

# Factors influencing moringa cultivation in Tamil Nadu – an economic analysis

## Abstract

Moringa (*Moringa oleifera* Lam.) is grown extensively in tropics and subtropics of India and Africa. It is widely used as vegetable and grown commercially for its edible pods and leaves. On realizing the nutritional importance, Moringa was used in different forms and hence the cultivation of Moringa is popular in different nations particularly in Tamil Nadu. The Factors influencing Moringa cultivation in Southern Districts of Tamil Nadu was carried out during 2016-17.1 The study revealed that presence of higher returns, sustainable income generation, availability of land and water resources for cultivation, minimal pest problems, good market demand for value added Moringa products in the national and international markets were found to be the principal factors influencing the area under Moringa. In this respect effort has been taken to assess the Resource use efficiency of Moringa Orchards. Resource Use Efficiency analysis revealed that four principal variables viz., number of limb cuttings used for planting, quantity of FYM, quantity of fertilizer applied (kg) and the number of human labour used (man days) per ha per annum were found to influence the yield of Moringa and the results indicated that all these four variables significantly contributed towards the yield of Moringa. Besides, the economics of Moringa cultivation also presented and discussed.

**Keywords:** moringa orchards, resource use efficiency, economic appraisal, factors influencing moringa

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## Introduction

Moringa (*Moringa oleifera* Lam.) belongs to the family 'Moringaceae' is a fast growing multipurpose medicinal tree extensively grown in tropics and subtropics of India and Africa. It is also widely distributed in Egypt, Philippines, Sri Lanka, Thailand, Malaysia, Burma, Pakistan, Singapore, West Indies, Cuba, Jamaica and Nigeria. In eastern and southern regions of India, Moringa is widely used as vegetable and grown commercially for its edible pods and leaves. *Moringa oleifera* is an important food commodity which has had enormous attention as the 'Natural Nutrition of the Tropics'. Almost all the parts of this plant: root, bark, gum, leaf, fruit (pods), flowers, seed and seed oil have been used for various ailments in the indigenous medicine of South Asia. Its popularity is increasing steadily because of its nutritional, medicinal value and for its sweetness in curry and slurry preparation along with red gram dhal. From that one could understand the importance of Moringa.<sup>2-4</sup>

India is the prime producer of Moringa (Drumstick) with an annual production of 2.20 to 2.40 million tonnes of tender fruits from an area of 38,000ha leading to the productivity of around 63 tonnes per ha.<sup>5</sup> Among the different states, Andhra Pradesh leads in both area and production (15,665ha) followed by Karnataka (10,280ha) and Tamil Nadu (13250ha). In other states, it occupies an area of 4,613ha. Tamil Nadu is the pioneering state as it has varied genotypes from diversified geographical areas. In Tamil Nadu, Moringa was cultivated as sole crop in homesteads, around cattle sheds, on farm boundaries, and as isolated plants in fences and as groups of trees on village waste lands. In the early 1990s, in southern Tamil Nadu, people started growing perennial Moringa types. In Moolanur block, Moringa is established as an intercrop on field boundaries and their allies were cropped with vegetables and Sorghum. This system evolved as Moringa based agro

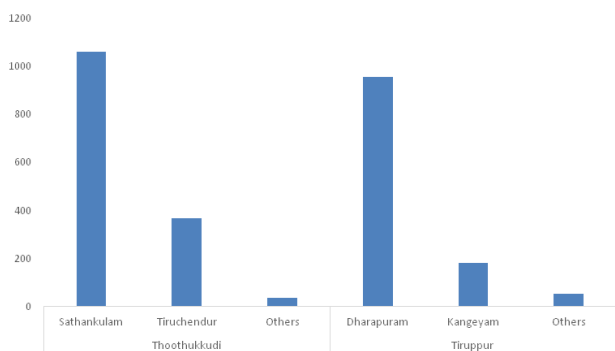
forestry system and these practices are almost endemic to Western Part of Tamil Nadu. Moringa offered some protection to alley crops from drying winds during summer and Moringa provided some additional income. With the migration of people from South to North India, and elsewhere in the world, the demand for Moringa picked up. Keeping these points in consideration, the present study with the specific objectives of assessing the factors influencing Moringa cultivation, Resource use efficiency and Economics of Moringa production in the Western and Southern districts of Tamil Nadu was carried out.

