Research Article

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Economics Feasibility of Okra - Ailanthus Based Silvi- Horticultural System in South Gujarat

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ABSTRACT

To evaluate the economic feasibility of okra cultivars under various land use regimes (under Ailanthus excelsa and in open condition), a field experiment was conducted in 2022–2023 and 2023–2024. The four varieties of okra i.e., Ajeet, Roshni, Sona-55 and Navsari okra, designated as V1, V2, V3 and V4, respectively, were grown beneath the five year old A. excelsa and in the open conditions. A randomized block design with four replications was used to create this experiment. According to the experiment's projected economics, growing the Sona-55 variety of okra under A. excelsa (V3 + A. excelsa) had the highest BC ratio (3.76) among the various land use systems. However, in a solo condition (V1 sole), the Ajeet variety of okra was reported to have a net realization maximum (Rs. 218,623 ha^{-1}). Therefore, the Sona-55 okra variety under A. excelsa has the potential to produce more revenue than the other land use systems.

INTRODUCTION

An agroforestry system is among the most economically significant of the various agriculture- integrated techniques, particularly when long-term benefits both tangible and intangible are taken into account (Elbakidze *et al.,* 2021). Despite this, farmers may have to deal with the difficulties of early investment, delayed profits, and risk diversification compared to traditional agriculture alone. The majority of farmers and agribusiness owners take the advantages of agricultural practices extremely seriously. As a result, economics plays a vital role in determining decisions made by governments, institutions, communities, and people. Agroforestry is widely regarded as a sustainable business and a way to address environmental issues, especially for farmers with few resources (Mahmud *et al.,* 2020).

Ailanthus excelsa is a deciduous tree species that grows quickly and is native to India. It is a member of the Simaroubaceae family and yields long-term returns from wood that is collected six to eight years later. It is also called Maharukh or Tree of Heaven. It grows well in dry and semi-arid areas and is commonly utilized in afforestation, social forestry, and agroforestry initiatives (Terzopoulou *et al.,* 2023; Lavhale and Mishra 2007). It is highly valued economically for its lightweight, termite-resistant wood, which is widely utilized in the pulp, plywood, matchstick, and packing box sectors (Kaushik *et al.,* 2017). Whereas, Okra (*Abelmoschus esculentus*), commonly referred to as lady's finger or bhindi, is a member of the Malvaceae family and is widely grown in tropical and subtropical areas, particularly in Nigeria, Sudan, and India. The warm- season vegetable crop, which is valued for its tender green pods that appear within two to three months, is widely farmed by farmers due to its market demand and nutritional quality (Mevada *et al.,* 2023). As a result, both the *A. excelsa* tree and the vegetable product okra have the potential to increase demand and

revenue. Thus, the economic assessment of okra - *A. excelsa* based silvi-horticulture systems in this work emphasizes their potential as a sustainable and lucrative land-use paradigm, especially in marginal and dryland areas. This integrated system makes it possible to grow okra for short-term revenue and reap long-term benefits from *A. excelsa*. For smallholder farmers, the method is both environmentally sustainable and economically viable thanks to this dual-income approach. Because cacao agroforestry systems in Costa Rica offer shade and reduced input costs, they have demonstrated higher long-term financial returns than monoculture cacao (Niether *et al.,* 2020).

Farmers in South Gujarat are interested in implementing agroforestry techniques on their properties. According to several studies, farmers in this area have adopted agroforestry techniques and are bringing in extra money (Deshmukh *et al.,* 2023; Mevada *et al.,* 2022; Dobriyal *et al.,* 2019). Farmers find it difficult to estimate the economics of complex agricultural practices, such as agroforestry systems like okra – *A. excelsa* combinations, which necessitate a more thorough economic evaluation than sole cropping because of the multi-component interactions between trees and crops. As a result, the current study was carried out to assess the viability of a silvi-horticultural system based on okra and ailanthus in South Gujarat

MATERIAL AND METHODS

Study site: The field experiment was conducted during kharif season of 2022-23 and 2023-24, at Forest Resource Management (FRM) Farm, Navsari Agricultural University, Navsari, Gujarat, India (Figure 1). It is geographically located at 20.95° N latitude and 72.93° E longitude with an elevation of 11 m above mean sea level (AMSL). This area is typically characterized by humid and warm monsoon with average annual rainfall of about 1500-1800mm, moderately cold winter, and fairly hot and humid summer. The mean annual temperature is 27.1 °C during the study period. **Materials:** For the experiment required seed of okra variety *i.e.* Hybrid Ajeet, Roshni F1, Hybrid Sona-55 were collected from the seed bhandar, Navsari, whereas the one variety of Okra (Navsari okra) collected from Regional Horticultural Research Station, NAU, Navsari.

