

Research Article

Productivity and economic assessment of fodder + Pigeon Pea (*Cajanus cajan*) intercropping system under upland situation of JharkhandBirendra Kumar^{1*}, Chandan Bharti², Sanjay Kumar³, Sheela Barla⁴ and D. K Chaudhary⁵^{1,4&5} Department of Agronomy, ² KVK Dhanbad ³ Department of Plant pathology, BCKV Mohanpur, WB Birsa Agricultural University, Kanke, Ranchi, Jharkhand-834006**Abstract**

A field experiment was conducted under All India Coordinated Research Project on (Forage Crops & Utilization) with the collaboration of Agrostology unit of College of Veterinary Science and Animal Husbandry Ranchi (Jharkhand) to study the Suitability of different cereal and legume fodder as intercropped with Pigeon pea (*Cajanus cajan*) during three consecutive *Kharif* seasons from 2014 to 2016. *Kharif* fodders as Sorghum, Maize, Pearl millet, Soybean, Rice bean, Cowpea and Clustered bean were intercropped in between two paired row 60 cm apart of Pigeon pea (paired at 30 cm). Altogether eight treatments were replicated thrice and analyzed the results. Pooled data of three years showed that, more pigeon pea yield (10.058 q/ha) was obtained when pigeon pea intercropped with Soybean and which was about more than 4.5 % than sole Pigeon pea (9.62 q/ha). However, intercropped Sorghum produced more green fodder yield (174.45 q/ha) and dry fodder yield (37.145 q/ha). In System, Pigeon pea + Cowpea intercropping system produced more Pigeon pea yield equivalent (15.76 q/ha) which was nearly 64 % more than sole Pigeon pea.

In other word, yield advantage due to paired row intercropped with fodder Cowpea showed 64 % yield advantages over sole. Economic studied reflect that, Pigeon pea + maize (2:1) produced highest **gross** return (Rs 78, 565 /ha), net return (Rs. 55,315/ha) and Benefit: cost ratio (2.15), which was at par with other non legumes intercropped fodder and legume cowpea which was nearly 49 per cent more over sole Pigeon pea.

Keywords: Pigeon Pea, Cereal fodder, Legume fodder, Paired row, Inter cropped fodder, Productivity and Economic

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Introduction

States like Jharkhand where 80 per cent of the farmers come under marginal category with holding size less than 2.5 Acre of land. Food production like paddy and vegetables are the major concerned of said marginal farmers. Animals always gets second priority, that's why they do not prefer fodder in good land, so scope of fodder cultivation shifted towards waste and or un-cultivated fallow land. Topographically Jharkhand is divided into three categories, out of which 40 % comes under upland categories and 45-50 % of said upland are always fallow even during *Kharif* due to fertility and topographic problem. This patch of land can be an effective resource for cultivation of fodder and pulses crop to cope up the shortage of animal green feed. These lands are generally characterized by less organic matter content with low water holding capacity as well as poor fertility coupled with compactness which results into more expense of money and energy during cultivation of cereal, vegetable crops and other commercial crops.

Growing of pulses/ legumes improves the soil health, as well as also improves the productivity of animal and human too. Apart from the cereal and legumes for human being, fodder cultivation attracts the farmers to domesticate the lactating animals, which certainly improves their Socio- economic condition.

In present contest protein became the essential parts of ration of human as well as animal which can be made available from pulses for human and green fodder for animals. Pigeon pea which require less irrigation and also a source of good human protein and fodder crops like Cowpea, Rice bean, fodder Soybean and Cluster bean are suitable for intercropped are ideal under concerned area of interest. Besides it, the importance of cereal fodder likes Sorghum, Maize and Pearl millet can't be ignored which acts as body building feed and sources of roughs too. Thus, in order to minimize the hidden hungriness and too cope up from malnutrition among three dimensional agricultural systems that is Soil, Animal and human growing of fodder along with Pulses in particular piece of land is essential. Apart from the above facts, to increase the area under cultivated land, and too increase cropping intensity, deep rooted legumes along with fodder as intercrop must be taken during the *Kharif* which will help in nutritional security of our system.

Technology cannot be adopted and get popularization until unless it was productive and economical, thus keeping the above facts in view present experiments was conducted on Productivity and economic assessment of fodder + Pigeon Pea (*Cajanus cajan*) intercropping system under upland situation of Jharkhand.