## Design of the study

Among the 31 Districts of Tamil Nadu, only 6 districts had the notable area under Moringa cultivation. Among the 6 Districts, the traditional Moringa growers were belonged to Tiruppur and Thoothukkudi Districts. Whereas, the Annual Moringa is cultivated largely in Theni District of Tamil Nadu. Other districts had very smaller area under annual Moringa. In these (Tiruppur and Thoothukkudi) two districts, area under Moringa is decreasing while other districts could witness a marginal increase in the area under Moringa and hence a study has been initiated to assess the reasons for the same. In this respect Tiruppur and Thoothukkudi districts were purposively chosen in the first stage. The taluk wise total area under Moringa in Tiruppur and Thoothukkudi districts are presented in Table 1 and Figure 1. Among the two taluks in Thoothukkudi District, Sathankulam found to have 73 per cent of the total area under Moringa. In respect of Tiruppur District, around 80 per cent of the total area under Moringa is vested with Dharapuram Taluk and hence the Sathankulam Taluk of Thoothukkudi District and Dharapuram Taluk of Tiruppur District were chosen purposively in the Second Stage.

In the Third Stage, the villages where the highest area under Moringa

available were enlisted after getting the list of farmers from the Department of Horticulture and Plantation Crops of Government of Tamil Nadu and in each village 10 sample farmers were randomly selected following a random sampling technique for the study. The samples selected in respect of Moringa are accounted for 50 samples from Thoothukkudi District and another 50 samples were drawn from Tiruppur District (Table 2). Put together, One hundred samples were selected for the study from the above two districts following a *Three Stage Random Sampling Technique*. From the sample farmers, the details of land use, crop management for its production and productivity, factors influencing Moringa cultivation, the resource use efficiency, cost of production of Moringa and the constraints involved are assessed using the structured and pretested questionnaire exclusively designed for the purpose and the same were analysed and documented in this study by adopting a descriptive statistics like mean and percentage analysis.



**Figure 1** Area under moringa in Thoothukkudi and Tiruppur Districts (2015-16).

**Table 1** Area under moringa in Thoothukkudi and Tiruppur Districts (2015-16)

Place	Area (ha)	(%) to Total cropping area
<b>Thoothukkudi District</b>		
Sathankulam	1062.86	72.55
Tiruchendur	367.81	25.11
Others	34.33	2.34
<b>Total Area under Moringa in Thoothukkudi District</b>	<b>1465</b>	<b>100</b>
<b>Tiruppur District</b>		
Dharapuram	956.25	80.24
Kangeyam	182.61	15.32
Others	52.88	4.44
<b>Total Area under Moringa in Tiruppur District</b>	<b>1191.74</b>	<b>95.56</b>

**Table 2** Details of samples selected for the study

Name of the Villages selected in Sathankulam Taluk	No. of Samples	Name of Villages selected in Dharapuram Taluk	No. of Samples
Sasthavinallur	10	Kilangundal	10
Naduvakkurichi	10	Komarapalayam	10

Name of the Villages selected in Sathankulam Taluk	No. of Samples	Name of Villages selected in Dharapuram Taluk	No. of Samples
Mudhalur	10	Mulayampoondi	10
Arasoor	10	Mulanur	10
Thatchamozhi	10	Puduppai	10
<b>Total Samples in Thoothukkudi District</b>	<b>50</b>	<b>Total Samples in Tiruppur District</b>	<b>50</b>

Under the head of tools of analysis, resource use efficiency analysis was analysed using a *Cobb-Douglas Production Function* and the author has identified the most influencing variables on getting the Yield of Moringa Pods. Thilagavathi et al.,<sup>6</sup> has also used linear production function to determine the resource use efficiency in Chillies. Hence it is appropriate to make use of the Cobb-Douglas production function in respect of Moringa. The Cobb-Douglas production function was fitted for finding the resource use efficiency at farm level for the two districts. Among the two districts, the Tiruppur District found to have cost efficient and output maximization based on the data. To reflect the same, area dummy has been given to capture the effect of area and other input use efficiency. The production function of the following form is used in this research paper.

$$Y = a X_1^{b_1} X_2^{b_2} X_3^{b_3} X_4^{b_4} D_1 \text{ ----- } 1$$

The Cobb-Douglas production function specified in the equation 1 is transformed into an estimable form of production function and presented the same in the equation – 2.

$$\ln y = \ln a + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + b_4 \ln X_4 + b_5 \ln X_5 \text{ ----- } 2$$

In order to get the 1, 0 after transformation of 2.71828 and 1 has been used in analysis of original data.

