Asian Journal of Agricultural Extension, Economics & Sociology

Volume 41, Issue 5, Page 29-35, 2023; Article no.AJAEES.98584
ISSN: 2320-7027

Economics of Coconut Cultivation Using Treated Sago Industrial Wastewater and Fresh Water in Salem District of Tamil Nadu

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJAEES/2023/v41i51897

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/98584

Original Research Article

Received: 05/02/2023
Accepted: 10/04/2023
Published: 10/04/2023

ABSTRACT

The study attempts to examine the socio- economic profile and economics of coconut cultivation using treated sago industrial wastewater and fresh water in the Salem district of Tamil Nadu. A sample of 180 farmers receiving treated wastewater from nearby industrial units and another 180 farmers receiving fresh water (control farms) were selected through a multistage purposive sampling technique. The major finding of economic analysis of coconut cultivation revealed that the gross income of the sample farm using treated sago industrial wastewater was high at ₹

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1,31,408.00 as a result of the better yield of nuts (12540) as compared to that obtained by irrigation with fresh water (12245). The net income per hectare of coconut was ₹ 46,128.64 and ₹ 34,245.72 for the farm using treated wastewater and control farms, respectively. The study; therefore could establish that using treated industrial wastewater for irrigation will be advantageous in terms of net returns and to an extent substitute use of fresh water for irrigation, besides helping to save on use of and expenditure of organic and inorganic fertilizers.

Keywords: Coconut, cost and return; sago units; Salem District; treated wastewater.

1. INTRODUCTION

Tapioca is cultivated in an area of 183 thousand hectare in India, with the total production of 6940.90 thousand metric tonnes. This tuber crop is largely cultivated in Tamil Nadu (50 per cent), Kerala (35 per cent), parts of Andhra Pradesh (5 per cent), Meghalaya (3 per cent), Nagaland (2.5 per cent) and Assam (1.8 per cent) [1]. Tamil Nadu stands first both in area and production of 91.51 thousand hectares and 3893.34 thousand metric tonnes with productivity 42.55 MT/ hectare [1]. Tapioca is mainly processed into starch and sago, which was introduced in India only in 1940's upwards.

In India, more than 70 per cent of sago production was contributed by Tamil Nadu. The sago industry is an agro-based seasonal industry, which is more water-intensive i.e., the extraction of sago from tubers requires 20,000 to 30,000 litres of water per ton of sago. Sago industries generate huge quantities of wastewater ranging from 30,000 to 40,000 litres per day of effluent were generated, which were rich in organic content [2]. The untreated effluents have high content of organic load, which when stored for some days results in obnoxious odour, irritating colour, lower pH (4.2-5.7) and higher BOD (840 mg/l - 4650 mg/l), COD (1600 mg/l -5500 mg/l) and TDS (2068 mg/l – 6864 mg/l) [3,4,2,10]. When this effluent is mixed in the agricultural farm without proper treatment, it is prone to increase soil and water pollution [5], which pushes the farmers towards non-agriculture. The acidic nature of the untreated effluent and the present of inorganic constituents such as phosphate, sulphate, chloride, cyanide etc. and metals like sodium, potassium, iron etc. in trace quantities are also harmful to the health of human being as well as to the aquatic culture. As per the pollution control law enforced by the government and Tamil Nadu Pollution control board to protect the environmental resources, most of the sago units have provided Effluent Treatment Plants (ETP) for the treatment of trade effluents. The sago units have provided Effluent Treatment Plants (ETP) so that the treated wastewater has standard pH (7.5), low BOD (30 mg/l – 340 mg/l), COD (200 mg/l – 448 mg/l) and TDS (680 mg/l – 1750 mg/l), which is permitted disposal to the land for irrigation [3]. Hence, these treated effluents bring more area under irrigation, reducing the water scarcity problem, avoiding direct pollution of rivers, canals, surface water; conserving water and soil nutrients, reducing the need for and expenditure on chemical fertilizer, thereby helping the small and marginal farmers to retain in agriculture activities. Considering the above aspects, the present study was based on the objectives: 1) To discuss the socio-economic profile of farmers and 2) To estimate and compare the input use pattern, cost of cultivation, yield and returns per hectare of coconut using sago industrial treated wastewater and fresh water in Salem district of Tamil Nadu.