Materials and Methods

A field experiment was conducted during three consecutive *Kharif* season from 2014 to 2016 under All India coordinated research project on forage crops at BAU, Ranchi situated at 23°34' N latitude and 85°31' E longitudes at an altitude of 645.45 meter above the mean sea level. It falls under humid sub tropical climatic conditions, which have features of hot dry summers and cool dry winters. The soil of the experimental field was sandy loam in texture, slightly acidic in reaction having different physical and chemical properties mentioned here under (**Table 1**). The experiment was laid out in Randomized Block Design (RBD) with eight treatments namely, T1 – Sole Pigeon pea (at R-R,60 cm), T2 – Pigeon pea + Sorghum (2:1), T3 – Pigeon pea + Maize (2:1), T4 – Pigeon pea + Pearl millate (2:1), T5 – Pigeon pea + Soyabean (2:1), T6 – Pigeon pea + Rice bean (2:1), T7 – Pigeon pea + Cowpea (2:1) and T8 – Pigeon pea + Clusture bean. Above treatment were sown in plot size 4 m x 3 m and replicated thrice. Initially well decomposed Farm Yard Mannure @10 tons/ha were applied.

Table 1 Physiochemical properties of the soil of experiment plot

Sl. No	Particulars	Value	Method used
I. Physical properties			
1.	Sand (%)	61.2	Hydrometer method [1]
2.	Silt (%)	22.4	
3.	Clay (%)	16.4	
	Texture	Sandy loam	
II. Soil Moisture Constants			
1.	Water holding capacity (%)	41.3	Keen Raczki modified [2]
2.	Field capacity at 0.33 bar (%)	19.7	pressure membrane plate apparatus [3]
3.	Permanent wilting point at 15 bar (%)	11.36	pressure membrane plate apparatus [3]
4.	Bulk density (Mgm ⁻³)	1.57	Core sampler [8] as described in [2]
III. Chemical properties			
1.	Soil pH (1:2.5, soil: water ratio)	6.23	Glass electrode pH meter [4]
2.	Organic Carbon (g/kg)	3.97	[5] as described in [4]
3.	Available N (kg/ha)	245	Alkaline KMnO ₄ [6]
4.	Available P ₂ O ₅ (kg/ha)	24.8	Colorimetric estimation [7]
5.	Available K ₂ O (kg/ha)	176	Flame Photometer [4]

Lines were opened along the 3 m width at 30 cm apart and two lines of Pigeon Pea and then one line of fodder as intercropped were sown. Under each plot 4 rows of fodder crop and 6 rows of Pigeonpea were sown at the same time, after harvest of fodder Pigeonpea get better space. Intercropped plots were sown with utilizing the exact proportionate amount of Inputs. Full dose of N, P and K in Legumes were applied at the time of sowing, while Full dose of P K and half dose of N in cereal at sowing time and rest half dose of N applied after 25 DAS. Fertilizers were applied as per recommendation and crops not irrigated as it sown under rainfed condition.

Weather information

Weather data of three crop years *w.r.t.* Average humidity (%), Rain fall (mm), Sun shine hour, temperature maximum and minimum (°C) were recorded from standard meteorological week 23 to 10, owing to the standard procedure and technique. Data are represented through graphical representation depicted in figure 1. Graph reflects that crop faces the average humidity (max 83.83 & min 63.34 %), rain fall 35.07 mm /week, sun Shine hour (50.94 hrs /week), maximum temperature (38.3⁰ C) and minimum temperature (3.5⁰C). Crops face slightly warmer at day and colder during night especially during winter season which causes less flowering as well as less pod formation in Pigeon pea.

Fodders were harvested at proper stage for different crops data of represented sample were taken from randomly selected place. Data were analyzed follow the standard formula prescribed [8].

Result and Discussion

Pigeon pea study

Intercropping of legumes fodder improve the soil condition and add nitrogen as well as enhance availability of nutrients resulted into bigger plant height of main crop as well as better yield. In terms of Pigeon pea equivalent yield, fodder cowpea intercropped with Pigeon pea produced more yield equivalent (15.76 q/ha) over sole Pigeon pea (9.620 q/ha), In other word Pigeon pea intercropped with cowpea produced about 63.82 % more produced over sole Pigeon pea. This was due to combined effect of more plant population as well as well better growth due to better availability of nutrients. [9] Reported that, the intercropped combination of early sorghum (82 days) and later maturing pigeon pea (173 days) in a row arrangement of 2 sorghum:1 pigeon pea. Prior to sorghum harvest, light interception by the intercrop combination was almost as high as sole sorghum. After sorghum harvest, light interception by the remaining pigeon pea was very poor and it is suggested that pigeon pea yield could be increased by higher plant population density and better plant distribution. Soil water measurements indicated that this would increase the amount of water being transpired through the crop but would not increase the total evapo-transpiration demand. Higher nutrient concentration in the intercrop pigeon pea compared with sole pigeon pea during this post-sorghum period suggested that yield of intercrop pigeon pea was not limited by nutrient stress, though the total uptake of nutrients by both crops was much greater from intercropping than sole cropping. [10-11] also reported similar finding.

