Print : ISSN 0970-7662

Journal of Tree Sciences
online available at www.ists.in

Volume 30 No.1&2 June & December, 2011

Bio-Economics of Casuarina-Fenugreek Based Agroforestry System in Coastal Regions of South Gujarat

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ABSTRACT

The present experiment explored the feasibility of raising fenugreek under six year old Casuarina (*Casuarina equsetifolia*) plantation as an Agroforestry system. The study was conducted on C. equisetifolia planted at spacing of 4m x 2m, 6m x 2m and 8m x 2m with three pruning intensities viz; unpruned, 50% pruned and 75% pruned. Fenugreek (*Trigonella foenum-graceum* cv. 'local') was raised as intercrop. In all, 10 treatment combinations, including sole plot of fenugreek without trees were maintained in the same field. Net returns were higher from sole crop than agroforestry intervention. Among different spacing and pruning intensities, 8m x 2m tree spacing and 75% tree pruning excelled over 4mx2m and 6mx2m spacing and their respective pruning intensities. From economic perspectives, comparative returns can be obtained from the said Agroforestry system at rotation age of the trees, especially when fenugreek yield is poor due to low light intensity and profuse needle fall. The yield of fenugreek can be increased by manipulating the pruning intensity to get more returns from the system even if there is glut of timber (pole) of *C. equisetifolia* in the market. This would, however, fetch more return from the woody component of the system to compensate yield losses.

Keywords:

Agroforestry, Casuarina, economics, fenugreek, pruning intensity, spacing

INTRODUCTION

Increasing pressure on land due to population explosion, high cost of fertilizers and commercial fuel have posed a serious threat to undeveloped / developing countries to meet the demand for timber and fuel wood. It is, also, well documented that there is critical shortage of firewood in third world countries. Furthermore, considerable reduction in land holding during the last decade is evident and the trend is expected to continue.

Tissaverasinghe (1980) used the term 'Agroforestry' to describe a system where a conscious effort is made to plant trees and agricultural crops as an integrated system. Batini (1978) defined the concept of Agroforestry in which tree should have something more than the timber value. *Casuarina*s fits well in with Batini's concept,

they not only have a good timber value but have other important uses also such as N-fixation, erosion control, provides mulch and shade. Fenugreek is an important vegetable crop grown in South Gujarat throughout the year mainly as sole crop but intercropping with Eucalyptus, Sapota and Mango is also not uncommon.

This experiment was undertaken to access the feasibility of Agroforestry crop combination when the harvesting of tree crop is delayed due to market glut, or any other unavoidable reasons. The present experiment is an attempt to explore the prospects of raising Fenugreek under six year old *Casuarina* plantation which has almost reached a rotation age. From a purely silvicultural consideration, the proper rotation appears to be 7 years (Anon. 1987).

MATERIALS AND METHODS

The experimental site was Instructional farm, ASPEE College of Horticulture and Forestry, Navsari. The study site is located at 20.95^0 N and 75.90^0 E at an altitude of 10 m AMSL. Climatically, the site is typically tropical, characterized by fairly hot summer, moderate winter and more humid and warm monsoon with an average precipitation of 1355 mm.

The present investigation was undertaken on a six year old plantation of *Casuarina equisetifolia* planted in east-west direction with spacing of 4 x 2m (S_1), 6 x 2m (S_2), 8 x 2m (S_3) raised in three replications. In addition to this, three pruning intensities viz., un-pruned (I_1), 50% pruned (I_2) and 75% pruned (I_3); considering the average height of the tree were done in each tree spacing. Fenugreek (*Trigonella foenum-graceum* cv. Local) was raised as an intercrop in six replications by broadcasting equal quantity of seed per sq. m in the In all, ten treatment combinations of spacing and pruning intensities were used including sole plot of fenugreek without trees was maintained in the same field (control).

Tree parameters *viz*., height, diameter, crown diameter, needle fall during the experimental period and yield of pruned material was calculated. Light intensity under trees in each treatment was measured using lux meter and average values were computed. The needle fall during the experiment was hand picked and the weight was measured.

The cost of cropping system consisting of expenditure incurred on the cultivation of fenugreek and the pruned material of *Casuarina* was computed on per hectare basis. The economics of crop production as well as net returns were calculated. The projected returns from tree component intercrop and Agroforestry component were computed. The net realization per annum for *Casuarina* and fenugreek was computed and net returns for the system on the whole were computed. The production economics of the Agroforestry component was calculated on the basis of the prevalent market prices of wood, fenugreek, cost of the seed, labour, field preparation, harvesting, transportation and marketing etc..

