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Studies on Fodder Based Intercropping Systems Under Southern Rajasthan Conditions

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A field experiment revealed that among sorghum and maize based intercropping systems, sorghum + cowpea in 2:1 row proportion produced significantly higher green fodder yield, dry matter production at harvest, N and P uptake, and fodder quality components (crud protein, ether extract, crude fibre, and mineral matter) while sorghum + clusterbean in 2:1 row proportion gave significantly higher LAI and LER over sole treatments. Maize intercropped with cowpea in 2:1 row ratio had significantly higher total digestible nutrients (TDN) over sole treatments.

Key words: LAI, LER, dry matter production, green fodder yield, inter cropping

In Indian agriculture, animal husbandry is closely linked with crop production programme as a complementary enterprise. On one hand, forage crops are of prime importance for economic feeding of the animals and on another hand, the livestock through supply of organic manures and draft power helps in balanced growth of crops. Our country support nearly 20 per cent of the world's livestock and 16.8 per cent population with only 2.3 per cent of the world's geographical area. India is leading in cattle (16 percent) and buffalo (55 per cent) population and has world's second largest in goat (20 per cent) and forth largest in sheep (5 per cent) population. The livestock contributes 32 per cent of the agriculture output, which is 27 per cent of total GDP. It also provides 70 per cent employment in rural areas (Anon., 2008).To explore livestock to their full potential, it is necessary that they should be supplied with nutritious fodder in sufficient amount. Three major sources of fodder supply are crop residue, cultivated fodder and fodder from common property resources. The projected shortage of dry fodder and concentrates are 21.8, 61.5 and 47.1 per cent compared with the requirement of 560, 1006 and 79.4 million tones, respectively for the current livestock population (Anon., 2008). Therefore, to fulfill the supply, there is a need to boost the production of green and dry fodder yields. There is a scarcity of fodder through out the country and particularly in NW India; hence certain efforts are needed to increase the production of fodder crops. Sorghum (*Sorghum bicolor L.*), maize (*Zea mays L.*), cow pea (*Vigna unguiculata L.*) and cluster bean (*Cyamopsis tetragonoloba L. Taub.*) have a greater scope as fodder crops in the region. These fodder crops have a prime role in food, feed, fodder and ration for humanity, cattle and poultry widely grown for grain and fodder owing to its ability to grow under varying soil and agro climatic situations. As fodder these are fast growing, palatable and nutritious. It can be utilized as hay and silage besides fresh feeding. Growing maize and sorghum for green forage and inclusion of legume component with these cereals have been advocated beneficial. Thus, there is a need to evaluate appropriate planting system either through cross sowing or line sowing in different proportion of cereals and legumes so as to maximize yield and quality of green fodder. Intercropping of legumes with cereals like sorghum or maize economizes the use of nitrogen fertilizer and increased the production per unit area and quality of forage sorghum. The higher green fodder and dry matter yield with the intercropping of sorghum with cowpea may be attributed to complementary effect of cowpea which supplemented nitrogen to sorghum and better utilization of environment resources by sorghum + cowpea system (Sood and Sharma,1992). The present investigation was therefore, carried out with a view to study the effect of intercropping and mixed cropping on forage yield and quality of fodder having different morphological characteristics.

Materials and Methods

A field experiment was conducted during *Kharif* 2010 at Rajasthan College of Agriculture, MPUAT, Udaipur, (Rajasthan). The farm is located at an altitude of 579.5 m above mean sea level at 24^{o} 35' N latitude and 73^{o} 42' E longitudes. The soil of experimental field was clay loam in texture, slightly alkaline in reaction (pH 7.7), low in available nitrogen (265 kg ha^{-1}), medium in available phosphorus (26 kg ha^{-1}) and high in available potassium (460 kg ha^{-1}), with bulk density 1.48 g/cc and particle density 2.68 gm/ cc. The experiment consisted of 16 treatments *i.e.* T_1 : Sorghum (sole cropping), T_2 : Maize (sole cropping), T_3 : Cowpea (sole cropping), T_4 : Clusterbean (sole cropping), T_5: Sorghum + Cowpea (Intercropping 1 : 1 Row proportion), T_6 : Sorghum + Clusterbean (Intercropping 1 : 1 Row

