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Economics of Cultivation and Value Addition of *Ocimum* spp. Cultivated with Teak-based Silvi-medicinal and Sole Cropping Systems in Gujarat§

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Abstract

The study has reported the economics of three *Ocimum* species, namely *O. tenuiflorum*, *O. gratissimum* and *O. basilicum*, which were grown under 18-year old teak (*Tectona grandis*) based silvi-medicinal (teak + *Ocimum* spp.) and sole cropping systems and has investigated the effect of value addition due to herb and oil production. The study has found that herbage production of *O. gratissimum* provided highest net returns of ₹ 38,018/ha (benefit-cost ratio (BCR): 1.85) when grown under sole cropping and ₹ 25,418/ha (BCR: 1.24) when grown under silvi-medicinal system. The essential oil production from *O. basilicum* accrued the highest net returns of ₹ 103327/ha with BCR of 2.56. The value addition due to essential oil production provided higher returns and benefit cost ratio in *O. tenuiflorum* and *O. basilicum*. The NPV, IRR, PBP and BCR analysis has suggested cultivation, either as sole crop or under silvi-medicinal system, of *O. gratissium* for raw herbage and of *O. basilicum* for essential oil production. The study has revealed that the financial flow on account of oil production was higher as compared to herb production and value addition in terms of net returns and BCR ratio proved more remunerative.

Key words: Agroforestry, essential oil, Gujarat, net returns, *Ocimum* spp., teak, value addition

JEL Classification: Q12

Introduction

The market of medicinal and aromatic plants (MAPs) plant material is highly agile and policy makers and researchers always advocate for their value addition to get higher economic returns. Even simple interventions, like better method of harvesting, storage, grading and local level value-addition can substantially improve returns. Marketing of semi-processed product rather than raw crop can improve the profitability of the cultivators (Mittal and Singh, 2007). Among several species of MAPs cultivated on commercial scales, is the genus *Ocimum,* of which, *O. americanum*, *O. basilicum*, *O. sanctum* and *O. tenuiflorum* are the important species with estimated annual trade of 500-1000, 1000-2000, 2000-5000 and 2000-5000 tonnes, respectively (www.nmpb.nic.in). Many species of *Ocimum* have medicinal value, oil of certain species has antifungal, bactericidal and insecticidal properties (Javanmardi *et al*., 2002; Harsa *et al*, 2003). Sweet basil *(O. basilicum*) and holy basil *(O. sanctum*) are the most widely grown species in the world either for fresh market or for essential oil production (Gupta *et al*., 2002; Zheljazkov *et al.,* 2008).

In Gujarat, teak is the main timber tree species planted as block plantations, under social forestry, farm

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forestry as well as mixed plantation with fruit trees (Bhusara *et al.,* 2016). Since the rotation of teak is very long, there is the need to develop agroforestry models by intercropping compatible intercrops for early returns on account of raw herb or essential oil production. The present paper presents the comparative analysis of net returns as accrued on account of dry herb and essential oil and value addition realised in three *Ocimum* spp. intercropped under *Tectona grandis* (L.f.).

Data and Methodology

The study was carried out in experimental farm of ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari, in the years 2013-2014. Three *Ocimum* species, namely *O. tenuiflorum* (O_1), *O. gratissimum* (O_2) and *O. basilicum* (O_3) were intercropped under 18-year old teak (*Tectona grandis*) plantation. The agroforestry systems so formed were named as silvi-medicinal systems (teak + *Ocimum* spp. =LU_2) and sole cropping system or open land use (LU_1). *Ocimum* spp. were grown following standard agro-techniques. Fresh herbage yield (stem, branches, leaves and inflorescence) was recorded after harvesting the intercrops. The dry herbage yield was estimated by taking the representative samples, which were dried in shade till constant weight was attained. The fresh and dry herb yield was extrapolated on one hectare basis. The oil recovery (from fresh herbage) was estimated by hydro distillation method using Clevenger Apparatus.

