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Comparative studies of growth attributes and their economic feasibility in western zone of U.P.

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Abstract
The field experiments was conducted during 2016-17 at Crop Research Centre (Chirauri) of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (U.P.) to evaluate the comparative production potential of forage based cropping sequences and their economic feasibility in western plain zone of U.P. and chemical properties of soil. The experiment was conducted in randomized block design with replicated four times with 06 forage based cropping 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).
Among six crop sequences tested Sorghum (F) – Berseem - Maize (F) + Cowpea (F) cropping sequence led to record the maximum productivity (2019.57 q/ha/year) in terms of berseem equivalent yield as well as production efficiency of (8.20 q/ha/day). Rice – Wheat - Maize (F) + Cowpea (F) obtained minimum berseem equivalent yield (1136.71 q/ha/year) and production efficiency of (3.64 q/ha/year), but it recorded maximum (85.479%) land use efficiency. Sorghum (F) + Cowpea (F) - Barley (F) - Maize (F) + Cowpea (F) crop sequence registered minimum (58.082%) land use efficiency. Total dry matter yield was found maximum under Sorghum (F) – Berseem - Maize (F) + Cowpea (F) (420.60 q/ha) and minimum in crop sequence Sorghum (F) + Cowpea (F) – Wheat -Sorghum (F) + Cowpea (F) (250.66 q/ha). Total protein yield was recorded highest in crop sequence of Sorghum (F) - Berseem - Maize (F) + Cowpea (F) (38.40 q/ha) where as lowest in Sorghum (F) + Cowpea (F) – Barley (F) - Maize (F) + Cowpea (F) (19.40 q/ha) crop sequence. Crop sequence Sorghum (F) – Berseem - Maize (F) + Cowpea (F) recorded the maximum uptake of N (620.55 kg/ha) where as minimum uptake of N was noted with Sorghum (F) + Cowpea (F) - Wheat - Sorghum (F) + Cowpea (F) (283.68 kg/ha). Total uptake of P was noticed maximum in Rice – Berseem – Sorghum (F) (144.24 kg/ha) and minimum in Sorghum (F) + Guar (F) – Oat (F) – Maize (F) + Cowpea (F) crop sequence (52.12 kg/ha). Uptake of K was highest in Sorghum (F) –Berseem - Maize (F) + Cowpea (F) (608.68 kg/ha) and lowest in Sorghum (F) + Cowpea (F) – Wheat – Sorghum (F) + Cowpea (F) (253.50 kg/ha).

Keywords: Cropping sequences and economic feasibility

Introduction
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) [2]. India is having the largest livestock population, 15% of the world's livestock population (Neelar, 2011) [6]. 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) [1]. 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) [4] 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 MT and is expected to rise 1025 MT (MOA, 2011) [5]. The productivity of our livestock often remains low due to inadequate and nutritionally unbalanced supply of feed and fodder.
India is one of the agricultural country where livestock plays an important role in it's 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.

Therefore, there is need for increasing forage production within existing farming system and utilization of marginal, sub marginal dry lands and problem soils for developing need for fodder resources in order to get year round forage and economise livestock feeding management. An integral approach of food-fodder production aims at obtaining food as well as fodder concurrently from the same piece of land. In view of this it would be desirable it a more profitable and economically viable sequence could be introduced under western Uttar Pradesh situation for long term productivity and sustainability of the system.

Materials and Methods

The experiment was conducted at Crop Research Centre of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (U.P.) during 20016-17. Meerut is located on the Delhi-Dehradun highway. Geographically it is located at 90^0 04, N latitude and 77^0 42 'E longitude at an altitude of 237 meters above the mean sea level. The soil of experimental field was low in available nitrogen (205 kg/ha) having organic carbon content (0.42%), medium in available phosphorus (12.50 kg/ha) and high in potassium (170.50 kg/ha). The reaction of the soil was slightly alkaline (7.8). The experimental soil was sandy loam in texture. The field experiment was consisted of 6 treatments as cropping sequences and they were tested in randomized block design with 4 replications. Cowpea was used as intercrop in maize and forage sorghum and it was harvested as fodder when the cutting/harvesting of main crop was done. After threshing the plot wise grain produce of each crop was separated from the chaffs manually by using hand fan (supa). Finally, plot wise weight of clean grains obtained from each crop was recorded on double pan balance.