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proportion), T_7 : Maize + Cowpea (Intercropping 1 : 1 Row proportion), T_8 : Maize + Clusterbean (Intercropping 1 : 1 Row proportion), T_9 : Sorghum + Cowpea (Intercropping 2 : 1 Row proportion), T_{10} : Sorghum + Clusterbean (Intercropping 2 : 1 Row proportion), T_{11} : Maize + Cowpea (Intercropping 2 : 1 Row proportion), T_{12} : Maize + Clusterbean (Intercropping 2 : 1 Row proportion), T_{13} : Sorghum + Cowpea (Intercropping 3 : 1 Row proportion), T_{14} : Sorghum + Clusterbean (Intercropping 3 : 1 Row proportion), T_{15}: Maize + Cowpea (Intercropping 3 : 1 Row proportion), T_{16}: Maize + Clusterbean (Intercropping 3 : 1 Row proportion). Varieties used were; Sorghum: Pratap Chari 1080; Maize: Pratap Chari 6; Cowpea: GFC- 2 and Cluster bean RGC 936. Crops were fertilized at recommended doses of nitrogen and phosphorus accordingly: sorghum (80+40 kg N: P_2O_5 ha^{-1}); Maize (80 kg N + 40 kg P_2O_5 ha^{-1}), Cowpea and cluster bean (20: 40 kg N + P_2O_5 ha^{-1}, each). Full dose of phosphorus and half dose of nitrogen were applied at the time of sowing through urea and DAP as a basal application, quantity of nitrogen supplied through DAP was adjusted with urea. The remaining dose of nitrogen was top dressed in rows of sorghum and maize at 30 DAS. Cowpea and clusterbean were fertilized with full dose of N at sowing. The crops were sown on 13th July, 2010 keeping row to row and plant to plant distance as 30 and 10 cm as per treatments, respectively. Seed rate for each intercropping system was calculated on the basis of ratio indicating the number of rows of each component. Total rainfall received during crop growing season was 638.0 mm. Crops were harvested at 70 DAS on 20th September 2010 for green fodder. Fodder samples from each plot were collected for dry fodder yield and analysis of quality parameters.

Results and Discussion

The data revealed that among sorghum based intercropping systems, the tallest plants of sorghum (291 cm) were observed when sorghum was intercropped with cowpea in 1:1 row ratio (T_5) followed by sorghum + cluster bean (1:1) row ratio (Table 1). All intercropping systems in different row proportion (1:1, 2:1, 3:1) tended to increase plant height over sole sorghum. In sorghum and maize intercropping systems, Significantly higher LAI (7.10 and 4.37) of these crops were recorded under sorghum / maize + clusterbean 2:1 row ratios. Higher LAI of intercrops *viz*. cowpea and cluster bean was recorded in 2:1 row proportion than sole legumes and 1:1 and 3:1 row proportions. Higher LAI of cowpea (2.92) was recorded when it was taken as an intercrop with sorghum (2:1) and that of cluster bean (1.92) when it was intercropped with maize (2:1). Sorghum intercropping with cluster bean in 2 : 1 row proportion (T_{10}) resulted in maximum LER (1.57), which was at par to that of all 1:1 and 2:1 row proportions of sorghum and maize based intercropping systems and superior over sole cropping and 3:1 intercropping system.

Table 1. Effect of fodder based sorghum and maize intercropping and planting system on plant height, LAI and LER.