The gross realization from dry herb and essential oil production (per hectare under LU_1 and LU_2) was worked out on the basis of prevailing market rates of herb and essential oil of individual *Ocimum* spp. (Table 1). The net present value (NPV), internal rate of returns (IRR @ 10%), payback period (PBP) and benefit-cost ratio (BCR) on account of herbage and essential oil were computed following the standard formulae.

Table 1. Cost of cultivation of *Ocimum* spp.

(₹)

Cost-head	Cost
Seed	150
Land preparation and layout	2050
Farm yard manure (FYM)	6000
Nursery bed preparation, raising and maintenance	1430
Transplanting	800
Weeding and hoeing	1800
Application of fertilizer 20 kg N per ha	240
Irrigation	1800
Plant protection measures, watch and ward	1400
Harvesting	1200
Managerial cost 10 % of total cost	1687
Interest on working capital @ 12 %	2024
Total cost	20581
Cost of distillation per tonne of fresh herb *	3500

* Anonymous (2008)

Table 2. Net returns from dry herbage of *Ocimum* species cultivated under *Tectona grandis-Ocimum* spp. based silvi-medicinal and sole cropping systems

(₹/ha)

Species	Cost of cultivation	Gross returns	Net returns
Sole crop (LU_1)			
O. tenuiflorum	20581	50200	29618
O. gratissimum	20581	58600	38018
O. basilicum	20581	54000	33418
Intercropping (LU_2)			
O. tenuiflorum	20581	41400	20818
O. gratissimum	20581	46000	25418
O. basilicum	20581	43800	23218

Note: LU denotes land-use system

Results and Discussion

Financial Feasibility from Production of *Ocimum* spp.

The gross and net returns from dry herb yield of three *Ocimum* spp. cultivated under teak [(Silvi-medicinal (LU_2)] and as sole crop (LU_1) are presented in Table 2. The highest net returns amounting to ₹ 38,018/ha and ₹ 25,418/ha were accrued from *O. gratissimum* under sole cropping system and silvi-medicinal system, respectively. The net returns accrued in the present study were higher than reported earlier from herb of *O. basilicum* and *O. tenuiflorum* (Anon., 2012) and *O. sanctum* cultivated under fruit and fodder based agroforestry systems (Thakur and Verma, 2012). This may be due to variability in rates, input and yield per hectare. The higher returns from medicinal and aromatic plants based agroforestry system have been reported earlier (Karikalan *et al*., 2002; Dutt and Thakur, 2004; Verma and Thakur**,** 2010; 2011).

Table 3. Net returns from essential oil of *Ocimum* species cultivated under *Tectona grandis-Ocimum* spp. based silvi-medicinal and sole cropping systems

(₹/ha)

Species	Cost of cultivation	Cost of oil distillation	Total cost	Gross returns	Net returns
		Sole crop (LU_1)			
O.tenuiflorum	20581	18795	39376	135319	95943
O.gratissimum	20581	23380	43961	94131	50159
O. basilicum	20581	19775	40356	143683	103327
		Intercropping (LU_2)			
O.tenuiflorum	20581	15575	36156	109376	73220
O.gratissimum	20581	18655	39236	71821	32585
O. basilicum	20581	16240	36821	113761	76939

Note: LU denotes land-use system

Financial Feasibility of Essential Oil Production

The net returns from essential oil of *Ocimum* spp. are presented in Table 3. Among the *Ocimum* spp., the highest net returns from essential oil were obtained from *O. basilicum* grown under sole cropping system (₹ 103327/ha) as well as under silvi-medicinal system (₹ 76939/ha). Net returns from oil production in the present study were higher than those accrued from essential oil of *O. sanctum* cultivated under different agroforestry systems (Thakur *et al.*, 2009).

Value Addition and Financial Feasibility

The value addition due to difference in net returns from herb (Panchang) and essential oil production of *Ocimum* spp. are presented in Table 4. Among *Ocimum* spp., the value addition was highest from *O. basilicum* (₹ 69908/ha), followed by *O. tenuiflorum* (₹ 66324/ ha) grown under sole cropping system. The same species also gave maximum value addition when grown under silvi-medicinal system. A perusal of Table 4 revealed that value addition was more remunerative in all *Ocimum* spp. grown either under silvi-medicinal systems or as sole cropping. Thakur *et al.* (2011) have also reported higher returns from *O. sanctum* oil production than herb production.