Results and Discussion

No. of shoots/meter row length

The highest number of fodder sorghum shoots/meter row length (41.05) in *kharif* season were observed in T_1 i.e. Sorghum (F) – Berseem - Maize (F) + Cowpea (F) and the lowest (38.42) in T6 i.e. Sorghum (F) + Cowpea (F) – Wheat – Sorghum (F) + Cowpea (F), though the number of shoots/meter row length did not differ significantly in T_1 i.e. Sorghum (F) – Berseem – Maize (F) + Cowpea (F), T_2- Sorghum (F) + Guar (F) - Oat (F) - Maize (F) + Cowpea (F) (39.54), T_3– Sorghum (F) + Cowpea (F)-Barley (F) - Maize (F) + Cowpea (F) (40.10) and T_6 - Sorghum (F) + Cowpea (F)–Wheat-Sorghum (F) + Cowpea (F) (38.42).

During *rabi* season higher (28.36) number of shoots/meter row length were recorded in berseem in T_5 i.e. Rice – Berseem – Sorghum (F) than in T_1- Sorghum (F) - Berseem - Maize (F) + Cowpea (F) (25.86). Similarly the more number of shoots/meter row length in wheat (36.26) were recorded in T_4 – Rice - Wheat – Maize (F) + Cowpea (F) than Sorghum (F) + Cowpea (F) – Wheat – Sorghum (F) + Cowpea (F).

During *summer* season highest number of shoots/meter row length (42.10) in fodder maize were recorded in T_1 i.e. Sorghum (F) – Berseem – Maize (F) + Cowpea (F) followed by T_4 – Rice - Wheat – Maize (F) + Cowpea (F) (42.0), T_2 – Sorghum (F) + Guar (F) – Oat (F) – Maize (F) + Cowpea (F) (41.31) and T_3 – Sorghum (F) + Cowpea (F) – Barley (F) – Maize (F) + Cowpea (F) (40.24). Though they were not differ significantly with each other. In fodder cowpea the highest (12.24) number of shoots/meter row length were observed in T_6 – Sorghum (F) + Cowpea (F) – Wheat – Sorghum (F) + Cowpea (F) where fodder cowpea was grown as mixed crop with fodder sorghum in *summer* after fodder sorghum and fodder cowpea grown in association in *kharif* and wheat as sole crop in *rabi* followed by T_1 i.e. Sorghum (F) – Berseem – Maize (F) + Cowpea (F) (11.80), T_2 – Sorghum (F) + Guar (F) – Oat (F) – Maize (F) + Cowpea (F) (11.80) and T_4 – Rice - Wheat – Maize (F) + Cowpea (F) (11.42) and the lowest number (10.94) in T_3 – Sorghum (F) + Cowpea (F) – Barley (F) – Maize (F) + Cowpea (F).

Berseem equivalent yield (BEY)

The data pertaining to berseem forage equivalent yields are presented in Table 1.

In *kharif* the highest green forage yield (604.20 q ha^{-1}) was recorded in treatment T_2 i.e. Sorghum (F) + Guar (F) - Oat (F) - Maize (F) - Cowpea (F), which is at par to T_3 i.e. Sorghum (F) + Cowpea (F) - Barley (F) - Maize (F) + Cowpea (F) (565.30 q ha^{-1}) is also at par with T_2 crop sequence. The minimum green forage yield (484.60 q ha^{-1}) was recorded in T_1 i.e. Sorghum (F) – Berseem - Maize (F) + Cowpea (F) crop sequence. The crop sequence T_3 i.e. Sorghum (F) + Cowpea (F) - Barley (F) - Maize (F) + Cowpea (F) (565.30 q ha^{-1}) is the second highest in green forage yield, which is at par to T_6 - Sorghum (F) + Cowpea (F) – Wheat - Sorghum (F) + Cowpea (F) (530.47 q ha^{-1}) crop sequence. The rice grain yield was (43.67 q ha^{-1}) highest in the treatment T_5 – Rice – Berseem - Sorghum (F) than treatment T_4 – Rice - Wheat - Maize (F) + Cowpea (F) (42.23 q ha^{-1}).

In *rabi* season the highest green forage yield (1073.80 q ha^{-1}) was recorded in the crop sequence T_1 i.e. Sorghum (F) – Berseem - Maize (F) + Cowpea (F), which is significantly superior over all the cropping sequences. The lowest green forage yield (255.80 q ha^{-1}) was recorded in T_3 i.e. Sorghum (F) + Cowpea (F) - Barley (F) - Maize (F) + Cowpea (F) crop sequence. The treatment T_5 – Rice – Berseem - Sorghum (F) produced higher (998.30 q ha^{-1}) green forage yield, which is significantly higher than all the treatments except T_1 i.e. Sorghum (F) – Berseem - Maize (F) + Cowpea (F). The grain yield of wheat was higher (37.65 q ha^{-1}) in treatment T_6 - Sorghum (F) + Cowpea (F) – Wheat - Sorghum (F) + Cowpea (F) than reatment T_4 – Rice - Wheat - Maize (F) + Cowpea (F) (35.59 q ha^{-1}).