Treatment		Plant height (cm)				Leaf area index (LAI)				Land equivalent ratio (LER)				
		Sorghum	Maize	Cowpea	Cluster bean	Sorghum	Maize	Cowpea	Cluster bean	Sorghum	Maize	Cowpea	Cluster bean	Total
T_1	Sole	253	-	-	-	6.32	-	-	-	1.00	-	-	-	1.00
T_2	Sole	-	192	-	---	-	3.72	-	-	-	1.00	-	-	1.00
T_3	Sole	-	-	75	-	-	-	2.07	-	-	-	1.00	-	1.00
T_4	Sole	-	-	-	72	-	-	-	1.65	-	-	-	1.00	1.00
I_5	1:1	291	-	86	-	6.35	-	2.43	-	0.62	-	0.85	-	1.47
T_6	1:1	287	-	-	80	6.28	-	-	1.69	0.59	-	-	0.89	1.48
T_7	1:1	-	215	81	-	-	3.78	2.36	-	-	0.60	0.88	-	1.47
I_8	1:1	-	218	-	80	-	3.72	-	1.59	-	0.58	-	0.91	1.50
T_9	2:1	267	-	79	-	6.93	-	2.92	-	0.84	-	0.71	-	1.55
T_{10}	2:1	270	-	-	77	7.10	-	-	1.85	0.83	-	-	0.74	1.57
I_{11}	2:1	-	202	80	-	-	4.37	2.81	-	-	0.83	0.72	-	1.55
T_{12}	2:1	-	213	-	79	-	4.07	-	1.92	-	0.81	-	0.70	1.51
I_{13}	3:1	258	-	78	-	6.63	-	2.51	-	0.97	-	0.41	-	1.38
I_{14}	3:1	265	-	-	75	6.70	-	-	1.65	0.95	-	-	0.40	1.35
I_{15}	3:1	-	198	77	-	-	3.83	2.56	-	-	0.97	0.43	-	1.40
T_{16}	3:1	-	200	-	75	-	3.97	-	1.65	-	0.97	-	0.37	1.34
SEm ±			6		2		0.11		0.05					0.04
C.D.(p=0.05)			16		5		0.31		0.16					0.12

With regard to dry matter production, higher DMP was observed under maize + cowpea (2:1), sorghum + cowpea (2 : 1) and at 25 and 50 DAS and at harvest, The treatments T_9 and T_{10} *i.e.* sorghum + cowpea / cluster bean (2:1) row ratios recorded higher green fodder yield of 22.36, 24.74, 20.70 and 23.12 percent higher than sole sorghum and sole maize, respectively. The treatment T_9 remained at par with T_{10}, T_{11}, T_{13} and T_{15} in this respect. Significant variation existed between various intercropping systems and sole cropping in respect to N and P content and their uptakes, net returns and B:C ratio of fodder crops. 2:1 row ratio of sorghum + cowpea recorded higher N and P concentration (2.16 and 0.61 %, respectively) and total N and P uptake (119.6 kg N and 35.0 kg P_2O_5 ha^{-1}) and net monetary returns (Rs 29285 ha^{-1}) and B:C ratio (2.45). This treatment gave

Table 2. Effect of fodder based sorghum and maize intercropping and planting system on total dry matter production and green fodder yield.

