Bamboo (*Bambusa* spp.) based agroforestry systems under rainfed upland ecosystem

H. BANERJEE, P. K. DHARA AND D. MAZUMDAR[1]

AICRP on Agroforestry, Regional Research Station,
Bidhan Chandra Krishi Viswavidlaya, Jhargram, Paschim Medinipur-721507, West Bengal , India
[1] Department of Agricultural Statistics, BCKV, Mohanpur, Nadia-741252, West Bengal, India

Bamboo is an extremely versatile plant capable of providing ecological, economic and livelihood security to the people. Bamboo reaches structural maturity within three years and the mean annual increment (MAI) of medium or large sized bamboos is as high as or higher than that of many other fast growing tree species. Bamboo generates plenty of oxygen, low light intensity and protects against ultra-violet rays and is also considered to be an atmospheric and soil purifier. Furthermore, it conserves water and greatly reduces soil erosion (Amneth, 1996; Thus, development of bamboo based agroforestry systems in this context holds great promise in augmenting the supply of bamboo. Under this system because of growing of various intercrops, products are obtained even in the early stages of plantations and the income is much higher than sole bamboo plantation. With this background the present study has been initiated during September, 2007.

Field experiments were carried out during 2007 to 2008 under rainfed upland ecosystem at Research Farm of BCKV, Jhargram, Paschim Medinipur to develop and standardize bamboo based agroforestry system suitable for red and laterite zone of West Bengal. It is situated at 22.5^0 N latitude and 87.0^0 E longitudes and at an elevation of 78.77 m above mean sea level. The experimental soil is coarse textured, strongly acidic (pH 5.1) and poor in organic matter (0.30%), available phosphorus (20.30 kg/ha) and potassium content (134.0 kg/ha). The culm cuttings of *Bambusa tulda* and *B. balcooa* were planted on 4 October 2007 and 20 May 2008, respectively. Each bamboo species was planted under two spacing, viz., 10 × 10 m and 12 × 10 m. Thirty six (36) nos. of culm cuttings of each bamboo species were planted under each spacing. The experiments were laid out in a 3 factor factorial RCBD with 3 factors as system of cropping, species and spacing replicated thrice. Each plot contains 12 clumps (3 × 4, rows × clumps) and altogether 12 such plots have been maintained in the experiment. The intercropping in bamboo plantation was done only during rainy (*kharif*) season of 2008 with the advent of monsoonal rain. The intercrops, namely, rice (var. Annada), groundnut (var. JL 24), pigeon pea (var. UPAS 120), cowpea (var. Pusa barsati), lady's finger (var. Parbhani kranti), bottle gourd (var. Summer prolific round), turmeric (var. Sugandham), colocasia (var. Satamukhi) and elephant foot yam (var. Kovvur) were grown in between two widely spaced rows of bamboo plants under recommended package of Practices. Plot sizes were 200 m^2 and 20 m^2 for intercropping and mono-cropping systems respectively. Different growth parameters of bamboo plants have been recorded. Yield and PLER of all intercrops were calculated after harvesting of each crop. All main and interaction effects were tested by F test. Standard error of mean i.e. S.Em± were calculated for mean comparison. Critical difference (CD at 5% level of significance) also calculated for interaction means as the no. of means are more than two (Gomez and Gomez, 1984).

Survival and growth parameters of bamboo plants

All the growth attributes of both the bamboo species except no. of internodes was statistically at par when planted at closer spacing (10 × 10) than wider spacing (12 m × 10 m). It was found that growth attributes of bamboo plants irrespective of species and spacing were significantly higher when grown with intercrops than sole plantation. Under sole bamboo plantation, *B. tulda* produced significantly higher no. of culms/clump as compared to *B. balcooa* (Table 3). Other growth attributes for both the bamboo species were statistically at par under both the spacing (Table 5). Though all the growth parameters of both the bamboo species were higher when grown under intercropping situation than sole plantation, but no significant difference was observed when planted at closer and wider spacing (under both sole and intercropping situation).

Yield and PLER of intercrops

The yield of all intercrops was higher in wider spacing (12 × 10) as compared to closer spacing (10 × 10). This is attributed to the fact that wider distance between two bamboo plants results into better utilization of sunlight, space, moisture and nutrients by the intercrops with minimum competition among them and between agricultural crops. Similar findings were also reported by Nath *et al.* 2008.

E mail : banhirak@rediffmail.com
Short Communication

Partial land equivalent ratio (PLER) of different intercrops was calculated with respect to their sole crop yield (Table 9). Values of PLER of different intercrops grown under two bamboo species with two different planting geometry were varied from 0.85-0.99 (i.e. PLER value < 1 but very close to 1), which indicates no yield advantage of intercrops under bamboo based intercropping situation over sole cropping. Here bamboo plants are at their juvenile stage and intercropping has been practiced for the first time, so yield reduction of intercrops under bamboo based agroforestry system is too little.

