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Productivity and economics of *kharif* fodder intercropping under dryland condition of temperate Kashmir valley

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Abstract
A field experiment was conducted during *kharif* season for two consecutive years at Research Farm of Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir, Wadura Campus (Jammu & Kashmir) to find out productivity and profitability of *kharif* fodder crops *viz*., maize (African Tall) and sorghum (M.P. Chari), intercropping each with fodder cowpea (UPC 9202) through uniform row (1:1) and paired rows (2:1 and 2:2) series of additive intercropping system. In the additive uniform row (1:1) series, each row of cowpea was accommodated between two uniform rows of maize or sorghum spaced at 45 cm. In paired row series, each pair of maize and sorghum was planted with 30 cm space between rows in the pair. The inter space between two pairs of these cereal fodders rows was 60 cm. The experiment was laid out in randomised block design and replicated thrice. The pooled data of two years revealed that total green and dry fodder yields of maize + cowpea (24.1 and 5.46 t/ha, respectively) and sorghum + cowpea (23.9 and 5.40 t/ha, respectively) were higher with uniform row series (1:1) of intercropping system. Total crude protein yield was also higher with uniform series of both the fodder intercropping systems. However, system productivity of 21.2 t/ha of green fodder in terms of cowpea equivalent yield in maize + cowpea was higher than sorghum + cowpea intercropping system. With uniform series of 1:1, fodder maize showed comparatively less aggressivity (dominance) than fodder sorghum intercropped with cowpea. Yield advantage in terms of land equivalent ratio (LER) of maize + cowpea was relatively higher than sorghum + cowpea under all series intercropping. The maximum net return and benefit: cost ratio was also higher with the uniform series of maize + cowpea intercropping system (Rs 6,400/ha, 1.00). Thus uniform row (1:1) series of intercropping system involving fodder maize and fodder cowpea could be a productive and profitable intercropping system under dryland condition of temperate Kashmir valley.

Keywords: Economics, Fodder crops, Intercropping, Land equivalent ratio, Productivity

The area under fodder cultivation is nearly 4% of the total cultivable area in India. Livestock rearing is an integral part of crop farming, particularly of dryland farming systems. The area of 0.45 lakh hectares (6% of total cultivable area) under fodder cultivation in Jammu & Kashmir needs to be covered with high yielding varieties of fodder crops. Efforts are also to be made to increase this area to 1.00 lakh hectares by bringing more current fallow lands under fodder cultivation (Masoodi *et al*., 2003) to meet the fodder requirement of livestock. Single crop cultivation is generally followed in the valley; where about 80% cultivable lands are being occupied by paddy with assured irrigation. Some farmers grow fodder oats after rice during *rabi* season which mature during April–May. With limiting area under cultivated fodder, the yield along with quality of fodder crops can be improved through intercropping of diverse forage species. Intercropping has long been recognised as a kind of biological insurance against risk under aberrant weather behaviour in dry land condition. Besides best utilization of all the resources, fodder cereals intercropped with fodder legumes can provide stability to production. The technique of paired row planting is one way of accommodating the full population of base crop and creating interspaces wide enough to accommodate one or two rows of intercrop. The unirrigated tracts of Kashmir valley during *kharif* season are suitable for growing of maize, sorghum and cowpea as fodder crops and can provide nutritious fodder when grown in association. However, information is lacking on spatial arrangement under intercropping system with different fodder crops reflecting productivity and profitability in this region.

In intercropping systems, one has a number of management options available to try and maximize productivity of the system. There was a strong response to plant density with maximum intercrop yields achieved at low to moderate plant densities (Craufurd, 2000; Singh *et al.,* 2011). Therefore, a rational approach is required on spatial arrangement of these fodder crops in an intercropping system as it has important effects on the balance of competition between component crops reflected by total productivity and profitability. Hence, present study was under taken to evaluate the effect of spatial arrangements of plant rows in fodder maize and sorghum intercropped with fodder cowpea on total productivity, production efficiency, yield advantage, crude protein yield and economic feasibility of the system under dryland condition of temperate Kashmir valley.