Where,

Y = Yield of Moringa in Tonnes per ha

a = Constant

X<sub>1</sub> = Number of Limb Cuttings of Moringa used per ha

X<sub>2</sub> = Quantity of Farm Yard Manure applied in Tonnes per ha per annum

X<sub>3</sub> = Quantity of Fertilizer applied in Kg per ha per annum

X<sub>4</sub> = Number of Human Labour used in Man Days per ha per annum

X<sub>5</sub> = Score 1; if Moringa Cultivated in Thoothukkudi District and Score 0; if Moringa was Cultivated in Tiruppur District.

b<sub>1</sub>, b<sub>2</sub>, b<sub>3</sub>, b<sub>4</sub>, b<sub>5</sub> are the regression coefficients to be estimated

To assess the economic incentives associated with Moringa Cultivation, the Benefit Cost Ratio, Net Present Value formulae were used. Besides, cost of production per unit of the produce was also arrived at and discussed suitably. Garrett’s Ranking Techniques was used to identify and prioritize the constraints faced by the farmers.

In this study, one per cent and five per cent level of significance of the variables were measured and interpreted for drawing appropriate findings.

## Results and discussion

The title of the research paper is analysing the factors which are influencing the Moringa cultivation. As a precursor to this analysis, one should analyse the aspects of size of holding with the farmer so as to analyse the status of farm households and their preference towards Moringa cultivation and hence the size of holding is analysed first and the results are presented in Table 3. The Ministry of Agriculture through its official publication of Horticultural Statistics at a Glance has classified the land holding into five different classification of land holding and designated the Marginal holding which possessed less than or equal to one ha. The land holding with the range of 1.01 to 2.00ha was designated as Small farms and the Semi – medium category of land was classified with the range of 2.01 to 4ha and the Medium class of land was described if it is in possession of 4.01 to 10ha and the Large category of farms were identified if it is cherished with higher than 10ha. This classification was practiced in this paper to analyse the type of farms involved in Moringa cultivation.

**Table 3** Size of farm households

Category of land holdings (ha)*	No. of households		Average Size (ha)	
	Thoothukkudi District	Tiruppur District	Thoothukkudi District	Tiruppur District
Marginal ( $\leq 1$ )	6 (12.00)	6 (12.00)	0.68	0.51
Small (1-2)	15 (30.00)	16 (32.00)	1.44	1.5
Semi-medium (2 - 4)	17 (34.00)	6 (12.00)	2.74	2.86
Medium (4 - 10)	9 (18.00)	20 (40.00)	5.43	5.24
Large (>10)	3 (6.00)	2	12.5	10.52
Total	50 (100.00)	50 (100.00)	2.9	3.35

(\*The land use classification is based on the norms enunciated in the Horticultural Statistics at a Glance – 2015, Ministry of Agriculture, GOI). (Figures in Parenthesis indicate Percentage to Total).

It is evident from Table 3 that the Semi-medium category of farm size was predominant followed by Small category of holdings which are respectively classified as 2.01 to 4ha and 1.01 to 2ha in Thoothukkudi District. But, the Medium category of land was predominant with 20 holdings and their average size of holding was found to be 5.24ha in respect of Tiruppur District followed by Small category of land prevalent in 16 holdings of Tiruppur District. In general, Tiruppur district found to have higher size of holding. On an average, the size of land holding was found to be 3.35ha in respect of Tiruppur District followed by 2.90ha in Thoothukkudi District. From this one could understand that Tiruppur District is in advantageous position for raising different crops like Perennial Moringa in the larger size of holding when compared to Thoothukkudi District inferring that the farms are categorized under Semi-Medium category.