Development and standardization of bamboo based agroforestry system suitable for red & laterite zone of West Bengal involving two bamboo species (*Bambusa tulda* and *Bambusa balcooa*) and agricultural crops like paddy (upland), groundnut, cowpea, lady's finger, bottle gourd, pigeon pea, turmeric, elephant foot yam and colocasia has immense potentiality of providing livelihood security to the poor farmers of western part of West Bengal through self employment and higher income. There is still a substantial need to promote bamboo based agroforestry systems as well as utilization of bamboos to the extent possible.

REFERENCES

Amneth, R. R. 1996. The role of bamboo on the social, cultural and economic life of the Philippines. *Bamboo People Env*. **4** : 70-78.

Anonymous, 1994. Bamboo for construction : A way to check deforestation. *International Network for Bamboo and Rattan, Newsletter*.

Anonymous, 2008. Development of bamboo based agroforestry systems for six agro-climatic zones. *Annual Report, September 2007-August 2008*, 3 pp. AICRP on Agroforestry, Bidhan Chandra Krishi Viswavidyalaya, West Bengal.

Gomez, Kwanchai A. and Gomez, Arturo A. 1984. Statistical Procedures for Agricultural Research (Second Edition). A Wiley-Interscience Publication (John Wiley & Sons.), New York : 130-39.

Sharma, B. D., Hore, D. K., Pandey, G. and Wadhwa, B. M. 1992. Genetic resources of bamboo in the North-Eastern region of India. *Ind. J. For*., **15** : 44-51.

Singh, S. P. 2006. Handbook of Agroforestry (2nd Edition), 143 pp. Agrotech Publishing Academy, Udaipur.

Table 1: Survival data of two bamboo species

Bamboo species under different planting geometry	Culm cuttings		
	Planted	Survived	
		Number	Percentage
Bambusa tulda			
10 ×10 m	36	36	100
12 ×10 m	36	36	100
Bambusa balcooa			
10 ×10 m	36	36	100
12 ×10 m	36	36	100

Table 2: Height (m) of bamboo plant as affected by spacing and system of cropping

System of cropping	*Bambusa tulda*			*Bambusa balcooa*			Mean		
	10 ×10m	12 ×10m	Mean	10 ×10m	12 ×10m	Mean	10 ×10m	12 ×10m	Mean
Without crop	4.80	4.39	4.60	1.22	1.64	1.43	3.01	3.01	3.01
With crop	4.97	4.57	4.92	1.97	1.99	1.98	3.47	3.43	3.45
Mean	4.89	4.63	4.76	1.59	1.81	1.70	3.24	3.22	-

Sources	SEm (±)	LSD(P=0.05)	Sources	SEm (±)	LSD(P=0.05)
SC	0.09	-	SC × Species	0.13	NS
Species	0.09	-	SC × Spacing	0.13	NS
Spacing	0.09	-	Species × Spacing	0.13	NS
			SC × Species × Spacing	0.18	NS

Table 3 : Number of culm/clumps of bamboo plant as affected by spacing and system of cropping

System of cropping	*Bambusa tulda*			*Bambusa balcooa*			Mean		
	10 ×10m	12 ×10m	Mean	10 ×10m	12 ×10m	Mean	10 ×10m	12 ×10m	Mean
Without crop	8.84	9.01	8.92	2.12	1.92	2.02	5.48	5.46	5.47
With crop	9.23	9.83	9.53	2.25	2.19	2.22	5.74	6.01	5.88
Mean	9.04	9.42	9.23	2.19	2.06	2.12	5.61	5.74	-

Sources	SEm (±)	LSD(P=0.05)	Sources	SEm (±)	LSD(P=0.05)
System of cropping	0.07	-	SC × Species	0.10	NS
Species	0.07	-	SC × Spacing	0.10	NS
Spacing	0.07	-	Species × Spacing	0.10	0.31
			SC × Species × Spacing	0.15	NS

Table 4: Length of lowest internode (cm) of bamboo plant as affected by spacing and system of cropping

System of cropping	*Bambusa tulda*			*Bambusa balcooa*			Mean		
	10 ×10m	12 ×10m	Mean	10 ×10m	12 ×10m	Mean	10 ×10m	12 ×10m	Mean
Without crop	21.86	23.26	22.56	6.97	6.95	6.96	14.41	15.10	14.76
With crop	24.07	24.33	24.20	8.27	8.27	8.27	16.17	16.30	16.23
Mean	22.96	23.80	23.38	7.62	7.61	7.61	15.29	15.70	-

Sources	SEm (±)	LSD(P=0.05)	Sources	SEm (±)	LSD(P=0.05)
SC	0.30	-	SC × Species	0.42	NS
Species	0.30	-	SC × Spacing	0.42	NS
Spacing	0.30	-	Species × Spacing	0.42	NS
			SC × Species × Spacing	0.59	NS

SC = System of Cropping

Table 5 : Diameter of lowest internode (cm) of bamboo plant as affected by spacing and system of cropping

System of cropping	*Bambusa tulda*			*Bambusa balcooa*			Mean		
	10 ×10m	12 ×10m	Mean	10 ×10m	12 ×10m	Mean	10 ×10m	12 ×10m	Mean
Without crop	2.55	3.02	2.79	0.98	1.05	1.02	1.77	2.03	1.90
With crop	3.53	3.53	3.53	1.18	1.21	1.20	2.36	2.37	2.37
Mean	3.04	3.28	3.16	1.08	1.13	1.11	2.06	2.20	-

