Cowpea(F)	4.87	10.31	9.18	7.90	14.39	10.50	32.79
	15.00		12.50				
T_3–Sorghum(F)+Cowpea(F)- Barley(F)- Maize(F)+Cowpea(F)	5.00	2.68	8.93	7.30	1.98	10.12	19.40
	12.75		11.93				
T_4–Rice-Wheat-Maize(F)+Cowpea(F)	8.31	8.81	9.31	6.10	6.72	10.80	23.62
	4.25	4.87	13.06				
T_5–Rice-Berseem-Sorghum(F)	8.25	12.50	5.00	5.99	18.52	7.91	32.42
	4.12						
T_6–Sorghum(F)+Cowpea(F)- Wheat-Sorghum(F)+Cowpea(F)	4.93	8.68	5.00	7.32	6.67	7.43	21.42
	12.93	4.93	13.12	-	-	-	
S. Em±	0.24	0.26	0.33	0.22	0.00	0.33	0.87
C. D. (P=0.05)	0.79	0.85	1.08	0.73	0.01	1.07	2.78

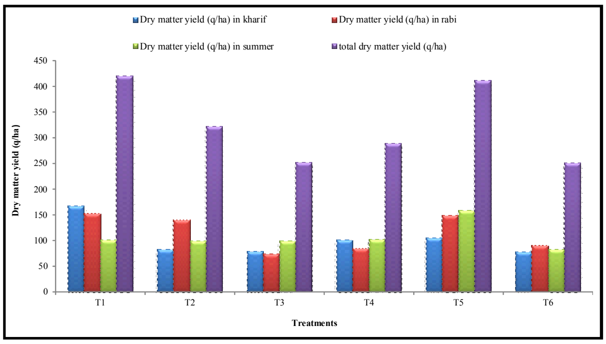

Fig. 1. Effect of different forage based cropping sequences on total dry matter yield (q/ha/1 year).

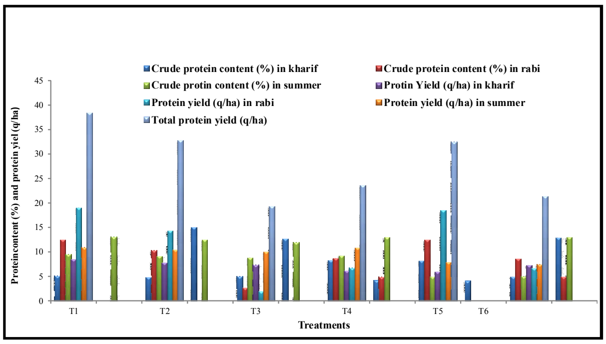

Fig. 2. Effect of different forage based cropping sequences on crude protein content (%) and protein yield (q/ha).

T_1 *i.e.* Sorghum (F)-Berseem-Maize (F)+Cowpea (F) due to high dry matter yield and more N content %. Nitrogen is an important constituent of protein. Through the assimilation process Nitrogen is first change in to amino acid then amino acid help in formation of protein, same result was also reported by Muhammad *et al.,* 2006 and Pachauri *et al.,* 2020.

CONCLUSION

On the basis of above results, it may be concluded that treatment T_1 Sorghum (F) – Berseem – Maize (F) + Cowpea (F) and T_5 Rice–Berseem-Sorghum (F) gave higher total dry matter and protein yield. So, treatment T_1 Sorghum (F)–Berseem–Maize (F) + Cowpea (F) will be suitable for farmers for cultivation in Western Plain Zone.

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