### Area under moringa in the sample farms

Main aim of the study is to focus on the status of Moringa cultivation in Tamil Nadu. When the researcher could analyse the area under Moringa in the sample districts, the area under Moringa was found to decrease over the years and the area under Moringa in Tiruppur District was found to increase over the years. It might be

due to the enterprising nature of the farmers in Tiruppur District when compared to Thoothukkudi District. On conducting the interview with the farmers, the farmers opined that the youngsters and the middle aged persons were seeking employment elsewhere particularly in Tiruppur District which has the strength of textile and spinning units and only the elders are caring the activities of the Moringa plantations in Thoothukkudi District. Whereas, Tiruppur District had higher number of entrepreneurs whom are having higher area and the leftover area other than the textile and spinning units, are much interested in utilizing the land as alternate source of income generation. Since Dharapuram taluk is known for good market for Moringa, the increasing area is visible. However, the same will also be discussed under the head of factors influencing Moringa cultivation. It is known from Table 4 that higher area under Moringa plantations is available with Thoothukkudi District which was accounted for 13.51 per cent to the total area under Moringa in Tamil Nadu State. Whereas, the Tiruppur District was blessed only with 8.90 per cent of area. However, the continuous increase in area under Moringa in Tiruppur District revealed that the farmers are much interested in establishing Moringa plantations in their farm holdings. In a year or two the farmers of Tiruppur District could achieve the higher area under Moringa to tap the benefits and cost incentives associated with Moringa.

**Table 4** Area under moringa in Thoothukkudi and Tiruppur Districts (2010-2016)

Year	Thoothukkudi District		Tiruppur District	
	Area (ha)	Cropping area (%)	Area (ha)	Cropping area (%)
2010-2011	1457	15.93	789	8.62
2011-2012	1524	16.18	885	9.4
2012-2013	1413	14.17	890	8.93
2013-2014	1398	12.45	982	8.74
2014-2015	1384	11.08	1074	8.6
2015-2016	1465	11.23	1191	9.13
Mean Area	1440.17	13.51	968.5	8.9

(Source: Season and crop report various issues)

### Factors influencing establishment of moringa plantations

The increasing area under Moringa necessarily called for analysing the influencing factors for establishing the Moringa Plantations in their farm holdings were analysed and the results are presented in Table 5. Table 5 revealed that the factors were positively influencing the farmers in the study area. The influencing factors are delineated as follows viz., higher income generation from Moringa, sustainable income generation, availability of land and water resources for growing Moringa, good market demand for Moringa products in the national and international markets, minimal pest problems. Among these factors, the Thoothukkudi farmers were of the opinion that the sustainable income generation possibilities from cultivation of Moringa and hence they prefer the crop maximum followed by higher return from Moringa. These two are the most influencing factors to the farmers of Thoothukkudi District. Whereas, higher returns from Moringa followed by sustainable income generation were the factors dearer to the people of Tiruppur District. Though these factors were

very closely related to income realization, the farmers have shown much interest in establishing Moringa plantations owing to heavy market demand that exists in the National and International Markets. The factor of 'Good Market Demand' is ranked by them to the fourth rank and indirectly this factor is supporting the farmers to enter into higher area under Moringa cultivation. Amidst area expansion which is influenced by several factors, one should be interested in learning the extent of income generation is associated with Moringa. In this circumstance, how much income is being generated from the Moringa plantations over the costs by the farmers is important. In this context the details on economic incentives generated by the farm households from Moringa plantations are analysed and discussed elsewhere.

**Table 5** Factors influencing moringa cultivation

Factors	Response		Response	
	Thoothukkudi Number of Farms	Per Cent	Tiruppur Number of Farms	Per Cent
Higher Return from Moringa Orchard	16	32	18	36
Availability of Land and Water Resources	8	16	3	6
Minimal Pest Problems	2	4	5	10
Sustainable Income Generation	18		16	32
Good Market Demand for Moringa Produce	6	12	8	16
Total	50	100	50	100

### Resource Use Efficiency Analysis

Any production process attracts some quantum of inputs for its output and its efficiency. Here, it is important to analyse how effective the farmers are in getting the yield of Moringa from their farms by applying different inputs at an appropriate time is much more important and hence these details are analysed and the results are presented in Table 6. Table 6 has incorporated five important variables in the analysis which has higher strength of association between the respective variable and the yield of Moringa in tonnes per ha. Accordingly the variables notified had been used in the analysis and the results were drawn. Among the five variables included, four variables are inputs and the other one is Area dummy (score) variable incorporated to highlight the influence of Area on yield of Moringa. Krishna & Narendar<sup>7</sup> reported that resource use efficiency in cotton has yielded the coefficient of multiple determination to the level of 80 per cent. In the study on Moringa, the coefficient of multiple determination was arrived at 79 per cent.