Fodder study

Data showed that, the intercropped Sorghum produced more green fodder yield (174.45 q/ha) and dry fodder yield (37.145 q/ha), which were significantly higher over other fodder crops taken under experimentation (**Table2**). The higher biomass production is frequently due to the enhanced growth of the component non-legume. Because the non-legume is generally taller than the legume and can therefore intercept adequate solar radiation, biomass production of the non-legume is more closely related to improved N nutrition [9, 12-13].

Table 2 Pigeon pea equivalent yield (q/ha), fodder yield and economics of pigeon pea+ fodder inter cropping system (Pooled)

Treatments	Pigeon pea equivalent yield(q/ha)	Fodder yield		Gross return (Rs.)			Net return (Rs)	B:C ratio
		Green (q/ha)	Dry (q/ha)	Pigeon pea	Fodder	Total		
T1- Sole Pigeonpea (at 60 cm R-R)	9.620	----	---	48,100	----	48,100	28,100	1.40
T2 – Pigeon pea + Sorghum (2:1)	15.75	174.45	37.15	43,846	34,890	78,736	55,186	2.13
T3 – Pigeon pea + Maize (2:1)	15.71	153.73	33.91	43,976	34,589	78,565	55,315	2.15
T4 – Pigeon pea + Pearlmillet (2:1)	14.89	131.69	24.54	48,105	26,339	74,444	50,894	1.97
T5 – Pigeon pea + Soyabean (2:1)	13.24	57.90	10.90	50,264	15,922	66,186	42,436	1.62
T6 – Pigeon pea + Ricebean (2:1)	14.88	88.62	17.74	50,027	24,370	74,398	50,648	1.93
T7 – Pigeon pea + Cowpea (2:1)	15.76	103.96	19.88	50,221	28,588	78,810	55,060	2.10
T8 – Pigeon pea + Clusturebean (2:1)	13.67	65.74	10.71	50,289	18,079	68,368	44,618	1.70
S. Em ±	0.24	2.28	0.56	1,046	559.	1,194	1,194	0.06
CD at 5%	0.53	5.02	1.24	2,306	1,233	2,630	2,631	0.14

Economic study

Gross return (Rs 78,736 /ha), net return (Rs. 55,185/ha) Benefit :cost ratio (2.13) under Pigeon pea+ Sorghum (2:1) and Pigeon pea + maize (2:1) (Rs 78,565 /ha, Rs 55,315 /ha & 2.15) and Pigeon pea + Cowpea (2:1) (Rs 78,810 /ha, Rs 55,060 /ha & 2.10) were at par to each other, which were significantly superior over other intercropped and sole Pigeon pea. Fodder sorghum maize and cowpea intercropped Pigeon pea produced nearly 49 per cent more economic return over sole Pigeon pea, This was due to combined effect of produced. Extra yield of fodder without compromising in population of main crop Pigeon pea was the main concerned.

Summery and Conclusion

Pigeon pea (cultivar Asha) with less branching ability was taken in paired row at 30 cm. one row of different fodder crops were placed in between the distance of 60 cm. paired to pair. As intercrop sorghum or maize among the cereal and cowpea among the legume performed equally well. However, Higher yield of Pigeon pea equivalent yield (15.76 q/ha) was recorded when intercropped with Cowpea, and higher green fodder yield (174.45 q/ha), DFY, 37.145 q/ha)

from intercropped Sorghum when crops were fertilized with standered recommended dose of fertilizer.

However, in terms of system Pigeon pea yield equivalent under Pigeon pea + Cowpea (2:1) was about 64 % more than sole Pigeon pea while, economically Pigeon pea + Cowpea (2:1) Pigeon pea + Sorghum (2:1) and Pigeon pea + Maize (2:1) were comparable and about 49 per cent more than sole Pigeon pea.

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