The field experiment was conducted in the *kharif* season for two consecutive years (2006 and 2007) at Research Farm, Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir, Wadura Campus (latitude of 34° 21' N, longitude of 74° 24'E and altitude of 1,595 m above mean sea level) under dryland temperate condition of Kashmir valley. The soil was well drained, non-saline (EC 0.27 dS/m) and neutral (pH 7.4). It was medium in organic carbon (0.63%), available nitrogen (298 kg/ha) and available phosphorus (18.3 kg/ha) and high in available potassium (320 kg/ha). Crops were grown under rainfed condition with total rainfall received 483.3 and 495.2 mm during the crop period of first and second years of experimentation, respectively. Experiment was consisted of nine treatments and laid out in randomized block design with three replications. Treatments comprised of three sole crops of fodder maize (African Tall), fodder sorghum (M.P. Chari) and fodder cowpea (UPC 9202) and six additive intercropping systems of maize and sorghum each with cowpea *i.e.* uniform row series of 1:1, paired row series of 2:1 (30/60) and paired row series of 2:2 (30/60) of maize + cowpea and sorghum + cowpea. Rows of sole maize and sole sorghum were spaced at 45 cm apart while those of sole cowpea were at 30 cm apart. In the additive uniform row series (1:1), each row of cowpea was accommodated between two uniform rows of maize or sorghum spaced at 45 cm. In paired row series, each pair of maize and sorghum was planted with 30 cm space between rows in the pair. The interspace between two pairs of these cereal fodders crops was 60 cm. The seed rates of maize sorghum and cowpea in pure stands were 40, 15 and 60 kg/ha, respectively. The fertilizers in pure stands of maize and sorghum were applied as 80: 40 kg N and P_2O_5/ha, and in pure stand of cowpea as 20: 80 kg N and P_2O_5/ha, respectively through urea and DAP. Due to high content of available K_2O in the soil, external application of potassium was not given. The fertilizers were applied as per row ratio of component crops in the intercropping treatments. The crops were sown in the first week of June and harvested at 75 DAS in the third week of August in both the years. Samples of all the crops were harvested manually from the central net areas for yield assessment. The yields of intercrops were calculated on the basis of proportionate area. The plant samples were oven dried for computation of dry matter and crude protein content. Crude protein yield was determined by multiplying protein content to dry matter yield. On the basis of prevailing market prices of green fodders, cowpea equivalent yield was calculated. Production efficiency was also calculated by dividing cowpea equivalent yield by 75 days of total crop duration (Dixit *et al.,* 2014; Kumar *et al.,* 2014; Singh *et al.,* 2011). For assessing the biological feasibility, intensity and effect of competition due to intercropping were evaluated by means of aggressivity and land equivalent ratio (LER). Economics was assessed by cost of cultivation, gross return, net return and benefit: cost ratio. Monetary advantage was also calculated to find out the absolute value of genuine yield advantage (Kumar *et al.,* 2005).

Monetary advantage =

$$\text{Value of combined intercrop yield} \times \frac{\text{LER} - 1}{\text{LER}}$$

The year-wise as well as two-year data were subject to the analysis of variance (ANOVA) in randomized design. Homogeneity of variances was tested by *F*–test for pool analysis of the two years data.

Green and dry fodder yields were significantly influenced by different intercropping treatments (Table 1). The total green and dry fodder yields were higher with uniform 1:1 row series of both maize + cowpea and that of sorghum + cowpea intercropping system, the later being at par with the former. Both the uniform intercropping systems were also remained at par with the paired 2:2 rows series of maize + cowpea and sorghum + cowpea. Total yield of all the intercropping systems under the experiment were significantly higher compared to sole stands of maize, sorghum and cowpea. In general, forage yield of all the component crops under different intercropping systems were reduced compared to their respective sole stands. Dry matter production of each component was reduced due to shading and competition for resources between component crops. Singh and Giri (2000) and Singh *et al.* (2008) also reported the similar effect on different component crops. This reduction in individual crop yield was however, compensated by contribution of all component crops in total intercrop yield. Maximum cont-

Table1. Green fodder, dry fodder and protein yield of cereal forage and cowpea intercropping system (pooled data of two years)

Treatment	Green fodder yield (t/ha)					Dry fodder yield (t/ha)				
	Maize	Sorghum	Cowpea	Total	Cowpea contribution (%)	Maize	Sorghum	Cowpea	Total	Cowpea contribution (%)
Sole cropping										
Maize	17.8	-	-	17.8	-	4.06	-	-	4.06	-
Sorghum	-	18.5	-	18.5	-	-	4.33	-	4.33	-
Cowpea	-	-	13.3	13.3	-	-	-	2.90	2.90	-
Maize+Cowpea intercropping										
1 : 1	16.7	-	7.4	24.1	30.7	3.90	-	1.56	5.46	28.6
2 : 1 (30/60)	16.9	-	4.1	21.0	19.5	3.90	-	0.90	4.80	18.7
2 : 2 (30/60)	16.6	-	7.1	23.7	29.9	3.90	-	1.50	5.40	27.8
Sorghum+Cowpea intercropping										
1 : 1	-	16.9	7.0	23.9	29.3	-	3.90	1.50	5.40	27.8
2 : 1 (30/60)	-	17.3	3.9	21.2	18.4	-	4.00	0.90	4.90	18.4
2 : 2 (30/60)	-	16.6	6.8	23.4	29.1	-	3.83	1.53	5.36	28.5
SEm	-	-	-	0.74	-	-	-	-	0.17	-
CD (P<0.05)	-	-	-	1.60	-	-	-	-	0.36	-

