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Studies on suitable intercrops under tree mulberry for additional income in Kolar district of Karnataka

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Abstract
Sericulture has become a good source for economic upliftment of rural people in view of its fast income generating nature. In India, sericulture is a well-developed cottage industry and the technologies developed recently have made it possible to practice sericulture intensively with concomitant higher profit than from the major agricultural crops. Intercropping with tree mulberry is one of the ways by which productivity and net returns per unit area of land can be increased. The present On-farm testing study was conducted during 2017-18 & 2018-19 in two villages of Kolar district to assess the suitable intercrops under tree mulberry. Five farmers field were randomly selected to compare and study the suitable intercrops under tree mulberry based cropping system *viz.*, tree mulberry + ragi, tree mulberry + groundnut, tree mulberry + field bean and tree mulberry as sole crop (control). The yield of intercrops along with growth parameters *viz.*, Number of branches per plant, number of leaves per tree, Maincrop leaf yield (q/ha), intercrop yield (q/ha), cocoon yield (kg/100 dfls) were recorded. The cost of cultivation and gross returns per hectare for each treatment was computed based on the prices of inputs and outputs during the study. It was found that there was no significant difference in the growth parameters and leaf yield of mulberry raised as sole crop and tree mulberry with intercrop. Among the three intercrops, tree mulberry + field bean was the most suitable cropping system as it gave the highest return per rupee invested followed by tree mulberry + groundnut & tree mulberry + ragi intercrops.

Keywords: Mulberry, ragi, groundnut, field bean, silkworm rearing, cocoon yield, B:C ratio

Introduction
Sericulture has become a good source for economic upliftment of rural people in view of its fast income generating nature. In India, the technologies developed recently have made it possible to practice sericulture intensively with concomitant higher profit than from the major agricultural crops. Mulberry leaf being the sole food for the silkworm *Bombyx mori* L., contributes to around 38.20% towards successful cocoon production. Limiting the use of chemical fertilizers and supplementing the nutritional requirement of mulberry by organic sources such as intercropping with pulses makes the soil more productive and enhance the quality of mulberry (Qadri *et al.*, 2004) [10]. Intercropping of short duration pulses *viz.*, green gram, black gram, horse gram, soybean, cowpea etc., in mulberry garden maintains soil fertility and helps not only to increase leaf yield, grain and fodder yields but also supplement bulk organic matter (Babu and Dandin, 2009) [1]. Intercropping of mulberry with saffron in Kashmir yielded a good quality of mulberry leaf from the same field Where saffron was cultivated alone to generate work as well as good deal of returns to farmers during lean period when there are no operations related to saffron cultivation (Kaur *et al.*, 2002) [6]. Various recent studies also suggest that mulberry can successfully intercropped with medicinal plants like *Aloe barbadense*, *Asparagus racemosus*, *Acorus calamus* (Madhusudan *et al.*, 2015) [7]. Intercropping of field crops in tree mulberry is one of the ways by which productivity and net returns per unit area of land can be increased (Rajegowda *et al.*, 2020) [11]. The present study was therefore an attempt to know the feasibility of growing mulberry and suitable intercrops to improve the economic returns per unit area of land so that sericulture becomes more remunerative.

Material and Methods
A field study was carried out during the subsequent rainy (kharif) season of 2017-18 & 2018-19 in two villages of Kolar district *viz.*, Venugopalapura and Parshvaganahalli as a part of on farm testing by ICAR - Krishi Vigyan Kendra, Kolar, Karnataka to assess the feasibility of

suitable intercrops under tree mulberry. Five farmers field were selected to compare and study the suitable intercrops under tree mulberry method. The plantation was maintained as per the recommended package of practices (Dandin and Sengupta 1988; Balavenkatasubbaiah *et al.*, 2016) [3, 2] and the experiment was carried out as per the following experimental details.

Table 1: Field details and experiment details

Field details		Experiment details	
Crop	Mulberry	Design	RCBD
Variety	Victory-1	Treatments	04
Type of Plantation	Tree	Replications	05
Spacing	10 ft × 10 ft	Soil type	Red sandy loam soil
Age of Tree	2 years old	Area	1.20 ha

Table 2: Treatment details

Treatments	Main crop	Intercrops	Intercrops Spacing ratio
T_1	Tree mulberry	Sole crop	1: 1
T_2	Tree mulberry	Ragi	1: 6
T_3	Tree mulberry	Groundnut	1: 5
T_4	Tree mulberry	Field bean	1: 4