The four principal variables used are Number of limb cuttings in Moringa used for planting of one ha area; Quantity of Farm Yard Manure (FYM) applied in tonnes per ha per annum; Quantity of fertilizer applied in Kgs per ha per annum and the Number of human labour used in many days per ha per annum. All these four variables were significantly contributing to the yield of Moringa at one per

cent level. Thakre *et al.*,<sup>8</sup> reported that the coefficients of area, seed and bullock labour were found to be significant while the manures and fertilizers and Irrigation were found to be non-significant. The findings are similar to this study. When one could examine the 'F' Value of Cobb-Douglas production function fitted, the 'F' value was arrived at 71 and it revealed that the function fitted was the Best Fit which is also significant at one per cent level.

**Table 6** Resource use efficiency analysis of moringa orchards

Variables	Coefficient	Standard error	't' value	Level of significance
Constant (a)	(-) 2.774	0.615	(-) 1.066	N.S.
Limb cuttings (X1)	0.483	0.105	4.663	***
Farm yard manure (X2)	0.354	0.091	3.873	***
Fertilizer (X3)	0.276	0.036	7.812	***
Human Labour (X4)	0.345	0.065	5.255	***
Area Dummy	0.019	0.01	1.855	*
Sum of coefficient	1.48	R <sup>2</sup> = 0.790		F = 70.72

(F = 71 Significant at one % level); (\* Significant at 10 % level; \*\*\* Significant at one % Level) (Number of observations: 100)

**Limb cuttings (X1):** One per cent increase in the number of Limb cuttings of Moringa in the production process of Moringa vegetables, the yield of Moringa vegetable could be increased to the tune of 0.48 per cent keeping all other variables at their mean level.

**Farm yard manure (X2):** One per cent increase in the application of FYM in the production process of Moringa vegetables, the yield of Moringa vegetable could be increased to the tune of 0.35 per cent keeping all other variables at their mean level.

**Fertilizer (X3):** One per cent increase in the quantity of Fertilizer applied in the production process of Moringa vegetables, the yield of Moringa vegetable could be increased to the tune of 0.276 per cent keeping all other variables at their mean level.

**Human labour (X4):** One per cent increase in the usage of number of Man Days of Human Labour in the production process of Moringa vegetables, the yield of Moringa vegetable could be enhanced to the tune of 0.345 per cent keeping all other variables at their mean level.

**Area score:** The area score was given to the analysis to highlight the yield difference if any between the plantations established at Tiruppur and Thoothukkudi Districts. Here the *score=2* was given to Tiruppur District and *score=1* was given to Thoothukkudi district. The area variable has yielded the coefficient to the level of 0.019. It implied that the yield difference between the two districts was 0.019 per cent indicated that higher yield could be obtained by Tiruppur District when comparing the Thoothukkudi District keeping all other variables constant at their mean level.

To sum up the results of production function, the total value of the coefficients of different variables had yielded the value of 1.48 revealed that the production function fitted has exhibited an increasing return to scale. It also implied that for every per cent of input application in the production process, the output of Moringa could yield at an increasing



rate keeping all other variables at their mean level.

### Yield and income potentials from moringa plantations

Yield and income potential from Moringa plantations were analysed and the results are presented in Table 7 in respect of sample farms. The average yield of fresh Moringa pod was arrived at 28 tonnes in respect of Thoothukkudi District. Whereas, Tiruppur District was capable of realizing 29 tonnes per ha. On examining the yield difference between the Thoothukkudi District and the Tiruppur District, the wide difference was invisible, but only marginal when comparing the mean yield parameter. The yield potential of Moringa in respect of Tamil Nadu state was also arrived and the details are presented elsewhere. On an average, Tamil Nadu could be able to produce around 2.81 lakh tonnes of Moringa pods per annum with the average productivity of 21 tonnes per ha. When one could compare the productivity of Southern District and the District from Western Part of Tamil Nadu with that of the average Productivity realized in Tamil Nadu, the study area had higher productivity which is accounted for 36 per cent higher. In this circumstance, whether the Moringa plantations are economically viable to the producers or not has to be analysed and hence the details were analysed and discussed under the head cost of production of Moringa.