In *summer* season highest green forage yield (548.40 q ha^{-1}) was recorded in the crop sequence T_6 i.e. Sorghum (F) + Cowpea (F) – Wheat - Sorghum (F) + Cowpea (F), which was significantly superior to all over treatments. The treatment T_2 i.e. Sorghum (F) + Guar (F) - Oat (F) - Maize (F) - Cowpea (F) (493.50 q ha^{-1}) was recorded second highest green forage yield, which is at par to crop sequence T_5 i.e. Rice – Berseem - Sorghum (F) (472.40 q ha^{-1}). The minimum green forage yield (401.80 q ha^{-1}) was observed in crop sequence T_3 i.e. Sorghum (F) + Cowpea (F) - Barley (F) - Maize (F) + Cowpea (F). The crop sequence T_5 i.e. Rice – Berseem - Sorghum (F) (472.40 q ha^{-1}) was at par to crop sequence T_1 i.e. Sorghum (F) – Berseem - Maize (F) + Cowpea (F) (461.17 q ha^{-1}).

Based on the results (Table 2) Sorghum (F) – Berseem - Maize (F) + Cowpea (F) produced maximum berseem equivalent yield (2019.57 q ha^{-1}) among all the crop sequences followed by Rice – Berseem - Sorghum (F) (1907.40 q ha^{-1}). Similar results were also reported by Singh (2008) [7]. Total productivity was higher where berseem was integrated in *rabi* and sorghum grown for forage in *kharif* and maize + cowpea for forage in *summer* season. Rice – wheat – maize + cowpea could not bring the yield advantages in forage equivalent yield when compared with other cropping sequences. This indicates forage based production systems edge over rice based production cropping systems (Kumar *et al*., 2009) [3]. Tables

Table 1: Effect of different forage based cropping sequences on no. of shoots per meter row length at 30 DAS

Treatments	No. of shoots per meter row length at 30 DAS		
	kharif	***rabi***	**summer**
T_1 – Sorghum (F)-Berseem- Maize (F)+ Cowpea (F)	41.05	25.86	42.10
			11.80
T_2 – Sorghum (F)+Guar (F)-Oat (F)- Maize (F)+ Cowpea (F)	39.54	50.60	41.31
	20.24		11.80
T_3 – Sorghum (F)+Cowpea (F)-Barley (F)-Maize (F)+Cowpea (F)	40.10	28.36	40.24
	12.20		10.94
T_4 - Rice-Wheat-Maize (F)+Cowpea (F)	29.80	36.26	42.00
			11.42
T_5 - Rice-Berseem-Sorghum (F)	29.50	28.36	46.50
T_6 – Sorghum (F)+Cowpea (F)-Wheat-Sorghum (F)+Cowpea (F)	38.42	35.29	47.40
	11.54		12.24
SEm±	1.08	1.14	1.20
CD at 5%	3.27	3.63	3.56

Table 2: Effect of different forage based cropping sequences on berseem equivalent yield (q $ha^{-1}year^{-1}$)

Treatments	Green forage yield (q ha^{-1})			Berseem equivalent yield (q ha^{-1})
	kharif	***rabi***	**summer**	
T_1 – Sorghum (F)-Berseem-Maize (F)+Cowpea (F)	484.60	1073.80	461.17	2019.57
T_2 – Sorghum (F)+Guar (F)-Oat (F)-Maize (F)+Cowpea (F)	604.20	492.80	493.50	1590.50
T_3 – Sorghum (F)+Cowpea (F)-Barley (F)-Maize (F)+Cowpea (F)	565.30	255.80	401.80	1222.90
T_4 - Rice-Wheat-Maize (F)+Cowpea (F)	42.23*	35.59*	425.25	1136.71
T_5 - Rice-Berseem-Sorghum (F)	43.67*	998.30	472.40	1907.40
T_6 – Sorghum (F)+Cowpea (F)-Wheat-Sorghum (F)+Cowpea (F)	530.47	37.65*	548.40	1384.77
SEm±	13.21	16.55	14.70	54.024
CD at 5%	42.16	52.83	46.91	172.432

*Grain yield

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