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Mulberry based farming system, an effective way of land utilization for silkworm rearers of Kashmir, India

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Abstract
Mulberry (*Morus* Sps), a fast growing, deciduous, woody perennial angiosperm which has an ability to grow as bush, dwarf and tree under varied agro climatic conditions. It produces leaf which is the only food to silkworm (*Bombyx mori* L.) reared to produce silk, the queen of textiles. Farmers in Kashmir feel reluctant to devote their land to mulberry cultivation because of the subsidiary occupation of sericulture. This is inspite of the fact that unlike other tree species of this region, mulberry provides two flushes of leaf in a year despite remaining bereft of leaf during major portion of a year. This is due to the fact that its annual growth cycle is such that it remains without foliage most of the time thereby causing least interception of solar light for the crops that can be grown underneath. This therefore provides an ideal choice of growing mulberry and short duration vegetables simultaneously for effective land and resource utilization besides round the year cash flow to farmers. The present paper explains how the integration of mulberry and vegetable cultivation can help in improving productivity per unit area through effective land utilization and resource management. This will assure the stakeholders of increased benefits and change their unwillingness to use their land exclusively for mulberry cultivation and will help address the problem of leaf shortage in the region.

Keywords: Mulberry, intercrop, silkworm, rearing, vegetables, rabi

Introduction
The global population is growing at a very high pace. Different strategies are followed to improve the agricultural produce to fulfill the needs of the living world. Amongst these, the application of synthetic agrochemicals in the form of fertilizers, pesticides etc. is practised at such a fast rate that the environment is rendered unfit for the living world. Integration approach involving growing more at a reduced input application, if practiced in agriculture, can address the problem of food shortage to a great extent. Growing crops in isolation does not seem to motivate the farmers where as growing crops together as intercrops is gaining importance but it demands for suitable crops to fit the combination.

Mulberry (*Morus* sps) is the sole food to silkworm (*Bombyx mori* L.), which is reared to produce silk. In Kashmir, mulberry is generally growing in a scattered manner on the roadsides, farm boundaries, river bunds, school grounds and Panchayat lands etc. It is cultivated under rainfed conditions and faces stiff competition with other agricultural and horticultural crops because only one or two crops of leaf can be harvested in a year from the mulberry, as against 4-5 crops under south Indian conditions. Further a belief that no crop can grow beneath this plant adds to the reluctance of farmers to devote their land for mulberry cultivation. This leads to shortage of mulberry leaf at the farmers' level. Farmers have to toil hard to get leaf for their worms and have to arrange it from far off places. The leaf transportation on one hand involves huge amounts as fright and on the other hand reaches the worms in a semi withered condition thereby reducing its acceptability by the worms and remains as refuse and thus goes a waste thereby making sericulture less remunerative. An effective way to address this problem is to motivate the silkworm rearers to establish their own mulberry plantations as intercrops with other routine crops of their choice. For this mulberry as tree seems to be an ideal option for integrative farming system under Kashmir climatic conditions. The plant has a great regeneration capacity and yields two flushes of leaf in the annual bearing phase of just 05 months in a year which makes two cocoon crops possible annually. Further the plant due to its physiological aspects coupled with the cultural operations followed in the region has a remarkable quality of being with no/low leaf during more than 07 months in a year and thus causing least interception of solar light. This therefore encourages growing intercrops under mulberry plantation.

Intercropping in mulberry can be beneficial as the resource demands (nutrients, water, sunlight, etc.) occur during different periods of the growing season which can lead to an effective means of minimizing interspecific competition and encouraging complementarity of crops. Some work has been done to find out the suitability of mulberry as a component of intercropping. Dayakar Yadav and Nagendra Kumar (1992) tested the effect of soya bean and green gram on productivity, monetary benefits and nodulation in soya bean/mulberry and green gram/mulberry intercropping systems. Singhvi and Katiyar (2009) [9] tested the intercropping of mulberry with garlic, onion and carrot in Maharashtra and reported that intercropping of mulberry resulted in generation of additional income to farmers by harvesting cocoons and intercrops. Rajegowda *et al*. (2020) [8] studied the effect of intercrops on growth and yield of mulberry and cocoon crop and reported that growing cowpea as an intercrop gave higher B: C (2.63) due to increased soil fertility, higher leaf and cocoon yield. Very less studies have been undertaken under Kashmir climatic conditions especially with tree mulberry except Kour *et al.* (2002) [6] who tested intercropping of mulberry with saffron (*Crocus* sps) and got encouraging results. The present study was therefore an attempt to study the feasibility of growing mulberry and vegetables as intercrops to improve the economic returns per unit area of land so that sericulture becomes more remunerative and popular to help increase the cocoon production and regain the past and lost glory of sericulture.

Material and Methods

The study was taken up at the mulberry farm of College of Temperate Sericulture Mirgund, SKUAST (K), Baramulla Kashmir on established young trees of Goshoerami, the most popular variety of mulberry in the region. The plantation was maintained as per the recommended package of practices and the experiment was carried out as per the following experimental details:

The experiment was carried out as per the following experimental details:

Design	:	RBD
Mulberry Variety	:	Goshoerami
Replications	:	04
Plants/treatment/replication	:	06
Treatments	:	06
Type of Plantation	:	Tree
Spacing	:	9ftX 8ft
Age of Trees	:	10 years
Treatments	:	06

Treatment details

Treatment	Tree crop	Rabi vegetable	Kharif vegetable
T1	Mulberry	Onion	Rajmash
T2	Mulberry	Garlic	Rajmash
T3	Mulberry	Turnip	Rajmash
T4	Mulberry	Peas	Sag
T5	Mulberry	Sag	Rajmash
T6 (Control)	Mulberry	Nil	Nil

The plantation was maintained under rainfed conditions. Rabi Vegetables were planted during August-October and harvested during February to May where as Kharif vegetables were planted during May-June and harvested during August-September. (Table-1) Observations on yield and yield attributing attributes of mulberry were recorded during Spring and Autumn crops coinciding with the Vth stage of silkworm rearing as the leaf consumption is tremendous (more than 85%) during this stage. Yield of vegetables harvested during the two crops (Rabi and Kharif) was recorded and sold to generate revenue as per the market rates and converted to per hectare values.