**Table 7** Yield and income realization from moringa orchards

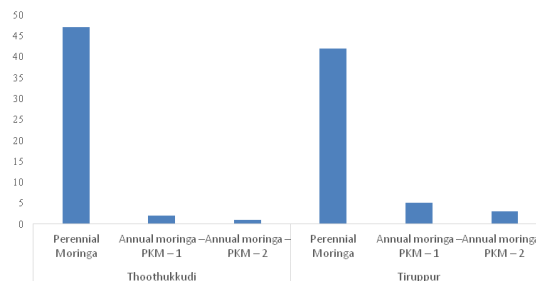
Year	Yield in Tonnes per Ha		Gross income in Rupees per Ha	
	Thoothukkudi	Tiruppur	Thoothukkudi	Tiruppur
1	7	8	75600	102465
2	13	14	132300	182160
3	27	28	278775	352935
4	28	29	297675	370013
5	30	31	316575	392783
6	31	33	326025	415553
7	34	35	354375	444015
8	36	36	378000	461093
9	38	38	382725	478170
10	36	40	396900	500940
Total	280	293	2938950	3700125

Source: Primary Survey (2016-2017)

### Cost of production of annual Moringa

So far, the discussions were made in favour of Moringa Orchards in general. However, it is important to categorize the economic incentives associated with Perennial Moringa. Only very few households particularly in Tiruppur and Thoothukkudi Districts had raised Annual Moringa (PKM-1 and PKM-2). Before analysing the cost of production of annual Moringa, the discussion on how many farm households are in practice with establishing annual Moringa is analysed and the details are presented in Table 8. The perennial Moringa was cultivated by 94 per cent of the farm households in Thoothukkudi District (Table 8). Whereas, only 84 per cent of the farm households have raised Perennial Moringa in Tiruppur District. Only 6 per cent of the farm households were having the practice of cultivating annual Moringa in Thoothukkudi District. But 16 per cent

of the farm households of Tiruppur District were having the practice of establishing annual Moringa in their farms revealed that the farmers of Tiruppur District are Technology adopters because of their enterprising nature especially in textiles and spinning at household level (Figure 2).



**Figure 2** Number of households established moringa orchards.

**Table 8** Number of households established moringa orchards

Particulars	Holdings			
	Thoothukkudi		Tiruppur	
	Numbers	Percent	Numbers	Percent
Perennial Moringa	47	94	42	84
Annual Moringa – PKM – 1	2	4	5	10
Annual Moringa – PKM – 2	1	2	3	6
Total	50	100	50	100

(Source: Primary survey); (Figures in parentheses indicate percentage to total)

Among the annual Moringa varieties, the PKM – 1 variety found to dominate both in Thoothukkudi District and Tiruppur District because the fresh Moringa Pods which are in optimum size which facilitates transportation to different consuming centres and the Moringa pods were consumer friendly because of their size and taste. Whereas, the PKM – 2 variety pods are fleshy and lengthy which has bit difficulties in transportation. Sometimes, breakage is also visible in PKM – 2 and hence it is less preferred among the farmers and the consumers. The consumers are also not much interested in buying the lengthy pods for their home as it is inconvenient to carry the same to their home. However, the cost of production of annual Moringa is important and hence these details are analysed and the results are presented in Table 9. The total operational cost incurred in respect of establishing annual Moringa is arrived at Rs. 66702 ha<sup>-1</sup> which was accounted for 77.47 per cent to the total cost of cultivation of annual Moringa (Table 9). Whereas, the annual fixed cost incurred was arrived at Rs 19402 which was accounted for 22.53 per cent. The total cost of establishing the annual Moringa ha<sup>-1</sup> was arrived at Rs 86104. The gross income realized by the farmer per ha was arrived at 5.69 lakhs in which the revenue earned from main product was accounted for 80 per cent and the bi-product accounted for only 20 per cent. The bi-product harvested was green leaves for local sales. Put together, the cost of production of fresh Moringa pod kg<sup>-1</sup> was arrived at Rs 2.38 kg<sup>-1</sup>. The cost of production per ton was arrived at rupees 2380. However, the sale of fresh Moringa pods per ton was arrived at Rs 11750 which has indicated that the cultivation of annual

Moringa was highly profitable as there exists good market for the produce. Hence, the farmers can take up annual Moringa cultivation in their farm lands in general. But, specifically, as the perennial Moringa was enriched with much of nutritional and pharmaceutical importance, the cultivation of Perennial Moringa in the sample farm households are predominant. In this context, the demanding places and centres need to be assessed. These are presented in the ensuing section.