Sources	SEm (±)	LSD(P=0.05)	Sources	SEm (±)	LSD(P=0.05)
System of cropping	0.06	-	System of cropping × Species	0.09	0.27
Species	0.06	-	System of cropping × Spacing	0.09	NS
Spacing	0.06	-	Species × Spacing	0.09	NS
			System of cropping × Species × Spacing	0.12	NS

Table 6: Number of internodes of bamboo plant as affected by spacing and system of cropping

System of cropping	*Bambusa tulda*			*Bambusa balcooa*			Mean		
	10 ×10m	12 ×10m	Mean	10 ×10m	12 ×10m	Mean	10 ×10m	12 ×10m	Mean
Without crop	13.22	13.93	13.58	9.97	10.91	10.44	11.59	12.42	12.01
With crop	14.43	14.90	14.67	10.87	11.77	11.32	12.65	13.34	12.99
Mean	13.83	14.42	14.12	10.42	11.34	10.88	12.12	12.88	-

Sources	SEm (±)	LSD(P=0.05)	Sources	SEm (±)	LSD(P=0.05)
System of cropping	0.23	-	System of cropping × Species	0.32	NS
Species	0.23	-	System of cropping × Spacing	0.32	NS
Spacing	0.23	-	Species × Spacing	0.32	NS
			System of cropping × Species × Spacing	0.46	NS

Table 7:. Length of 5th internode (cm) of bamboo plant as affected by spacing and system of cropping

System of cropping	*Bambusa tulda*			*Bambusa balcooa*			Mean		
	10 ×10m	12 ×10m	Mean	10 ×10m	12 ×10m	Mean	10 ×10m	12 ×10m	Mean
Without crop	32.21	31.95	32.08	10.27	11.17	10.72	21.24	21.56	21.40
With crop	33.30	33.57	33.43	12.04	12.55	12.29	22.67	23.06	22.86
Mean	32.75	32.76	32.76	11.16	11.86	11.51	21.95	22.31	-

Sources	SEm (±)	LSD(P=0.05)	Sources	SEm (±)	LSD(P=0.05)
SC	0.27	-	SC × Species	0.38	NS
Species	0.27	-	SC × Spacing	0.38	NS
Spacing	0.27	-	Species × Spacing	0.38	NS
			SC × Species × Spacing	0.54	NS

SC = System of Cropping

Table 8: Diameter of 5th internode (cm) of bamboo plant as affected by spacing and system of cropping

System of cropping	*Bambusa tulda*			*Bambusa balcooa*			Mean		
	10 ×10m	12 ×10m	Mean	10 ×10m	12 ×10m	Mean	10 ×10m	12 ×10m	Mean
Without crop	2.41	2.20	2.31	0.73	0.83	0.78	1.57	1.52	1.55
With crop	2.80	2.78	2.79	0.85	.89	0.87	1.83	1.84	1.83
Mean	2.61	2.49	2.55	0.79	0.86	0.82	1.70	1.68	-

Sources	SEm (±)	LSD(P=0.05)	Sources	SEm (±)	LSD(P=0.05)
SC	0.07	-	SC × Species	0.10	NS
Species	0.07	-	SC × Spacing	0.10	NS
Spacing	0.07	-	Species × Spacing	0.10	NS
			SC × Species × Spacing	0.14	NS

SC = System of Cropping

Table 9: Yield and partial land-equivalent ratio (PLER) of different intercrops as affected by system of cropping and spacing during rainy (*kharif*) season 2008

Intercrop	Yield (t/ha)					Partial land-equivalent ratio (PLER)			
	Sole cropping	*Bambusa tulda*		*Bambusa balcooa*		*Bambusa tulda*		*Bambusa balcooa*	
		10 × 10 m	12 × 10 m	10 × 10 m	12 × 10 m	10 × 10 m	12 × 10 m	10 × 10 m	12 × 10 m
Rice	1.95	1.80	1.88	1.85	1.90	0.92	0.96	0.94	0.97
Groundnut	1.57	1.34	1.45	1.40	1.47	0.85	0.92	0.89	0.93
Pigeon pea	2.20	1.92	2.10	1.98	2.17	0.87	0.95	0.90	0.98
Cowpea	5.20	4.89	5.11	4.95	5.15	0.94	0.98	0.95	0.99
Lady's finger	7.50	6.95	7.10	7.05	7.12	0.95	0.96	0.96	0.96
Bottle gourd	11.50	10.00	11.01	11.15	11.11	0.93	0.97	0.94	0.98
Turmeric	25.05	21.90	24.00	22.16	24.52	0.87	0.95	0.88	0.97
Colocasia	30.50	28.47	29.65	28.50	29.71	0.93	0.97	0.93	0.97
Elephant Foot Yam	52.50	49.00	50.10	49.57	51.25	0.93	0.95	0.94	0.97