Treatment	Crude protein yield (q/ha)				
	Maize	Sorghum	Cowpea	Total	Cowpea contribution (%)
Sole cropping					
Maize	4.41	-	-	4.41	-
Sorghum	-	3.56	-	3.56	-
Cowpea	-	-	4.78	4.78	-
Maize+Cowpea intercropping					
1 : 1	4.10	-	2.52	6.62	38.1
2 : 1 (30/60)	4.08	-	1.46	5.54	26.4
2 : 2 (30/60)	4.09	-	2.41	6.50	37.1
Sorghum+Cowpea intercropping					
1 : 1	-	2.94	2.42	5.36	45.2
2 : 1 (30/60)	-	3.00	1.46	4.46	32.7
2 : 2 (30/60)	-	2.87	2.46	5.33	46.1
SEm	-	-	-	0.18	-
CD (P<0.05)	-	-	-	0.39	-

Table 2. System productivity, competitive indices and economics of cereal forage and cowpea intercropping system (pooled data of two years)

Treatment	System productivity		Competitive indices	
	CEY (t/ha)	Production efficiency (kg/ha/day)	Aggressivity	LER
Sole cropping				
Maize	14.75	196.70	-	-
Sorghum	10.73	143.06	-	-
Cowpea	13.30	177.30	-	-
Maize+Cowpea intercropping				
1 : 1	21.23	283.06	0.76	1.49
2 : 1 (30/60)	18.13	241.73	0.50	1.26
2 : 2 (30/60)	20.88	278.40	0.80	1.46
Sorghum+Cowpea intercropping				
1 : 1	16.78	223.77	0.77	1.43
2 : 1 (30/60)	13.93	185.73	0.52	1.22
2 : 2 (30/60)	16.49	219.86	0.77	1.40
SEm	0.59	-	-	-
CD (P<0.05)	1.25	-	-	-

Treatment	System economics				
	Cost of cultivation (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B:C ratio	Monetary advantage
Sole cropping					
Maize	5700	8900	3200	1.56	-
Sorghum	5600	6475	875	1.15	-
Cowpea	6900	7980	1080	1.15	-
Maize+Cowpea intercropping					
1 : 1	6390	12790	6400	2.00	2105
2 : 1 (30/60)	6150	10910	4760	1.77	982
2 : 2 (30/60)	6390	12560	6170	1.96	1935
Sorghum+Cowpea intercropping					
1 : 1	6315	10115	3800	1.60	1143
2 : 1 (30/60)	6075	8395	2320	1.38	418
2 : 2 (30/60)	6315	9890	3575	1.56	1021
SEm	-	357	219	0.03	-
CD (P<0.05)	-	757	464	0.07	-

CEY: Cowpea equivalent yield; LER: Land equivalent ratio; Market price of green fodder: Maize Rs 500/t; sorghum Rs 350/t; cowpea Rs 600/t

-ribution of cowpea was observed when one row of cowpea was added as in uniform 1:1 row series with maize (30.7% of green fodder) followed by sorghum (29.3% of green fodder) intercropping systems, indicating more ecological feasibility of maize intercropping with cowpea. The increase in total green and dry fodder yields in the intercropping systems might be owing to better utilization of all sources like space, light, moisture coupled with nutrient contribution of leguminous fodder to cereal fodders (Kumar *et al*., 2005; Dixit *et al.,* 2014).

The effect of intercropping of maize and sorghum with cowpea was clearly evident in total crude protein yield (Table 1). The significantly higher total crude protein yield was recorded with uniform 1:1 and paired 2:2 rows series of maize + cowpea than the other treatments. The result clearly indicated superiority in crude protein yield with maize + cowpea to sole stands of maize and cowpea. Varying levels of nutrients assimilated in dry matter due to spatial arrangements both in sole and intercropping might have resulted into differences in crude protein content. The difference in crude protein yield of all the treatments was due to variation in dry matter yield and protein content of the component fodder crops. The higher protein yields were due to high protein content in fodder cowpea. Thus intercropping systems with more number of cowpea rows recorded higher crude protein yield. However, the total crude protein yield of an intercropping system was the reflection of contribution from all the component crops involved. The pronounced effect of intercropping of fodder legumes with cereals and other grasses on crude protein yield was also reported earlier (Kumar *et al.,* 2005; Patidar *et al.,* 2008).