The farmer's practice which is solely grown tree mulberry without any intercrop considered as control (T_1). The tree mulberry was cultivated with a short duration crops in between the rows as T_2 = Ragi (ML-365), T_3 = Groundnut (GKVK-5) and T_4 = Field bean (HA-4) during the period of the study. The intercrops were sown between the rows of tree mulberry plantation 7 days after pruning during June-July and recommended NPK & FYM was applied as per the package of practices for main crop as well as intercrops. Weeds were controlled through manual weeding at 30 days after sowing. The intercrop yield was harvested during October - November. The leaf obtained from the soils of trial fields for evaluating tree mulberry and intercrops crops were red sandy loam soil with pH 6.83, EC 0.39 dSm, available organic carbon 0.40%, available N, P and K were 285.68, 124.56 and 210.88 kg/ha, respectively. Five randomly selected plants from five sites in each treatment were harvested. Standard procedures were used to measure the yield attributes and yield parameters of tree mulberry and intercrops. Variables were analyzed and least significance difference (LSD) test was carried out for analyzed mean square errors using Web Based Agricultural Statistics software Package (WASP 2.0). Significance and non-significance difference between treatments was derived through procedure provides for a single LSD value (Gomez and Gomez, 1984) [4].

Results and Discussion

Growth and yield performance of tree mulberry & intercrops: The two years pooled data revealed that the highest number of branches per tree, number of leaves per tree, weight of 100 leaves (g), leaf yield (kg/tree), leaf yield (q/ha) and cocoon yield (kg/ha) were recorded in tree mulberry sole crop (T_1) (51.10, 1319.33, 599.66, 7.399, 79.54 q/ha and 288.30 kg/ha) respectively and it was followed by tree mulberry + field bean T_4 (50.20, 1233.13, 595.00, 7.370, 79.23 q/ha and 284.62kg/ha), tree mulberry + groundnut T_3 (49.73, 1204.80, 590.00, 7.079, 76.10 q/ha and 267.39kg/ha) and tree mulberry + ragi T_2 (48.80, 1076.40, 581.00, 6.372, 68.49 q/ha and 232.41kg/ha) respectively. Similarly, the intercrops yield was recorded 17.26 q/ha, 10.37 q/ha and 35.52 q/ha from finger millet, groundnut and field bean respectively (Table 3). The highest growth and yield parameters of tree mulberry alone or intercropping with ragi, groundnut and field bean did not have any adverse effect on mulberry during both the seasons of study. This may be due to mulberry and the intercrops do not compete with each other due to differential canopy height, growth cycle, Requirement of nutrients and position of root in the soil. Further it may increases soil fertility as legume crop. The results were in conformity with the findings of Rajegowda *et al*., 2020; Mir *et al*., 2022 [11, 8] reported the similar findings on efficacy of mulberry based intercropping system in Hassan district of Karnataka and Pirpanjal and Shiwalik regions of Himalayas.

Table 3: Growth and yield performance of tree mulberry and intercrops as influenced by intercropping system (Average of Two Year)

Parameters	No of branches/ tree (No)	No of leaves/tree (No)	Wt of 100 leaves (g)	Leaf yield (Kg/tree)	Main crop yield (q/ha)	Intercrop yield (q/ha)	Cocoon yield (Kg/ha)
T_1: Tree mulberry as sole crop (Control)	51.10	1319.33	599.66	7.399	79.54	0	288.30
T_2:Tree mulberry + Ragi (1:6)	48.80	1076.40	581.00	6.372	68.49	17.26	232.41
T_3:Tree mulberry + Groundnut (1:6)	49.73	1204.80	590.00	7.079	76.10	10.37	267.39
T_4:Tree mulberry + Field bean (1:2)	50.20	1233.13	595.00	7.370	79.23	35.52	284.62
S.Ed ±	1.167	21.831	15.852	0.686	1.771	0.662	4.134
CD (P=0.05)	NS	47.565	NS	1.494	3.859	1.441	9.008

NS – Non-significant; S - Significant

Economics of tree mulberry leaf production with intercrops: The cost of cultivation of tree mulberry along with different field crops depicted in table 4 and fig 1 clearly showed that the benefit cost ratio was recorded as 5.56, 3.92 and 4.34 in field bean, finger millet and ground nut intercrops compare to tree mulberry sole crop 5.11. Further, net return obtained from finger millet (Rs. 1,08,873), Groundnut (Rs. 1,33,044) and Field bean (Rs.1,69,986) compare to tree mulberry sole crop (Rs. 1,02,832). Farmers obtained additional income of Rs. 15727, Rs. 40743 and Rs. 66966 from finger millet, groundnut and filed bean grown as intercrop under tree mulberry during subsequent kharif season. These findings are in conformity with Rajegowda *et al*. (2020) [11] opined that growing cowpea as an intercrop given higher B:C (2.63) due to increased soil fertility, higher leaf yield, cocoon yield and additional income as compared with other intercrops (Ragi- 2.56, Groundnut-2.46) and control (2.54). (Singhvi and Katiyar 2009; Khan *et al.* 2015) [12, 5] tested the intercropping of mulberry with garlic, onion, carrot and turmeric and reported that intercropping of mulberry resulted in generation of additional income to farmers by harvesting cocoons and intercrops. Maximum yield of intercrops as well as net profit per hectare were obtained in 90 x 90cm spacing with the combination of mulberry with cowpea in June-August (Rs. 10,114/-) and also showed better benefit: cost ratio in all the seasons (Mishra *et al*. 2009) [9].