RESULTS AND DISCUSSION

The economics of crop with *Casuarina* has been analysed so as to realize the profitable combination suitable in conditions where tree component has attained exploitable age and diameter, and when the light conditions under the tree component was poor and were facilitated by pruning. The light intensity available to the intercrop and the needle fall of *Casuarina* had the major impact on the yield and in turn affected the bio-economics of the agroforestry component (Table 1). The perusal of the data revealed that the maximum yield was observed in open field (144.17 q ha^{-1}) followed by spacing S_3 and pruning intensity I_3 (82.28 q ha^{-1}) which is 54.64% low in comparison to open field. The lowest yield (15.09 q ha^{-1}) was seen in spacing S_1 and pruning intensity I_1 which is 89.52% less than the open field. This may be due to favourable light conditions coupled with lack of competition from tree component from tree component under open field conditions resulting in better synthesis of food material. Also, the data on light intensity and needle fall recorded in the present study also favoured the increase in yield of the intercrop when raised as open field crop. These results are in conformity with the results reported by Singh et.al. (1980) George and Nair (1987), Patel (1995), Singh *et. al.* (1997) and Miah et al. (1997). In general, the trend of yield in intercrop was $I_3 > I_2 > I_1$ and $S_3 > S_2 > S_1$. Also, with in each pruning

Table 1: Effect of pruning intensity and spacing of *Casuarina equisetifolia* on light intensity, needle fall and yield attributes of Fenugreek

Spacing	Pruning Intensity Parameter	I_1 (Un-pruned)	I_2 (50% pruned)	I_3 (75% pruned)	MEAN
4 x 2 m (S_1)	Yield of Fenugreek (Intercrop q ha^{-1})	15.09	42.20	43.07	33.45
	light intensity (% availability to Intercrop)	7.69	17.60	24.02	16.43
	% reduction of the yield of intercrop as compared to open field (control)	89.52	70.80	70.12	76.81
	Needle fall in grams (per sq.m) from *C. equisetifolia*	45.76	27.70	22.12g	31.86
6 x 2 m (S_2)	Yield of Fenugreek (Intercrop q ha^{-1})	31.73	62.90	63.89	52.84
	Light intensity (% availability to Intercrop)	12.62	22.71	33.57	22.96
	% reduction of the yield of intercrop as compared to open field (control)	77.98	56.36	55.67	63.33
	needle fall in grams (per sq.m) from *C. equisetifolia*	36.40	20.87	16.34	24.53
8 x 2 m (S_3)	Yield of Fenugreek (Intercrop q ha^{-1})	44.53	69.30	82.28	65.37
	light intensity (% availability to Intercrop)	20.50	44.26	61.34	42.03
	% reduction of the yield of intercrop as compared to open field (control)	69.10%	51.92%	42.92%	54.64%
	needle fall in grams (per sq.m) from *C. equisetifolia*	27.23	15.88	10.8	17.97
Mean	Yield of Fenugreek (Intercrop q ha^{-1})	30.45	58.13	63.08	
	light intensity (% availability to Intercrop)	13.60	28.19	39.64	
	% reduction of the yield of intercrop as compared to open field (control)	78.86	59.69	56.23	
	needle fall in grams (per sq.m) from *C. equisetifolia*	36.46	21.48	16.42	
	Yield of Fenugreek (Intercrop q ha^{-1})	Control (Open Field)			144.17[a] 100%[b]

intensity, it was maximum in wider spacing (8x2m) and reduced towards lower spacing. Furthermore, the per cent availability of light intensity in the intercrop as compared to the open field (100%) was maximum in spacing S_3 and pruning intensity I_3 (61.34%) followed by S_3 and I_2(44.26%). The lowest availability of light intensity (7.69%) was seen in spacing S_1 and pruning intensity I_1 than the open field. In general, under the tree species, light intensity was low (7.69 to 61.34% of the normal light) throughout the growth period of intercrop which might acted as limiting factor for photosynthesis. These factors probably resulted in low accumulation of fresh weights under the influence of tree shade. Similar results were also recorded in rice by Venkateshwarlu and Srinivasan

Table 2: Returns from Tree component, intercrop and Agroforestry component

Treatment	Sole Casuarina at the age of 6 years*		Sole Fenugreek		Casuarina + Fenugreek	
	Cost per annum	Net Returns per annum	Cost per annum	Net Returns per annum	Cost per annum	Net Returns per annum
T_1 (S_1I_1)	1052.5	15614.42	----	----	12231.29	16507.38
T_2(S_1I_2)	1052.5	13947.75	----	----	16631.29	32128.71
T_3(S_1I_3)	1052.5	13111.42	----	----	16631.29	31991.38
T_4(S_2I_1)	701.08	15958.92	----	----	11986.80	30057.20
T_5(S_2I_2)	701.08	14292.67	----	----	14902.30	50419.45
T_6(S_2I_3)	701.08	13542.67	----	----	14902.30	50453.45
T_7(S_3I_1)	547.08	23015.42	----	----	11873.12	47313.38
T_8(S_3I_2)	547.08	20659.17	----	----	14060.62	62585.63
T_9(S_3I_3)	547.08	19481.04	----	----	14060.62	71791.50
Control (T_{10}-Open field)	----	----	11447.07	75881.00	----	----