Treatment		Dry matter production (gm^{-2})										Green fodder yield (tha^{-1})				
		At 50 DAS					At harvest									
		Sorghum	Maize	Cowpea	Cluster bean	Total	Sorghum	Maize	Cowpea	Cluster bean	Total	Sorghum	Maize	Cowpea	Cluster bean	Total
T_1	Sole	580	-	-	-	580	1020	-	-	-	1020	29.5	-	-	-	29.5
T_2	Sole	-	573	-	-	573	-	1002	-	-	1002	-	28.6	-	-	28.6
T_3	Sole	-	-	425	-	425	-	-	660	-	660	-	-	18.3	-	18.3
T_4	Sole	-	-	-	410	410	-	-	-	620	620	-	-	-	17.1	17.1
T_5	1:1	350	-	260	-	610	787	-	399	-	1186	18.5	-	15.5	-	34.0
T_6	1:1	342	-	-	260	602	770	-	-	398	1168	17.6	-	-	15.2	32.8
T_7	1:1	-	322	273	-	595	-	750	392	-	1142	-	17.2	16.0	-	33.2
T_8	1:1	-	320	-	263	583	-	758	-	380	1138	-	16.8	-	15.6	32.4
T_9	2:1	460	-	192	-	652	972	-	323	-	1295	25.0	-	13.0	-	38.0
T_{10}	2:1	450	-	-	192	642	955	-	-	325	1280	24.6	-	-	12.6	37.2
T_{11}	2:1	-	452	178	-	630	-	895	353	-	1248	-	23.8	13.0	-	36.8
T_{12}	2:1	-	438	-	180	618	-	884	-	362	1246	-	23.2	-	12.0	35.2
T_{13}	3:1	498	-	132	-	630	990	-	235	-	1225	28.7	-	7.5	-	36.2
T_{14}	3:1	506	-	-	115	621	973	-	-	225	1198	28.3	-	-	6.8	35.1
T_{15}	3:1	-	478	122	-	600	-	937	238	-	1175	-	27.9	7.8	-	35.7
T_{16}	3:1	-	485	-	123	608	-	930	-	230	1160	-	27.8	-	6.3	34.1
SEm ±						18					39					10
C.D.(p=0.05)						51					111					27

net profit of Rs. 11619, 13835, 18510 and 19710 Rs/ ha and B:C ratio of 0.97, 1.28, 1.56 and 1.64 over sole crops of sorghum, maize, cowpea and cluster bean, respectively. T_9 remained at par with T_{10} and T_{11} in case of net returns. Significant improvement in crude protein, crude fibre extract, and mineral matter production was realized under T_9 which was 33.9, 6.4, 34.1and 21.2 percent higher than sole sorghum, where as (T_{12}) maize + cluster bean (2:1) row ratios recorded significantly higher NFE and TDN production registering 35.92, 25.98, 50.18 and 17.90 percent higher over sole sorghum and sole maize, respectively.

The improvement in nutritional status of plant might have resulted in greater synthesis of amino acids, protein and other growth promoting substances which might have enhanced the meristematic activity and increased cell division and enlargement and their elongation resulting in higher plant height, dry

Table 3. Effect of fodder based sorghum and maize intercropping and planting system on nitrogen and phosphorus content (%) in plant and their uptake

Treat -ment		Nutrient content (%)		N uptake ($Kg\ ha^{-1}$)					P uptake ($Kg\ ha^{-1}$)					Available N($Kg\ ha^{-1}$)	Available P ($Kg\ ha^{-1}$)	Net return ($Rs\ ha^{-1}$)	B:C ratio
		N	P	Sorghum	Maize	Cow -pea	Cluster bean	Total	Sorghum	Maize	Cow -pea	Cluster bean	Total				
T_1	Sole	0.82	0.22	79.07	-	-	-	79.1	21.15	-	-	-	21.15	268.6	26.00	17666	1.48
T_2	Sole	0.72	0.17	-	68.20	-	-	68.2	-	16.36	-	-	16.36	269.7	25.87	15450	1.17
T_3	Sole	1.22	0.31	-	-	76.30	-	76.3	-	-	19.37	-	19.37	273.1	26.65	10775	0.89
T_4	Sole	1.12	0.21	-	-	-	65.44	65.4	-	-	-	12.30	12.30	274.4	26.49	9575	0.81
T_5	1:1	2.06	0.57	61.51	-	46.61	-	108.1	18.31	-	12.10	-	30.41	269.4	25.88	25905	2.16
T_6	1:1	1.96	0.45	59.94	-	-	42.91	102.9	16.70	-	-	8.41	25.11	264.5	25.45	24750	2.09
T_7	1:1	1.95	0.50	-	51.52	45.46	-	97	-	12.47	12.10	-	24.57	267.7	25.80	24605	1.95
T_8	1:1	1.86	0.39	-	51.12	-	41.05	92.2	-	12.14	-	8.03	20.17	263.2	25.46	23825	1.91
T_9	2:1	2.16	0.61	80.56	-	39.09	-	119.7	24.44	-	10.58	-	35.02	253.7	23.80	29285	2.45
T_{10}	2:1	2.05	0.54	78.28	-	-	36.26	114.5	23.73	-	-	8.59	32.32	255.0	24.48	28505	2.41
T_{11}	2:1	2.05	0.56	-	65.66	42.51	-	108.2	-	16.86	11.90	-	28.76	255.6	24.20	27261	2.12
T_{12}	2:1	1.94	0.47	-	63.08	-	40.81	103.9	-	15.85	-	9.49	25.34	256.2	24.32	25490	2.01
T_{13}	3:1	2.08	0.59	78.69	-	27.52	-	106.2	24.13	-	7.32	-	31.45	264.5	24.94	26135	2.19
T_{14}	3:1	1.96	0.51	75.76	-	-	24.24	100.0	23.61	-	-	5.32	28.94	267.7	25.37	24950	2.11
T_{15}	3:1	1.98	0.50	-	65.85	27.73	-	93.6	-	14.85	7.58	-	22.44	263.2	25.38	24768	1.92
T_{16}	3:1	1.88	0.42	-	64.90	-	24.87	89.8	-	14.62	-	5.43	20.05	263.5	25.51	22883	1.78
SEm ±		0.01	0.00					3.3					0.92	6.65	0.57	1030	0.08
C.D.(p=0.05)		0.03	0.01					9.4					2.64	NS	NS	2974	0.24