Layout and design of the experiment The ailanthus based agroforestry system was laid out in randomized block design with treatments of four okra varieties grown under ailanthus tree and also all these varieties grown in sole condition (Total eight treatments combination) and tested in four replications. Okra was grown at a spacing of 45cm x 30cm. Where, four okra varieties *Viz*; V1: Ajeet, V2: Roshni, V3: Sona-55 and V4: Navsari okra. The existing *Ailanthus excelsa* plantation was planted at the spacing of 5m X 3m in the East- West direction (5 year old plantation).

Economic Analysis: Economic estimation of different crops like okra and ailanthus involves assessing costs of production and returns to evaluate profitability, viability, and sustainability. The process typically follows agro-economic analysis standards recommended by institutions. Economic analysis methods such as NPV, IRR, BCR, and sensitivity analysis are essential for assessing the long-term viability of agroforestry systems. In this study BCR method was used for estimate the economics of okra- ailanthus based silvi-horticulture system. The market value for the current year (2024–25) was used to determine the cost of growing *A. excelsa* and okra as well as the selling price of okra fruits and ailanthus wood.

Table 1. Economics of Okra - Ailanthus based silvi-horticultural systems

BCR		**Under *A. excelsa***	3.39	2.96	3.79	2.95	4.48	**In open Condition**	3.56	2.98	3.04	2.77	
Net Realization (Rs ha-1)			156494	127937	182410	127527	50352		218623	168873	173873	151373	
Total Cost of Cultivation (Rs ha-1)			65356	65356	65356	65356	14449		85377	85377	85377	85377	
Total Gross Realization (Rs ha-1)			221850	193293	247766	192883	64801		304000	254250	259250	236750	
A. excelsa	**Gross Realization (Rs ha-1)**		58100	57043	62266	57883	64801		-	-	-	-	
	Cost (Rs ha-1)		14449	14449	14449	14449	14449		-	-	-	-	
	Productivity (t ha-1 year-1)		11.62	11.41	12.45	11.58	12.96		-	-	-	-	
Okra	**Gross Realization**		163750	136250	185500	135000	-		304000	254250	259250	236750	
	Total Cost (Rs ha-1)		50907	50907	50907	50907	-		85377	85377	85377	85377	
	Yield		6.55	5.45	7.42	5.40	-		12.16	10.17	10.37	9.47	(Rs. 25000/tonne
Land Use Systems			V1 + *A. excelsa*	V2 + *A. excelsa*	V3 + *A. excelsa*	V4 + *A. excelsa*	*A. excelsa* Sole		V1	V2	V3	V4	Price rate : Okra rate

RESULTS AND DISCUSSION

Economics has a key role in determining whether the system is lucrative or not. Consequently, the economics of the implemented systems were computed and displayed in Table 1. It can be shown from the systems' calculated economics that the several okra kinds under the A. excelsa tree and in open conditions are the most investigated. It turns out that when okra varieties were cultivated in an open environment, the V1 variety (Ajeet) had the highest BCR (3.56:1) and net realization (Rs. 218623 ha-1) of all the kinds. With the exception of the Ajeet variety, all okra types cultivated in an ailanthus- based silvi-horticulture system showed higher BCR than those produced in an open environment. Under an ailanthus-based silvi-horticulture system, the sona-55 okra variety (V3 + *A. excelsa*) showed the highest BC

Table 2. Cultivations cost of okra in open condition and under *A. excelsa*

Description	Rate	Open (Rs. ha-1)	Afs (Rs. ha-1)
Preparatory tillage			
Ploughing by tractor with (1time) M.B. plough	Rs.600 per hr for 8 hours	4800.0	2880.0
Ploughing by tractor with (2 times) cultivator	Rs.500 per hr for 6 hours	6000.0	3600.0
Ploughing by tractor with (1 times) Rotavator with planking	Rs.800 per hr for 4 hours	3200.0	1920.0
Total		**14000.0**	**8400.0**
Lay out and Transplanting			
Layout ,Preparation of channel, beds and earthing up (8 labour in open and 5 labours in AF for 2 days)	Rs.399 per labour per day	6384.0	4788.0
Seed requires (4.5 kg/ha in open and 2.5 kg/ha in AFs)	Rs.1500 per kg	6750.0	4050.0
Sowing (18 labours in open and 15 labours in AFs for 1 days)	Rs.399 per labour per day	7182.0	4788.0
Gap filling (8 labours in open and 5 labours in AFs for 1 days)	Rs.399 per labour per day	3192.0	1995.0
Total		**23508.0**	**15621.0**
Manures			
FYM (15 t/ha in open and 9 t/ha in AFs)	Rs. 1000 per tonne	15000.0	9000.0