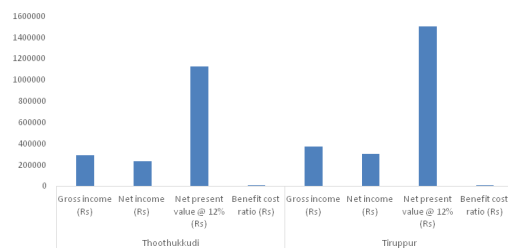
**Table 9** Costs and returns in moringa orchards

Particulars	Units	Rupees per Unit	Rupees per Ha
<b>A. Operational Cost</b>			
Preparatory cultivation and tillage (machine hours)	3	700	5187
Cost of farm yard manure (t)	12	400	11856
Application of Farm Yard Manure (man hours)	24	25	1482
Seed and planting material (kg)	0.5	2400	2964
Weeding (man hours)	54	25	3335
Hiring (man hours)	4	260	2569
Plant protection chemicals	-	-	6175
Neem Cake (kg)	150	23	8522
Urea (kg)	275	6	40756
Super phosphate (kg)	100	8	1914
Potash (kg)	130	17	5459
Harvesting (men hours)	68	60	10078
Harvesting (women hours)	50	25	3088
Total operational cost (A)			66702.35 (77.47)
<b>B. Annual Fixed Cost</b>			
Rental value of land (ha)	1	7720	19302.3
Land tax, cess, etc. (ha)	1	95	100
Total Annual Fixed Cost (B)			19402.30 (22.53)
Total Cost of Cultivation (A+B)			86104.65 (100)
<b>C. Gross Income</b>			
Income from main product (drumstick) (kg)	14605	12.65	456340.5
Income from by-product (leaves) (kg)	9100	5	112385
Total income from Moringa			568725.5
Cost of production per kg of main product			2.38
Output – Input Ratio			6.62

(Source: Primary survey) (Figures in parentheses indicate percentage to total)

## Economics of moringa plantations in Tamil Nadu

The plantations raised are economically viable or not has to be discussed and hence the data have been analysed using the economic appraisal tools which are presented in Table 10. It is known from Table 10 and Figure 3 that the perennial Moringa was generating a net income of Rs 2.31lakhs in Thoothukkudi District. But the same perennial Moringa is able to provide 3.05lakhs per annum as its net income per ha. This is comparatively more because Tiruppur farm households able to receive an average price of Rs 12.65kg<sup>-1</sup> of Moringa pods. Whereas, the farm households at Thoothukkudi District was able to receive an average price of Rs 10.50kg<sup>-1</sup> of Moringa vegetables. It is mainly due to the export competitiveness available in Tiruppur and the demanding firms are checking the quality of the produce and offer best price. The Tiruppur produce naturally commands best price due to its taste because of its cultivation made in calcium rich soils. On discounting the values of income and investment over years using 12 per cent discount rate, the Thoothukkudi farm households are able to generate the Net Present Value of Rs 11.39lakhs while the Tiruppur counterparts are able to secure net present value of Rs 15.07lakhs. The Benefit Cost Ratio was arrived at 4.17 and 5.07 in respect of Thoothukkudi farm households and Tiruppur farm households revealed that the farmers respectively could earn a profit of Rs 4.17 and 5.07 for a rupee of investment in the establishment and maintenance activities of Moringa. The study conducted by Ritambhara Singh et al.,<sup>9</sup> during the year 2017 in Gujarat State has arrived the Benefit Cost Ratio to the tune of 10.76 for a rupee of investment and the NPV under normal cost and return was arrived at Rs 25.24lakhs per ha and the IRR was estimated at 95.53 %. In this study, the returns are valued at lower price per unit of the produce. None other enterprises are able to provide such returns and hence the area under horticulture particularly Moringa can best be encouraged by the extension functionaries in their respective districts.



