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## Economics of cucurbitaceous vegetable crops under teak (*Tectona grandis* L.f.) based silvi-horticultural system in South Gujarat

SM Patel, MB Tandel, MK Desai, JG Pathak, LK Behera and MR Parmar

**Abstract**

The present trial was carried out with the objective to find the economics of cucurbitaceous vegetables under a teak based silvi-horticultural system in South Gujarat condition. The trial was carried out at College Farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari, Gujarat, during summer 2016 and 2017. The experiment was comprised of eight treatments with three replications in Randomized Block Design. The highest net realization (Rs. 1,42,315.00) and benefit cost ratio (2.05) was registered when T<sub>7</sub>: Smooth Gourd var. Pusa Chikni was grown in sole cropping system as compared to Teak based silvi-horticultural system. Moreover, if we considered yield of teak then maximum net realization (Rs. 4,78,519.13) and benefit cost ratio (7.53) was registered significantly maximum in T<sub>1</sub>: Bottle Gourd var. Local grown under teak based silvi-horticulture system.

**Keywords:** BCR, cucurbitaceous crop, economics, silvi-horticultural system, teak

**Introduction**

Agroforestry is a collective name for land-use systems and technologies in which woody perennials including trees, shrubs, bamboos *etc.* are deliberately combined on the same land-management unit with herbaceous crops or animals either in some form of spatial arrangement or temporal sequence. In agroforestry system there are both ecological and economic interactions amongst the different components (Lundgren and Raintree, 1982) [9]. Again it plays the major role to overcome the problems of global climate change, reduces the pressure on natural forests, fulfils the requirement of various tangible and intangible returns from trees, *etc.* in the present world demanding context. An efficient agroforestry system would aim at systematically developing integrated land use systems and practices where the positive interaction between trees and crops are encouraged and maximized. Agroforestry offers an economical and ecologically viable option for large scale diversification in agriculture on one hand and environmental amelioration on the other. Hence, to save forests and meet the growing demands of wood, there is need for large scale plantations of fast growing tree species outside forests to make country self reliant in its timber requirements. On-farm timber tree plantations can also benefit from the global environmental facilities like carbon trading (Pandey, 2007 and Dogra, 2007) [12, 7]. It is expected that improving tree cover in the agroforestry plantation in the state may accelerate in near future, taking tree population from about 269 million to about 350 million in the next two five years plan. Development of agroforestry provides another opportunity to the state to become global leader in improving tree cover, initiating a new approach to address global warming and also to evolve a model of rural development in the line of the dream of Mahatma Gandhi for "Gramya Swaraj" (Singh and Khanna, 2012) [20].

In the present investigation, four Cucurbitaceous vegetable like Bottle gourd, Smooth gourd, Ridge gourd and Cucumber were intercropped with the established tree species of *Tectona grandis* (Teak). These crops are selected on the basis of their adaptation, growing habit, production and requirement. Cucurbitaceous is one of the largest families in vegetable kingdom consisting one of largest number of edible type species. Cucurbitaceous family is commonly known as the gourd, melon or pumpkin family. This family is composed of 118 genera and 825 species, which are widely distributed in the warmer regions of the world (Parle and Kaur, 2011) [14].

The teak tree is well known for its versatile timber. Its heartwood combines several qualities like termite and decay resistance, lightness and strength, drying without warping and splitting, easy workability and attractive appearance, making it one of the world's finest timbers. Teak position among timbers has been similar to that of gold among metals and diamond among precious stones. Teak has many other uses in addition to excellent timber. Among gourds, bottle gourd (*Lagenaria siceraria* L.) commonly grown extensively in India. It is a vegetable with a good source of carbohydrates, vitamin A, vitamin C and minerals (Patel *et al.*, 2017) [15]. It can commercially be grown throughout the year, particularly in areas where winters are mild. The leading states in India producing bottle gourd are Bihar, Madhya Pradesh, Odisha, Chattisgarh, Uttar Pradesh and Gujarat (Anonymous, 2015) [2]. The cucumber (*Cucumis sativus*) is an important summer vegetable and is a trailing or climbing annual, bearing elongated, thick, cylindrical fruits of varying sizes and forms. It is widely cultivated throughout India as well as in other tropical and subtropical parts of the world (Chandy, 2014) [5]. Smooth gourd (*Luffa cylindrica*) belongs to genus *Luffa* member of the cucurbitaceae family. *Luffa* is closely related to cucumber and has similar cultural requirements as the cucumber. Only two species *L. cylindrica* and *L. acutangula* are domesticated. *Luffa* is environmentally safe, biodegradable and a renewable resource (Thapa and Tripathy, 2017) [21]. Ridge gourd (*Luffa acutangula* Roxb.) fruits are used for culinary preparation in tender form. Both crops are widely cultivated in almost all tropical countries and throughout India (Thapa and Tripathy, 2017) [21]. Keeping in view the above facts and economic importance of the cucurbitaceous vegetable crops and teak the present investigation undertaken with the objective to study the economic performance of understory cucurbitaceous vegetables under the teak based silvi-horticultural system in South Gujarat condition.