Table 4: Economics of tree mulberry leaf production with intercrops (Average of Two Year).

Parameters	Gross cost (Rs./ha)	Gross Return (Rs./ha)	Net Return (Rs./ha)	Additional returns from intercrops	B:C Ratio (Rs.)
T_1	25010	127842	102832	0	5.11
T_2	37335	146208	108873	15727	3.92
T_3	39830	172874	133044	40743	4.34
T_4	37383	207369	169986	66966	5.56

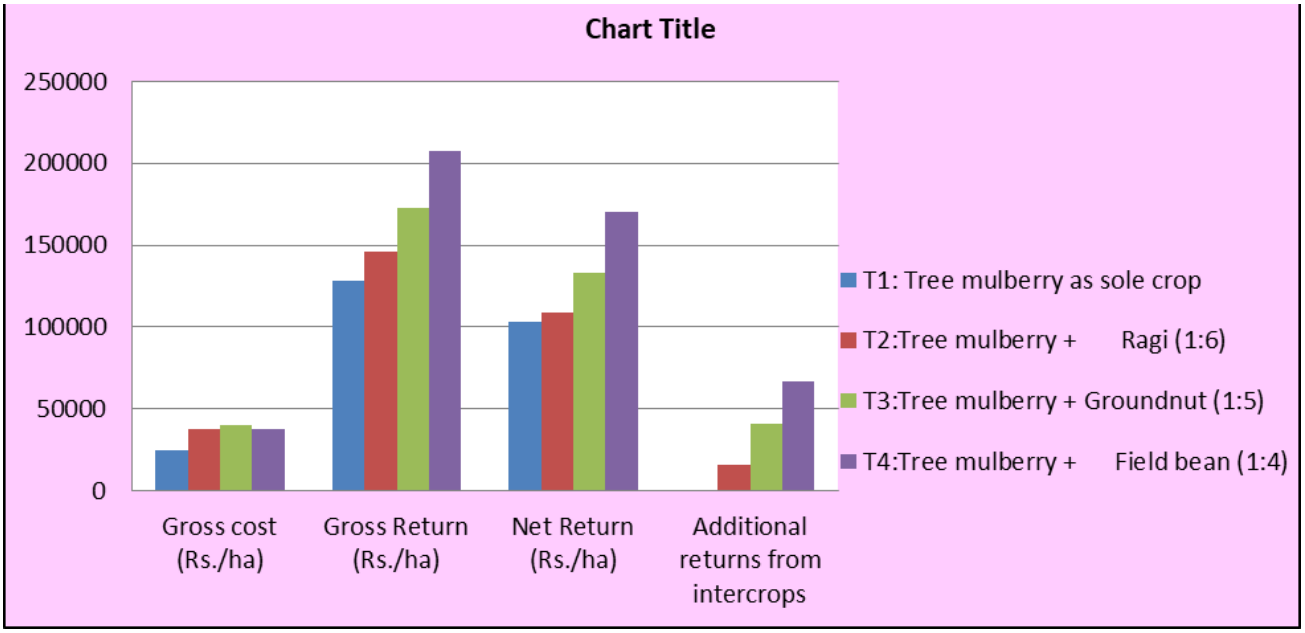

Fig 1: Economics of tree mulberry leaf production with intercrops

Plant 1: Tree mulberry sole crop

Plant 2: Tree mulberry + Ragi

Plant 3: Tree mulberry + Groundnut

Plant 4: Tree mulberry + field bean

Plant 5: Ragi, Groundnut, Field bean intercrops with Tree mulberry and silkworm rearing

Conclusion

Based on two year results, it may be summarized that, intercropping of tree mulberry with field bean earned better returns followed by groundnut and ragi without affecting on main crop yield. Before intervention of the technology sericulture farmers in that villages were cultivating tree mulberry for foliage and cocoon production only. After intervention the farmers obtained additional income of Rs. 15727/ha, Rs. 40743/ha and Rs. 66966/ha from finger millet, groundnut and filed bean grown as intercrop. Since inclusion of legumes in the intercropping system results in sustaining the soil productivity and Problem of weeds is also overcome by coverage of land.

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