Economics of *Ocimum* spp. Cultivation

The net present value (NPV), internal rate of returns (IRR), payback period (PBP), and benefit-cost ratio (BCR) for *O. gratissimum* cultivated under sole and silvi-medicinal systems were worked out as follows under raw product scenario: maximum NPV: ₹ 133463 and ₹ 2113; IRR: 84.72 per cent and 23.50 per cent; PBP: about 3 months, and 4.5 months and BCR: 1.85 and 1.24, respectively. From *O. basilicum*, under value addition scenario (on account of essential oil), maximum NPV ₹ 51900 and ₹ 31874; IRR of 156 per cent and 108 per cent; lesser PBP of about 3 months and higher BCR of 2.56 and 2.09 under sole and intercropping cropping, respectively were recorded. Thus, on the basis of raw product sale, *O. gratissimum* proved to be better; however, under value addition

Table 4. Comparative net returns from herbage and essential oil yield of *Ocimum* spp. cultivated under *Tectona grandis-Ocimum* spp. based silvi-medicinal and sole cropping systems

(₹/ha)

Species	Net returns		Value addition
	Herbage	Essential oil	
	Sole crop(LU_1)		
O. tenuiflorum	29618	95943	66324
O. gratissimum	38018	50159	12141
O. basilicum	33418	103327	69908
	Intercropping (LU_2)		
O. tenuiflorum	20818	73220	52401
O. gratissimum	25418	32585	7166
O. basilicum	23218	76939	53721

Note: LU denotes land-use system

Table 5. Net present value (NPV), internal rate of returns (IRR), payback period (PBP) and benefit cost ratio (BCR) on account of herbage and essential oil from different *Ocimum* spp. cultivated under *Tectona grandis-Ocimum* spp. based silvi-medicinal and sole cropping systems

Species	Herbage (raw product)				Essential oil (value addition)			
	NPV (₹)	IRR (%)	PBP (years)	BCR	NPV (₹)	IRR (%)	PBP (years)	BCR
				Sole crop (LU_1)				
O. tenuiflorum	5663	43.91	0.41	1.44	46287	143.66	0.29	2.44
O. gratissimum	133463	84.72	0.35	1.85	1195	15.05	0.47	1.15
O. basilicum	9256	62.37	0.38	1.62	51899	156.04	0.28	2.56
				Intercropping (LU_2)				
O. tenuiflorum	-1993	1.15	0.50	1.01	29218	102.51	0.33	2.03
O. gratissimum	2113	23.50	0.45	1.24	-9417	-14.88	0.54	0.85
O. basilicum	149	12.81	0.47	1.13	31874	108.95	0.32	2.09

Note: Crop enterprise budgets are subject to prevailing weather conditions of 2013-14. Inputs were computed at the prevailing market rates. Fixed costs such as land rent, depreciation, teak trees, etc. were not included. Benefits have been calculated on the prevailing whole herb and essential oil rates. The benefit: cost ratio for a particular crop and inter-crop comparisons should be viewed cautiously.

scenario, it was *O. basilicum*. This may be attributed to lower market price of essential oil of *O. gratissimum.*

Conclusions

The present ha revealed that net returns from herb, essential oil production and value addition are higher as compared to agroforestry systems elsewhere involving medicinal and aromatic plants and their value added products. However, most of studies corroborate that MAPs based cropping systems are more remunerative compared to systems involving other traditional crops. Further, the study has pointed out that *O. gratissiumum*, due to low market rate of essential oil, should be grown for herbage for better BCR. In case of *O. tenuiflorum* and *O. basilicum*, the value addition is very remunerative hence, farmers may opt for essential oil extraction and can get higher returns. The NPV, IRR, PBP and BCR analysis has suggested that cultivation, either sole crop or under silvi-medicinal system, of *O. gratissium* for raw herbage and of *O. basilicum* for essential oil production is profitable. Although land-use economic viability analysis parameters have shown lower values under teak-*Ocimum* spp. silvi-medicinal systems, the farmers may get additional income from such land-uses till teak trees come to harvest stage.

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