**Figure 3** Economics of moringa cultivation.

On analysing the economic worthiness of annual Moringa, the annual Moringa established by the farm households could generate a net income of Rs 4.83lakhs per annum with the cost of production of Rs 2380t<sup>-1</sup> of Moringa vegetables. On an undiscounted term, the Output-Input ratio was arrived at 6.62 revealed that the farmers could able to generate a gross income of Rs 6.62 per rupee of investment. The return on Investment figure revealed that the farm households whom were capable of establishing the annual Moringa in their farms, could generate 5.60 as their profit per unit of investment.

**Table 10** Economics of moringa cultivation

Tools of Appraisal	Thoothukkudi	Tiruppur
<b>I. Perennial Moringa</b>		
Gross income (Rs)	293895	370013
Net income (Rs)	231703	304660

Table Continued

Tools of Appraisal	Thoothukkudi	Tiruppur
Net present value @ 12% (Rs)	1128756	1507024
Benefit cost ratio (Rs)	4.17	5.07
Internal rate of return	>100	>100
II. Annual Moringa		
Gross income (Rs)		568725.5
Net income (Rs)		482620.9
Cost of production (Rs.t-1)		2380
Output – input ratio		6.62
Return on investment		5.6

### Problems in Moringa cultivation

Any production practices particularly in agriculture and horticulture, the constraints are many to the farm folks. Moringa cultivation is one of the practices which has also faced few constraints and the same are enlisted and the opinion of the farmers of the study area have been analysed and the results are presented in Table 11. The problems faced by Moringa farmers are presented in Table 11 and it is revealed that the availability of labour alone found to be the principal constraints to the farmers in the study area followed by insect attack during certain period and its control was found to be the second important constraint. The sample farmers of Thoothukkudi District has opined that the lack of knowledge in organic pest control practices found to be the third important constraint to them. Still most of the farmers particularly around 50 per cent of the farmers were deficient with adoption of appropriate technology in producing the crop profitably. The availability of irrigation water was the constraint to the farmers of Tiruppur District where the bore well source was also sub optimal and hence it is found to be the big constraint to them. Drip irrigation and fertigation technique is practiced in most of the Moringa farms to generate their own income in Tiruppur District. However, the Micro Irrigation practices were not penetrated to the Moringa growing farmers of Thoothukkudi District. To sum up, the Moringa plantations could also generate sustainable income coupled with high profit per annum motivated many of the farmers to think of area expansion. Only thing that the support of Government Departments should do is establishing a cold storage or the infrastructure development of proceeding further to establish the value-added products like Moringa Chips from the Fresh Vegetable Pod could generate higher foreign exchange earnings. In this circumstance, one should assess the potential markets and marketing practices available for Moringa produce. These are discussed separately.

Table 11 Problems encountered by the households

Category	Multiple Responses				Total
	Thoothukkudi		Tiruppur		
	Number	Percent	Number	Percent	
Labour availability	48	96	48	96	96 (96)
Insect attack	42	84	46	92	88 (88)

Category	Multiple Responses				Total
	Thoothukkudi		Tiruppur		
	Number	Percent	Number	Percent	
Lack of knowledge in organic pest control	41	82	28	56	69 (69)
Lack of knowledge on efficient production practices	34	68	16	32	50 (50)
Shortage of water for irrigation during dry months	28	56	32	64	60 (60)

Source: Field survey; (Figures in parenthesis indicate percentage to total)

### Conclusions and policy implications

The Factors influencing Moringa cultivation and the Resource use efficiency analysis indicated that Moringa plantations are capable of generating sustainable income coupled with high profit per annum motivated many of the farmers to think of area expansion. During the summer months, the yield of Moringa vegetable per unit area was alarmingly increased and hence the excess supply can be put to value addition process. Only thing that the support of Government Departments should do is, establishing a cold storage or the infrastructure development for proceeding further to establish the value-added products like Moringa chips from the fresh tender vegetable pod during the seasons could generate higher foreign exchange earnings and higher return to the producer farmers. To activate this process further, the policy makers can think of establishing a Moringa Board on the lines of Tea Board or Coffee Board to promote the small and marginal farmers whom are involved in cultivating Moringa in a big way.

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### Conflict of interest

Author declares that there is no conflict of interest.

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