*Net returns per annum from *Casuarina* includes the return from fuel-wood and the value of stand at that age

(1978), and John and Nair (1999) in coconut based homestead gardens. The needle fall during the period of experimentation showed that it was higher in closer spacing due to more number of trees followed by the wider ones. Also, with in the same spacing, it was maximum in un-pruned (I_3) and minimum in 75% pruned (I_3) trees.

The reduction in the yield of intercrop in I_3 and S_1 was might be due to reduction in the light intensity available to the intercrop which probably beyond the threshold level. Furthermore, the perusal of the data revealed that only 7.69% light intensity (per cent of light intensity in open field) was available to Fenugreek (Intercrop) which increase the needle fall due to the shading of the lower branches and greatly influenced the yield of the intercrop. Also, the data on needle fall revealed that 45.76g of needles were colleted in I_3 and S_1. This further supports the smothering effect of the needles on the intercrop which might have resulted in reduction of the plant density and lodging of the intercrop and thereby resulted in the reduction in yield in closer spacing and un-pruned tree stands.

The monetary returns from *Casuarina* and Fenugreek (as a sole crop) and cumulative returns from both the components have been compared (Table 2). The highest net returns (Rs 75881 ha^{-1}) was obtained in sole crop (T_{10}) followed by treatment T_9 (75% pruned and 8x2 m spacing) Rs 71791.50 ha^{-1} was obtained during the period of experimentation. The reduction in monetary returns from the agroforestry component was probably due to reduction in light intensity beyond the threshold level, needle fall and increase in cost per annum than the fenugreek grown as sole crop. The lowest net return (Rs 16507.38 ha-^{1}) was obtained in sole crop (T_1). This was probably due to low light intensity, higher needle fall, low plant density and lodging of the crop which resulted in the low crop yield in this treatment. The observed trend was open field > 75% pruning, 8x2 m spacing > 75% pruning, 6x2 m spacing > 50% pruning, 4x2

Table 3: Production economics of the Agroforestry component

Treatment	Yield (q ha^{-1})	Gross realization ((Rs ha^{-1})			Cost of planting material (Rs)	Labour cost (Rs)	Fixed cost (Rs)	Total cost (Rs)	Net Returns (Rs)
	pruned material	Fenugreek	Pruned material	Total					
T_1 (S_1I_1)	0	12072	0	12072	782.04	7422	2975	11179.04	892.96
T_2(S_1I_2)	312.5	33760	29687.5	63447.5	782.04	11822	2975	15579.04	47868.46
T_3(S_1I_3)	418.75	34456	39781.25	74237.25	782.04	11822	2975	15579.04	58658.21
T_4(S_2I_1)	0	25384	0	25384	888.72	7422	2975	11285.72	14098.28
T_5(S_2I_2)	316.54	50328	30071.3	80399.3	888.72	10337.5	2975	14201.22	66198.08
T_6(S_2I_3)	383.18	51112	36402.1	87514.1	888.72	10337.5	2975	14201.22	73312.88
T_7(S_3I_1)	0	35624	0	35624	929.04	7422	2975	11326.04	24297.96
T_8(S_3I_2)	337.5	55440	32062.5	87502.5	929.04	9609.5	2975	13513.54	73988.96
T_9(S_3I_3)	406.25	65824	38593.75	104417.8	929.04	9609.5	2975	13513.54	90904.21
Control (T_{10}-Open field)	--	87328.07	--	87328.07	1050	7422	2975	11447	75881.07

Market price: Fenugreek:Rs 8 per kg

Pruned material (fuelwood): Rs 95 per quintal on fresh weight basis.

m spacing.

The economics of treatments indicating gross realization per hectare, net realization and net return per rupee invested were worked out from the average yield of the intercrop and the pruned material, taking into account the prevailing market prices of the intercrop and the fuel wood. The highest net realization of Rs. 90904.21 per hectare was obtained from spacing S_3 and pruning intensity I_3 (8m x 2m spacing and 75% pruned).(Table 3)

CONCLUSION

From the present study, it can be concluded that, *Casuarina*-Fenugreek based agroforestry system can be grown successfully in coastal region of Gujarat by manipulating pruning intensities in widely spaced plantations, especially, which have reached rotation age by compromising some monetary retuns. Further, the yield of fenugreek can be increased by manipulating the pruning intensity to get more returns from the system when the tree component has almost reached the rotation age.

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