matter production and LAI. The improvement in morphological as well as photosynthetic parameters (leaves, stem girth, LAI and chlorophyll content) might have resulted in better interception and utilization of radiant energy leading towards higher photosynthesis and finally more accumulation of dry matter of individual plants. These results are in conformity with the findings of Singh *et.al* (2005) and Singh *et.al.*

Table 4. Effect of fodder based sorghum and maize intercropping and planting system on crude protein, crude fibre and crude fat production at harvest

	Treat-ment	Crude protein (kg ha^{-1})					Crude fibre (kg ha^{-1})					Crude fat (kg ha^{-1})				
		Sorghum	Maize	Cowpea	Cluster bean	Total	Sorghum	Maize	Cow-pea	Cluster bean	Total	Sorghum	Maize	Cow-pea	Cluster bean	Total
T_1	Sole	494.2	-	-	-	494.2	2834.2	-	-	-	2834.2	122.8	-	-	-	122.8
T_2	Sole	-	426.3	-	-	426.3	-	2745.9	-	-	2745.9	-	113.1	-	-	113.1
T_3	Sole	-	-	476.9	-	476.9	-	-	1975.3	-	1975.3	-	-	133.8	-	133.8
T_4	Sole	-	-	-	409.0	409.0	-	-	-	1847.1	1847.1	-	-	-	141.4	141.4
T_5	1:1	384.5	-	291.4	-	675.8	1762.9	-	1159.0	-	2921.9	72.5	-	111.1	-	183.7
T_6	1:1	374.6	-	-	268.2	642.9	1740.6	-	-	1051.3	2791.9	71.0	-	-	109.6	180.6
T_7	1:1	-	322.0	284.2	-	606.2	-	1631.9	1122.9	-	2754.8	-	69.7	107.8	-	177.5
T_8	1:1	-	319.5	-	256.6	576.1	-	1651.9	-	1038.7	2690.5	-	70.3	-	104.0	174.3
T_9	2:1	503.5	-	244.4	-	747.9	2262.9	-	766.3	-	3029.2	91.7	-	94.7	-	186.4
T_{10}	2:1	489.3	-	-	226.6	715.9	2246.1	-	-	680.2	2926.3	89.4	-	-	93.1	182.5
T_{11}	2:1	-	410.4	265.7	-	676.1	-	2075.7	749.6	-	2825.2	-	84.1	100.3	-	184.5
T_{12}	2:1	-	394.3	-	255.1	649.4	-	1985.8	-	660.9	2646.7	-	80.9	-	101.9	182.8
T_{13}	3:1	491.8	-	172.0	-	663.9	2330.9	-	548.8	-	2879.7	124.5	-	45.7	-	170.2
T_{14}	3:1	473.5	-	-	151.5	625.0	2287.0	-	-	452.1	2739.1	125.9	-	-	43.7	169.6
T_{15}	3:1	-	411.6	173.3	-	584.9	-	2162.7	545.7	-	2708.4	-	130.2	43.3	-	173.5
T_{16}	3:1	-	405.7	-	155.4	561.1	-	2160.8	-	456.6	2617.4	-	138.2	-	43.3	181.5
SEm ±						20.4					97.9					6.1
C.D.(p=0.05)						58.9					282.9					17.6