## Material and Methods

The investigation on "Economic of cucurbitaceous vegetable crops under teak (*Tectona grandis* L.f.) based silvi-horticultural system in South Gujarat" was carried out at College Farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari, Gujarat, during summer 2016 and 2017. The experiment was comprised of eight treatments viz., T<sub>1</sub>-Bottle Gourd Var. Local + *Tectona grandis* L.f., T<sub>2</sub> - Ridge Gourd Var. Pusa Nasdar + *Tectona grandis* L.f., T<sub>3</sub>- Smooth Gourd Var. Pusa Chikni + *Tectona grandis* L.f., T<sub>4</sub>- Cucumber Var. Local + *Tectona grandis* L.f., T<sub>5</sub>- Bottle Gourd Var. Local sole crop, T<sub>6</sub> - Ridge Gourd Var. Pusa Nasdar sole crop, T<sub>7</sub>- Smooth Gourd Var. Pusa Chikni sole crop and T<sub>8</sub> - Cucumber Var. Local sole crop with three replications in Randomized Block Design (RBD). The experiment was conducted in an already established twenty three year old plantation of Teak (*Tectona grandis* L.f.) planted at 3m x 2m spacing were used and four cucurbitaceous vegetables crops viz., Bottle Gourd, Ridge Gourd, Smooth Gourd and Cucumber were planted at a spacing 2m x 1m for the present study. The experimental field was brought to fine tilth by ploughing, clods crushing and harrowing with the tractor. Then experimental field was leveled and plots were prepared as per the details of experiment. Well decomposed Farm Yard Manure was applied uniformly to the entire experimental plot at the rate of 20 t/ha. Phosphorus was applied in the form of single super phosphate and potash in the form of murate of potash uniformly to the each plots at the rate of 40 kg/ha. Nitrogen

was applied in two splits doses first half dose of nitrogen (40 kg/ha) was applied as basal dose at the time of planting and remaining second half dose of nitrogen (40 kg/ha) was applied in the form of urea after 45 days after sowing. Crop was irrigated immediately after each application of fertilizer. Seeds of all cucurbitaceous vegetable crops as per experimental details (inter crop and sole) were planted at the spacing 2 m x 1 m. Immediately after planting a light irrigation was given to the crop for better establishment of seeds in the field. Depending upon the soil moisture condition, the irrigation was provided at 10 to 15 days intervals. Weeding and hoeing were done 15 days intervals to keep plot clean and weed free. Necessary plant protection measures were adopted. No serious pest and diseases were observed on this crop during the cropping period. For the performance in terms of economics the gross realization in term of rupees per hectare was worked out on the basis of yield of each treatment. The price of cucurbitaceous vegetable was accounted on the basis of prevailing market rate. The cost of fertilizers is taken as form the current market price. The cost benefit ratio (CBR) was calculated by an incremental cost of different treatment and benefit obtain through an increase in production due to the respective treatment. The net returns per hectare were calculated by deducting the cost of cultivation from gross return per hectare. The benefit cost ratio was calculated as per formula in which net realization divided by cost of cultivation. For analysing the economic performance, parameters of tree component tree height, DBH, crown spread (East-West and North-South direction) and yield of intercrops were recorded and analysed as per the procedure described for RBD (Panse and Sukhatme, 1967) [13]. Standard error of means i.e. SE<sub>m</sub> (±) and Critical Difference (CD) were calculated at 5% level of significance and compared the treatments means, wherever 'F' test was found significant.