System productivity in terms of cowpea equivalent yield (CEY) was highest (21.23 t/ha) with uniform 1:1 row series followed by paired rows 2:2 series of maize + cowpea intercropping systems (Table 2). Both the above intercropping systems remained at par to each other. Similar trend was also observed in sorghum + cowpea intercropping system but significantly inferior to maize + cowpea intercropping systems. This was might be due to higher market value of fodder maize compared to fodder sorghum. Production efficiency of maize + cowpea was also maximum with uniform 1:1 row series (283.06 kg/ha/day) followed by paired 2: 2 rows series (278.40 kg/ha/day).

LER calculated from combined intercrop yield was higher (more than 1.0) in all intercropping systems than either of the sole crops i.e. maize, sorghum and cowpea indicating suitability of the practice in quantitative term (Table 2), which clearly indicate greater biological efficiency of the intercropping treatments. The maximum LER (1.49) was recorded in intercropping of maize and cowpea planted in the uniform row arrangements of 1:1 followed by paired row of 2:2 (1.46). Positive value of aggressivity with all row ratios indicated that maize and sorghum crops showed dominance in the intercropping system. However, lower value of aggressivity with 1:1 row ratio of maize + cowpea showed less aggressivity of fodder maize compared to fodder sorghum intercropped with cowpea. Better complimentary relationship between maize and legumes was also observed by Singh *et al.* (2008).

The mean gross return, net return and benefit: cost ratio were higher with row ratio 1:1(uniform row) closely followed by 2:2 (paired rows) of maize + cowpea intercropping system (Table 2). Similar trend was also observed with sorghum + cowpea intercropping systems. The maximum monetary advantage index was found with uniform rows arrangement of 1:1 followed by paired rows arrangement of 2:2 under maize + cowpea intercropping system which indicates the suitability of the system with appropriate assessment of intercropping in terms of increased value per unit area of land.

The present study thus revealed that during *kharif season* one row of fodder cowpea in between two uniform rows of maize could be a productive and profitable intercropping system in dryland temperate condition of Kashmir Valley. However, two rows of cowpea in between two paired row of maize are also equally profitable.

References

Craufurd, P. Q. 2000. Effect of plant density on the yield of sorghum–cowpea and pearl millet–cowpea intercrops in Northern Nigeria. *Experimental Agriculture* 36: 379-395.

Dixit, A. K., S. Kumar, A. K. Rai and D.R. Palsaniya. 2014. Productivity and profitability of fodder sorghum + cowpea – chickpea cropping system as influenced by organic manure, phosphorus and sulphur application in central India. *Range Management and Agroforestry* 35: 66-72.

Kumar, B., U.S. Tiwana, A. Singh and H. Ram. 2014. Productivity and quality of intercropped maize (*Zea mays* L.) + cowpea [*Vigna unguiculata* (L.) Walp.] fodder as influenced by nitrogen and phosphorus levels. *Range Management and Agroforestry* 35: 263-267.

Kumar, S., C. R. Rawat and N. P. Melkania. 2005. Forage production potential and economics of maize (*Zea mays*) and cowpea (*Vigna unguiculata*) intercropping under rainfed condition. *Indian Journal of Agronomy* 50: 184-186.

Masoodi, M. A., S. D. Masoodi and N. A. Masoodi. 2003. *Agriculture in Jammu and Kashmir- A Perspective*. Mohisarw Book Series, Srinagar. pp 264.

Patidar, M., B. K. Mathur, M. P. Rajora and D. Mathur. 2008. Effect of grass – legume strip cropping and fertility levels on yield and quality of fodder in silvipastoral system under hot arid condition. *Indian Journal of Agricultural Sciences* 78: 394-398.

Singh, U., A. A. Saad and S. R. Singh. 2008. Production potential, biological feasibility and economic viability of maize (*Zea mays*)-based intercropping systems under rainfed conditions of Kashmir valley. *Indian Journal of Agricultural Sciences* 78: 1023-1027.

Singh, U., S. R. Singh, A. A. Saad, B. A. Khanday, and J. K. Singh. 2011. Yield advantage, reciprocity functions and energy budgeting of lentil (*Lens culinaris*) + oat (*Avena sativa*) intercropping under varying row ratio and phosphorus management. *Indian Journal of Agricultural Sciences* 81: 219–25.

Singh, V. B. and G. Giri. 2000. Influence of intercropping and weed control measures on dry matter accumulation and nutrient uptake of sunflower (*Helianthus annus*) and groundnut (*Arachis hypogea*) and their effect on succeeding maize. *Indian Journal of Agronomy* 46: 50-55