DAP (312.5 kg/ha in open and 187.5 kg/ha in AFs)	Rs. 9 per kg	3250.0	1950.0
Urea (83.33 kg/ha in open and 50 kg/ha in AFs)	Rs. 15 per kg	1200.0	720.0
Expenditure on manures application	Rs. 200 per tonne of FYM	3000.0	1800.0
Expenditure on fertilizer application (6 labours for 1 day)	Rs.399 per labour per day	2394.0	1436.4
Total		**24844.0**	**14906.4**
Intercultural operations			
Weeding (two times in Open and one time in Afs) (8 labours in open and 5 labours in AFs per weeding)	Rs.399 per labour per day	6384.0	1995.0
Total		**6384.0**	**1995.0**
Irrigation application			
Electric Charge for 5 Irrigations in open and 3 irrigations in AFs)	Rs. 30 per hour	3000.0	1800.0
Labour charges (2 men for 1 irrigation)	Rs.399 per labour per day	3990.0	2394.0
Total		**6990.0**	**4194.0**
Plant protection			
Labour for spraying (2 men per spray)	Rs.399 per labour per day	1596.0	957.6
Pendimethalin (Pre-emergance Weedicide @1 lit/ha)	Rs. 475 per Liter	475.0	285.0
Quizalofop-ethyl 10% EC (Post-emergance Weedicide @500 ml /ha)	Rs. 850 per 500ml	850.0	510.0
Total		**2071.0**	**1242.6**
Harvesting			
Fruit harvest (16 picking) (4 labours in open and 3 labours in AFs per picking)	Rs.399 per labour per day	25536.0	19152.0
Uprooting the plants (5 labours in open and 3 labours in AFs for 1 day)	Rs.399 per labour per day	1995.0	1197.0
Total		**1995.0**	**1197.0**
Grand Total		**79792.0**	**47556.0**
Interest on working capital @ 7 %		**5585.4**	**3351.3**
Gross total		**85377.4**	**50907.3**

Table 3. Cultivations cost of *A. excelsa*

Operations	Cost tree-1	Total cost (Rs. ha-1)
Cost of Planting (Planting Material, Preparation of Pits, Planting)	Rs. 7.5	5000.00
	i.e. ha year-1	1000.00
FYM	Rs. 1	133.33
Urea	Rs. 2	266.66
SSP	Rs. 1	133.33
Weeding and cleaning (10 labours 2 times per year)	Rs.399 per labour per day	7980.00
Pruning (10 labours 1 times per year)	Rs.399 per labour per day	3990.00
Total		**13503.33**
Interest on working capital @ 7 %		945.23
Gross Total		**14448.56**

ratio (3.79: 1) and net realization (Rs. 182410 ha-1) compared to other varieties. The V4 variety of okra had the lowest net realization and BCR among the intercrops, measuring Rs. 127527 ha-1and 2.95:1, respectively. In

contrast to the ailanthus-based silvi- horticulture system, the open condition's increased growth and yield parameters are likely the cause of the highest net realization (Table 1). The lower expense of the *A. excelsa* plantation and the higher return from the systems may be the reasons for the BCR ratio was at its highest with the V3 type of ok okra. The Sona-55 okra variety outperformed the other kinds under the *A. excelsa*. Similar outcomes were seen in okra under *Litchi chinensis*, which was previously reported by Hanif *et al.* (2010), Kumar *et al.* (2016) in *Ocimum spp.* under *Tectona grandis*, Rajalingam *et al.* (2016) in vegetable crops under *Ailanthus excelsa*, Kazi *et al.* (2017) in colocasia under *Borassus flabellifer*, Bhusara *et al.* (2018) in okra under *Melia composita*, Patel *et al.* (2018) in cucurbitaceous vegetable crops under *Tectona grandis*, Jilariya *et al.* (2019) in *Aloe vera* under *Melia dubia* and Mevada *et al.* (2022) in okra under *Tectona grandis.*

The projected variable cost of growing okra was calculated on the basis of one hector area of okra under *A. excelsa* trees and in open spaces shown in Table 2. Additionally, Table 3 presents the several variable particles that were used to evaluate the plantation cost and variable management cost of *A. excelsa*.

CONCLUSION

According to the estimated economics of several varieties of okra under different land use systems shown above, the Sona-55 variety of okra grown under

A. excelsa produced the highest BC ratio when compared to the other systems. However, in solitary condition, the Ajeet variety of okra showed the highest net realization, followed by the Sona-55 variety under *A. excelsa*. Thus, growing the sona-55 variety of okra with *A. excelsa* has the potential to produce more revenue than the other land use systems.

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DECLARATIONS

On behalf of all Co-Authors, I shall bear full responsibility for the submission. I confirm that all authors listed on the title page have contributed significantly to the work, have read the manuscript, attest to the validity and legitimacy of the data and its interpretation, and agree to its submission. It is not under consideration for publication elsewhere.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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