## Results and Discussion

### Economics without Teak

The data with respect to benefit cost ratio without teak are presented in table- 1. It is evident from data presented in table that cucurbitaceous crops grown in sole cropping system recorded highest net realization and BCR as compared to Teak based silvi-horticultural system. In case of open field condition the highest net realization and benefit cost ratio (BCR) was recorded in T<sub>7</sub>- Smooth Gourd var. Pusa Chikni sole crop (Rs. 1,42,315.00/ha and 2.05, respectively) as compared to T<sub>5</sub>: Bottle Gourd (Rs.1,38,643/ha and 1:2.00, respectively), T<sub>6</sub>. Ridge Gourd (Rs.1,04,119/ ha and 1.50, respectively) and T<sub>8</sub>. Cucumber (Rs. 98,243/ha and 1.35, respectively). Moreover, in case of Teak based silvi-horticultural system, the highest net realization and BCR was registered when T<sub>3</sub>. Smooth Gourd var. Pusa Chikni (Rs. 65,261/ha and 1.43, respectively) as compared to T<sub>1</sub>: Bottle Gourd (Rs. 63,485/ha and 1.39, respectively), T<sub>2</sub>. Ridge Gourd (Rs. 55, 937/ha and 1.23, respectively) and T<sub>4</sub>. Cucumber (Rs. 52,181/ha and 1.09, respectively). Among four cucurbitaceous crops highest net realization and BCR was registered when Smooth Gourd was grown in sole cropping system. The highest net realization and benefit cost ratio was registered when T<sub>7</sub>: Smooth Gourd var. Pusa Chikni was grown in sole cropping system. The probable reason for it might be good availability of light in sole cropping system as compared to teak based silvi-horticultural system as well as good increase of growth and yield parameters of in sole cropping system as compared to teak based silvi- horticultural system. These

results are in line with earlier findings of Rajput *et al.* (1988)<sup>[17]</sup> in Dashehari mango orchard, Bhuvu *et al.* (1988)<sup>[4]</sup> in Mango with tomato, Shanmugasundaram and Subrahmaniyam (1993)<sup>[18]</sup> in coconut with papaya, Sharma *et al.* (1996)<sup>[19]</sup> in coconut with ginger and Chaturvedi and Jha (1998)<sup>[6]</sup> in litchi plantations with paddy-wheat-green gram-ginger and maize-toria-green gram-pointed gourd.

### Economics with Teak

The data regarding benefit cost ratio with teak are presented in Table-2. The benefit cost ratio was noted maximum in teak based silvi-horticulture system as compared to sole cropping system. The highest BCR and net realization (7.53 and Rs. 4,78,519.13, respectively) were registered in T<sub>1</sub>: Bottle Gourd var. Local + *Tectona grandis* L.f. which was followed by T<sub>2</sub>: Ridge Gourd var. Pusa Nasdar + *Tectona grandis* L.f. (5.86 and Rs.3,72,572.70, respectively). When we considered yield of teak than highest BCR and net realization were

reported in teak based silvi-horticulture system as compared to sole cropping system. Also height and diameter of teak under teak based silvi-horticulture system is more compare to teak crop alone. The probable reason for more height and diameter of teak under teak based silvi-horticulture system is availability of water and nutrients which was applied to cucurbitaceous during cropping period. Akin results were earlier reported by Sharma *et al.* (1996)<sup>[19]</sup> in coconut with ginger, Anonymous (2000)<sup>[1]</sup> in *Tectona grandis* and *Embilica officinalis* with cucumber, radish, ridge gourd, bitter gourd, beans and ground nut, Islam *et al.* (2008)<sup>[8]</sup> in winter vegetable with guava and coconut, Arya *et al.* (2010)<sup>[3]</sup> in tree fruits moreover in case of annual crops, Pandey *et al.* (2010)<sup>[11]</sup> in neem with black gram, Munde *et al.* (2011)<sup>[10]</sup> in cowpea, sorghum, horse gram, *Stylo hamata* and *Cenchrus ciliaris* with custard apple and Rajalingam *et al.* (2016)<sup>[16]</sup> in tomato, brinjal, bhendi, cluster beans and vegetable cowpea under *Ailanthus*.

**Table 1:** Economics of various cucurbitaceous crops as affected by teak based silvi-horticultural and sole cropping system (Without Teak)

Treatments	Yield (q/ha)	Fixed Cost (Rs/ha)	Variable Cost (Rs/ha)	Total Cost (Rs/ha)	Gross Realization (Rs/ha)	Net Realization (Rs/ha)	BCR
T <sub>1</sub>	90.86	42307	3240	45547	109032.00	63485.00	1.39
T <sub>2</sub>	84.57	42307	3240	45547	101484.00	55937.00	1.23
T <sub>3</sub>	92.34	42307	3240	45547	110808.00	65261.00	1.43
T <sub>4</sub>	83.24	42307	5400	47707	99888.00	52181.00	1.09
T <sub>5</sub>	173.35	64577	4800	69377	208020.00	138643.00	2.00
T <sub>6</sub>	144.58	64577	4800	69377	173496.00	104119.00	1.50
T <sub>7</sub>	176.41	64577	4800	69377	211692.00	142315.00	2.05
T <sub>8</sub>	142.35	64577	8000	72577	170820.00	98243.00	1.35