(2007). The correlation studies also substantiated positive relationship between dry fodder yield and plant height (r = 0.909**), LA 1 (r=0.874**), LER (r= 0.843**) and N and P content at harvest (r = 0.742** for N and 0.771** P content), respectively.

The increase in total green fodder yield under various intercropping systems might be owing to better utilization of space and light interception coupled with nutrient contribution of leguminous fodder to cereals (Sunitha and Sreekantan, 1992; Dixit *et. al*., 2005; and Singh *et. al*., 2007. The correlation studies also showed positive relationship between green fodder yield and plant height (r = 0.893**), LA1 (r = 0.870**), LER (r = 0.824**) and N content (r= 0.741**) and P content (r = 0.780 **).

The uptake of nutrients is primarily a function of total biomass production and nutrient concentration at the cellular level. An increase in uptake of N and P was observed under different intercropping and planting systems as compared to sole crop. It mainly appears to be due to increased total dry matter production. This may also be due complementary effect of legumes component on sorghum and maize (Mohammad *et al.*, 1996).

Table 5. Effect of fodder based sorghum and maize intercropping and planting system on mineral ash, NFE and TDN production (kg ha^{-1}) at harvest

	Treat-ment	Mineral Ash uptake (kg ha^{-1})					NFE uptake (kg ha^{-1})					TDN uptake (kg ha^{-1})				
		Sorghum	Maize	Cowpea	Cluster bean	Total	Sorghum	Maize	Cowpea	Cluster bean	Total	Sorghum	Maize	Cowpea	Cluster bean	Total
T_1	Sole	863.8	-	-	-	863.8	5330	-	-	-	5330	5209	-	-	-	5209.3
T_2	Sole	-	827.7	-	-	827.7	-	5362	-	-	5362	-	6423	-	-	6422.6
T_3	Sole	-	-	763.2	-	763.2	-	-	2901	-	2901	-	-	3445	-	3445.5
T_4	Sole	-	-	-	716.6	716.6	-	-	-	2748	2748	-	-	-	2843	2843.2
T_5	1:1	568.2	-	477.6	-	1045.8	4654	-	1740	-	6394	4073	-	2097	-	6170.7
T_6	1:1	566.9	-	-	423.9	990.8	4528	-	-	1910	6438	3979	-	-	1913	5892.2
T_7	1:1	-	546.8	467.8	-	1014.6	-	4522	1724	-	6246	-	4877	2064	-	6940.8
T_8	1:1	-	540.2	-	415.0	955.2	-	4586	-	1779	6365	-	4939	-	1804	6743.4
T_9	2:1	679.9	-	416.2	-	1096.2	5653	-	1533	-	7186	5039	-	1751	-	6790.1
T_{10}	2:1	670.8	-	-	372.7	1043.6	5535	-	-	1701	7235	4950	-	-	1623	6573.3
T_{11}	2:1	-	622.4	406.9	-	1029.3	-	5271	1816	-	7087	-	5832	1991	-	7823.1
T_{12}	2:1	-	611.7	-	357.8	969.5	-	5150	-	2095	7245	-	5663	-	1924	7586.8
T_{13}	3:1	720.6	-	274.2	-	994.8	5694	-	1181	-	6875	5131	-	1292	-	6423.5
T_{14}	3:1	720.2	-	-	263.3	983.6	5594	-	-	1217	6811	5039	-	-	1124	6163.2
T_{15}	3:1	-	680.7	267.3	-	948.0	-	5478	1221	-	6699	-	6119	1321	-	7439.5
T_{16}	3:1	-	670.8	-	231.7	902.5	-	5420	-	1290	6710	-	6082	-	1179	7260.7
SEm ±						33.5					202.3					213.1
C.D.(p=0.05)						96.7					584.2					615.4