The results got during the 02 years of study in terms of the growth and yield parameters of mulberry and the yield of vegetables in terms of kind and cash were pooled season wise to derive conclusions. Leaf and cocoon yield and the expected revenue to be earned through silkworm has also been worked out for different ages of mulberry plantation. Appropriate statistical procedures were followed to analyze the growth and yield data of mulberry.

Table 1: Sowing and Harvesting Details of Vegetables

Rabi Vegetables			Kharif Vegetables		
Name	**Sowing**	**Harvesting**	**Name**	**Sowing**	**Harvesting**
Onion	October end-15th November	May- mid June	Rajmash	Mid-June	September
Garlic	October end-15th November	May- mid June	Rajmash	Mid-June	September
Turnip	Last week of August	Last week of November-February end	Rajmash	Mid-June	September
Peas	October end-15th November	May- mid June	Sag	Mid-June	August-September
Sag	Last week of August-15th September	November-February end	Rajmash	Mid-June	September

Results and Discussion

The growth parameters of mulberry viz number of shoot lets/ branches per plant respectively during Spring And Autumn, total shoot length/plant (m) and the leaf yield per plant depicted non-significant differences among the treatments suggesting that growing mulberry alone (T6) or in intercropping with short duration vegetables (Rabi and Kharif) did not have any adverse effect on mulberry other treatments during both the seasons of study, i.e., spring and autumn (Table-1). This may be because the 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. Increased production more in intercropping can be attributed to the higher growth rate, reduction of weeds, reducing the pests and diseases and more effective use of resources due to differences in resource consumption (Eskandari, 2012b; Eskandari et al., 2009b) [4, 3]. In addition, if there are "complementary effects" between the components of intercropping, production increases due to reducing the competition between them (Mahapatra, 2011; Zhang and Li, 2003) [7, 11]. This increased resource use efficiency is important, especially for small-scale farmers and also in areas where growing season is short (Altieri, 1995) [1]. Willey (1979) [10] has also reported that intercropping results in increased yield. This can be due to the fact that mulberry and the vegetables grow at different heights with their root systems reaching different depths do not have stiff competition for space, sunlight, nutrients and water and thus

do not have a competition with mulberry for light, space, nutrients and water. This is further explained by the difference in growth resources of component crops which reduces the inter crop competition. Khan *et al*., (2015) [5] have also reported the suitability of mulberry for intercropping with turmeric to harvest maximum potential of resources. A farmer can get revenue through the sale of vegetables (Table-2) and silkworm rearing (Table-3). This module therefore fulfills the basic idea of companion cropping to make the silk worm rearers harvest benefit from each other rather than compete with each other. Further the farmers will get work and produce throughout the year thereby doing away with the age old notion that nothing can grow as an intercrop with mulberry.

Table 1: Growth and yield of mulberry under intercropping with vegetables

Treatment	No. of shoot lets/ branches Per plant		Total shoot length per plant (m)		Leaf yield per Plant (Kg)	
	Spring	Autumn	Spring	Autumn	Spring	Autumn
T1 (Onion + Rajmash)	61.71	19.50	36.06	26.69	4.55	4.00
T2 (Garlic + Rajmash)	60.12	19.67	69.90	28.47	4.06	4.30
T3 (Turnip + Rajmash)	60.07	18.66	35.45	26.79	3.98	3.88
T4 (Peas + Sag)	61.48	19.45	35.02	26.66	3.87	3.81
T5 (Sag + Rajmash)	61.22	18.88	35.49	26.15	3.91	4.37
T-6 Control	61.55	19.34	35.08	26.10	3.92	3.83
F- test	NS	NS	NS	NS	NS	NS

Table 2: Details of vegetable crops harvested

Treatment	Rabi yield (Kg)	Kharif yield (Kg)	Income by sale of		Total income (Rs)	Production cost (Rs)	Net income (Rs)
			Rabi crop	Kharif crop			
T1 (Onion + Rajmash)	20.00	9.00	200	90	290	100	190 (58727)
T2 (Garlic + Rajmash)	16.50	9.50	285	110	395	205	190 (71,595)
T3 (Turnip + Rajmash)	28.00	9.00	295	99	398	100	298 (1,12,291)
T4 (Peas + Sag)	15.00	16.50	165	178	343	120	223 (84,030)
T5 (Sag + Rajmash)	18.00	9.25	196	106	302	100	202 (78,754)
T-6 Control	Nil	Nil	Nil	Nil	Nil	Nil	Nil

Figure in parenthesis are estimated per hectare values.

Table 3: Expected revenue through the sale of cocoons after the establishment of mulberry garden (Estimated values)

Expected Produce	5-10 years @ kg/plant/year	10-20 years @ 25kg/plant/year	Above 20 years @ 40kg/plant/year
Leaf yield per hectare per year(kg)	13440	33600	53760
Expected seed (oz) that can be brushed @ 1200kgs/oz	11.20	28.00	44.8
Expected cocoon yield (Kg) @ 50 kgs/oz (Green)	560	1400	2240
Expected revenue @ 300/kg (Rs)	1,68,000	4,20,000	6,72,000

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