**Note:** Selling price of various cucurbitaceous crops @ Rs. 12 / kg

**Table 2:** Economics of various cucurbitaceous crops as affected by teak based silvi-horticultural and sole cropping system (With Teak)

Treatment	Cucurbitaceous Crops				Gross Realization of cucurbitaceous Crops (Rs/ha)	Teak		Total Cost of Cultivation (Rs/ha)	Total Gross Realization (Rs/ha)	Net Realization (Rs/ha)	BCR
	Yield (q/ha)	Fixed Cost (Rs/ha)	Variable Cost (Rs/ha)	Total Cost (Rs/ha)		Teak Cost (Rs/ha)	Gross Realization of Teak (Rs/ha)				
T <sub>1</sub>	90.86	42307	3240	45547	109032.00	18017.39	433051.52	63564.39	542083.52	478519.13	7.53
T <sub>2</sub>	84.57	42307	3240	45547	101484.00	18017.39	334653.09	63564.39	436137.09	372572.70	5.86
T <sub>3</sub>	92.34	42307	3240	45547	110808.00	18017.39	249192.43	63564.39	360000.43	296436.04	4.66
T <sub>4</sub>	83.24	42307	5400	47707	99888.00	18017.39	315400.56	65724.39	415288.56	349564.17	5.32
T <sub>5</sub>	173.35	64577	4800	69377	208020.00	0.00	0.00	69377.00	208020.00	138643.00	2.00
T <sub>6</sub>	144.58	64577	4800	69377	173496.00	0.00	0.00	69377.00	173496.00	104119.00	1.50
T <sub>7</sub>	176.41	64577	4800	69377	211692.00	0.00	0.00	69377.00	211692.00	142315.00	2.05
T <sub>8</sub>	142.35	64577	8000	72577	170820.00	0.00	0.00	72577.00	170820.00	98243.00	1.35

**Table 3:** Cost of cultivation (Rs. /ha) bottle gourd, sponge gourd, ridge gourd and cucumber

Description	Rate	Open Condition	Teak Based Silvi-Horti System
<b>Fixed Cost</b>			
<b>Preparatory tillage</b>			
Ploughing by tractor with (1time) M.B. plough	@Rs.300/ hr	Rs. 2400 for 8 hours	Rs. 1800 for 6 hours
Ploughing by tractor with (2 times) cultivator	@ Rs.200/ hr	Rs. 2400 for 6 hours	Rs. 1200 for 3 hours
Ploughing by tractor with (1 times) Rotavator with planking	@ Rs.600/ hr	Rs. 2400 for 4 hours	Rs. 1200 for 2 hours
Total		Rs. 7200	Rs. 4200
<b>Lay out and Transplanting</b>			
Layout, Preparation of channel, beds, making furrows, and earthing up	@ Rs.178 /day	Rs. 2136/ 12 labour	Rs. 1424/ 8 labour
Planting	@ Rs.178/ day	Rs. 2670/ 15 labour	Rs. 1780/ 10 labour
Gap filling	@ Rs.178/day	Rs. 890 / 5 labour	Rs. 534 / 3 labour
Total		Rs. 8368	Rs. 3738
<b>Manures and fertilizers (80-40-40 NPK kg/ha)</b>			
FYM 20 t /ha	@ Rs. 470/t	Rs. 9400/ 20 t/ha	Rs. 6345/ 13.5 t
Urea	@ Rs. 6/kg	Rs. 1044 / 174 kg	Rs. 696 / 116 kg
SSP	@ Rs. 9/kg	Rs. 2250 / 250 kg	Rs. 1503 / 167 kg
MOP	@ Rs. 15/kg	Rs. 1005 / 67 kg	Rs. 675 / 45 kg
Expenditure on manures application	@ Rs. 200/ t of FYM	Rs. 4000	Rs. 2700
Expenditure on fertilizer application (5 labours for 1 day)	@ Rs.178/	Rs. 890/ 5 labour	Rs. 534/ 3 labour
Total	/labour/day	Rs. 18589	Rs. 12453
<b>Intercultural operations</b>			