Table 6. Correlation coefficient (r) and regression equation (Y = a + b X) between crop parameters on mean basis

Dependent variable (Y)	Independent variable (X)	Correlation coefficient (r)	(r_2)	Regression equation (Y = a + b X)
Green fodder yield	LAI	0.870**	0.757	178.509+ 22.113x
Green fodder yield	LER	0.824**	0.679	7.663+232.313x
Green fodder yield	N content	0.741**	0.549	154.012+96.389x
Green fodder yield	P content	0.780**	0.608	170.980+ 343.100x
Dry fodder yield	Plant height (cm.)	0.909**	0.827	51.398+0.191x
Dry fodder yield	DMA at harvest	1.000**	1.000	0.258+0.094x
Dry fodder yield	LAI	0.874**	0.764	61.128+6.776x
Dry fodder yield	LER	0.843**	0.710	7.102+72.426x
Dry fodder yield	N content	0.742**	0.550	53.821+ 29.421x
Dry fodder yield	P content	0.771**	0.595	59.558+103.454x
Dry fodder yield	N uptake	0.850**	0.722	9.582+1.000x
Dry fodder yield	P uptake	0.779**	0.608	47.095+2.350x
CP production	N uptake	1.000**	1.000	0.00001+6.250x
Ash production	N uptake	0.953**	0.907	346.295+6.298x
Fibre production	N uptake	0.719**	0.517	1311.367+14.395x
NFE production	N uptake	0.822**	0.675	-742.0909+71.813x
TDN production	N uptake	0.626**	0.392	1096.969+53.885x
EE production	N uptake	0.859**	0.738	43.428+12.87x
CP production	P uptake	0.944**	0.892	223.680+15.114x
Ash production	P uptake	0.899**	0.809	571.791+15.225x
Fibre production	P uptake	0.736**	0.542	1754.233+37.748x
NFE production	P uptake	0.671**	0.450	102.754+ 2.575x
TDN production	P uptake	0.734**	0.539	2057.026+ 164.326x
EE production	P uptake	0.503*	0.253	3508.148+110.697x

* Significant at 5 and ** at 1 % levels

Higher crude protein, crude fibre and either extract production levels were due to its higher forage yield along with higher nitrogen content in legume crops (cowpea and cluster bean). The quality production is a function of quality components which multiplied by the dry fodder yield, ultimately increased production of mineral matter of the crop (Sunitha and Sreekantan, 1992; Thakur, 2003.Variation in total TDN and NFE production is a function of total digestible nutrient and NFE content of plants and dry matter production. Sorghum and maize contains higher TDN content compared to legumes and so the highest TDN production (6790 kg ha^{-1}) was recorded in sorghum along with cowpea 2:1 row proportion. Bishnoi *et al.*,(2003) and Chotiya (2005) also reported increased crude protein, crude fibre, fat and TDN production with the enhancement in N and P levels. Production of all the quality parameters are positively correlated with N and P uptake viz. for N uptake in CP (r = 1.000**), ash (r =0.953**), CF(r= 0.719**), crude fat (r= 0.859**), NFE (r=0.822**) and TDN (r = 0.626**) and for P uptake in CP (r = 0.944**), ash (r =0.899**), CF (r= 0.736**) crude fat (r = 0.671**), NFE (r = 0.734**) and TDN (r=0.503*) production (Table 6).

It may be concluded that among fodder based intercropping systems, sorghum + cowpea in 2:1 row ratio intercropping recorded significantly higher green fodder yield (38.0 t ha^{-1}) and dry matter production (1295.g m^{-2}) at harvest over sole treatments.

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