Weeding two times	@ Rs.178/day	Rs. 3560/ 10 labour	Rs. 2848 / 8 labour
Total		Rs. 3560	Rs. 2848
<b>Irrigation application</b>			
Irrigations - 8	@ Rs. 30 per hour	Rs. 4800/ (@ 20hr for 1 ha.)	Rs. 3360 / (@ 14hr for 1 ha.)
Labour charges (2 men for 1 irrigation)	@ Rs.178/	Rs. 2848	Rs. 2848
Total	/labour/day	Rs. 7648	Rs. 6208
<b>Plant protection</b>			
Labour for spraying (2 men per spray)	@ Rs.288	Rs. 2880	Rs. 2880
DDVP 1 spray	/labour/day	Rs. 364/ 800 ml/ ha	Rs. 250 /550 ml/ ha
Chloropyrifos 1 spray	@ Rs.455/ lit	Rs. 430/ 2 lit / ha	Rs. 323 / 2 lit / ha
Thimethozam) 1 spray	@ Rs. 215 /lit	Rs. 372 /400 g/ ha	Rs. 249 /267 g/ ha
Imeda chlor 1 spray	@ Rs. 930/ kg	Rs. 426 / 300 ml/ ha	Rs. 284 / 200 ml/ ha
Profenophos 1 spray	@ Rs. 1420/lit	Rs. 500/ 1 lit/ha	Rs. 330/ 660 lit/ha
Total	@ Rs. 500/lit	Rs. 4972	Rs. 4316

<b>Harvesting and Marketing</b>			
Harvesting – 8 times	@ Rs.178/day	Rs. 14240 / 10 labours for 1 day	Rs. 14240 / 6 labours for 1 day
Total		Rs. 14240	Rs. 8544
Fixed Cost - Grand Total		Rs. 64577	Rs. 42307

Variable Cost			
Description	Rate	Open Condition	Teak Based Silvi-Horti System
<b>Seed (4 kg/ ha )</b>		<b>(4 kg/ ha )</b>	<b>(2.70 kg/ ha )</b>
Bottle Gourd	@ Rs. 1200 /kg	Rs. 4800 /kg	Rs. 3240 /kg
Ridge Gourd	@ Rs. 1200/ kg	Rs. 4800/ kg	Rs. 3240/ kg
Smooth Gourd	@ Rs. 1200/kg	Rs. 4800/kg	Rs. 3240/kg
Cucumber	@ Rs. 2000/ kg	Rs. 8000/ kg	Rs. 5400/ kg

**Table 4:** Various growth parameters of teak as affected by teak based silvi-horticultural system

Treatments	Height (m)	Collar Diameter (cm)	Crown Spread (m)	
			E-W	N-S
T <sub>1</sub> : Bottle Gourd var. Local + <i>Tectona grandis</i> L.f.	16.79	21.23	2.54	3.48
T <sub>2</sub> : Ridge Gourd var. Pusa Nasdar + <i>Tectona grandis</i> L.f.	16.09	19.62	2.54	3.53
T <sub>3</sub> : Smooth Gourd var. Pusa Chikni + <i>Tectona grandis</i> L.f.	15.64	17.89	2.53	3.50
T <sub>4</sub> : Cucumber var. Local + <i>Tectona grandis</i> L.f.	16.13	19.17	2.49	3.58
T <sub>5</sub> : <i>Tectona grandis</i> L.f. alone	15.62	17.61	2.46	3.40
S.Em. <sub>±</sub>	0.365	0.892	0.035	0.056
C.D. @ 5 %	NS	NS	NS	NS
C.V.%	6.44	13.20	3.90	4.49

**Table 5:** Cost of cultivation of teak (Rs. /ha)

Operations	Cost/unit	Total cost (Rs./ha)
Cost of Planting (Planting Material, Preparation of Pits, Planting)	Rs 1/-	Rs 5000/-i.e. 217.39 ha/Year
Weeding and cleaning (20 labours 3 times per year)	@ Rs 178/labour/day	Rs 10680/-
Pruning (20 labours 2 times per year)	@ Rs 178/labour/day	Rs. 7120/-
Total		Rs. 18017.39

**Table 6:** Estimation of volume

Treatments	Plant Height(m)	DBH (m)	Volume (m <sup>3</sup> )	-0.10 due to tapering and branching formation
T <sub>1</sub>	16.79	0.21	0.59	0.49
T <sub>2</sub>	16.09	0.20	0.49	0.39
T <sub>3</sub>	15.64	0.18	0.39	0.29
T <sub>4</sub>	16.13	0.19	0.47	0.37

Selling of teakwood @ Rs. 14000/m<sup>3</sup>

## Conclusion

From the above findings, it is concluded that, the highest net realization and benefit cost ratio was registered in T<sub>7</sub>: Smooth Gourd var. Pusa Chikni was grown in sole cropping system as compared to teak based silvi-horticultural system. Moreover, when we considered yield of teak than maximum BCR and net realization were recorded in T<sub>1</sub>: Bottle Gourd var. Local grown under teak based silvi-horticultural system. On the basis of data of present investigation it is concluded that growing of various cucurbitaceous crops under Teak can provide additional income to the teak farmers.

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