2. DATA SOURCE AND METHODOLOGY

In Tamil Nadu more than 400 sago processing units are functioning of which 215 units are present in Salem district. Hence, Salem district of Tamil Nadu was purposively selected due to the location of highest concentration of sago processing units and due to the consequent pollution problem. Attur taluk was purposively selected from Salem district, which is based on the location of maximum number of sago industrial units. From the selected taluk, three villages that have maximum number of sago units such as Ammampalayam (12 units), Thulukkanur (9 units) and Kattukkottai (11 units) were selected. The number of farmers selected from each village was based on the probability proportional to size. A total of 360 farmers were selected for the present study. This consists of 1) farmers receiving treated wastewater from nearby industrial units (treated wastewater used farms within a 3 km radius from sago units) (180 farmers) and 2) control farms (farmers being distant from the source of industrial wastewater) (180 farmers). The data pertaining to the agricultural year 2021-22 were collected for the

study during the month of November 2021– May 2022 with a multistage purposive sampling technique.

2.1 Cost of Cultivation

Coconut being a perennial crop, the cost of cultivation is to include; fixed and variable cost by considering both establishment cost and operation and maintenance cost [6].

The establishment cost includes cost of digging of pits, value of planting material, cost of gap filling, value of manure (owned and purchased), value of fertilizer, value of human labour, value of machine power, value of plant protection chemicals, rental value of land and land tax. The operation and maintenance cost includes value of human labour, value of machine power, value of insecticides and pesticides, value of manure (owned and purchased), value of fertilizer, irrigation charges, land revenue and miscellaneous expenses. The fixed cost included: the amortized annual share of establishment cost, interest on fixed capital excluding land, rental value of owned land and depreciation. The variable cost includes all the operation and maintenance cost and Interest on working capital

Depreciation means declining in the value of the assets over the period of time, due to the wear and tear of its usage. Annual depreciation on individual items of fixed capital can be worked out by using straight line method and then aggregated to get the total annual depreciation [7].

$$Amount\ of\ depreciation = \frac{(Original\ cost\ of\ the\ asset - Junk\ value)}{Useful\ life\ of\ the\ asset}$$

Amortization of Fixed Cost [8],

$$A = \frac{P\left(\frac{r}{100}\right)[1+\frac{r}{100}]^n}{[1+\frac{r}{100}]^n - 1}$$

Where, A = Amortization cost, P = Total establishment cost, r = Rate of interest @ 6.25 per cent (bank rate) and n = Number of years.

2.2 Return Analysis

Gross Income = (Quantity of main product× Price of main product) + (Quantity of by-product × Price of by-product)

Net Income = Gross Income - Total Cost

Benefit- Cost ratio is the ratio between gross return and total annual expenses incurred for the coconut farming.

3. RESULTS AND DISCUSSION

3.1 Socio- Economic Status of Sample Respondents in Study Area

The general socio-economic characteristics of the sample respondents such as age, education, farming experience, farm size and annual income were tabulated and analysed with percentage analysis. The results of the analysis are presented in Table 1.

Table 1. Socio- Economic status of sample respondents

S. No.	Particulars	Treated wastewater irrigated farms	Control farms (Fresh water)
A	Age in years (Average)	47.76	49.04
B	Education		
1	No formal education	-	2 (1.11)
2	Primary level	7 (3.88)	20 (11.11)
3	Secondary level	66 (36.67)	94 (52.22)
4	Higher secondary level	57 (31.67)	36 (20.00)
5	Collegiate level	50 (27.78)	28 (15.56)
C	Farming Experience (Average) in years	25.88	28.79
D	Farm size in hectares (Average)	1.66	1.23
E	Source of Income (₹ per farm)		
1	On-farm income		
	Crop income	1,55,678 (47.00)	1,19,654 (45.97)
	Livestock income	87,345 (26.37)	71,267 (27.38)
2	Off-farm income	55,679 (16.81)	38,957 (14.97)
3	Non-farm income	32,547 (9.83)	30,386 (11.68)
	Gross income	3,31,249 (100)	2,60,264 (100)

Source: Field Survey, 2022

Note: Figures in parentheses indicate percentage to total

The average age of the sample respondents using treated wastewater was 47.76 years which is slightly lower as compared to that of control farms (49.04 years). Most of the respondents in treated wastewater irrigated farms have secondary level of education constituting about 36. 67 per cent followed by higher secondary level with 31.67 per cent, collegiate level with 27.78 per cent) and primary school with 3.88 per cent. Among the respondents of the control farms, 52.22 per cent had a secondary level of education, 20 per cent had higher secondary level education, 15.56 per cent had collegiate level, 11.11 per cent had primary school of education, and only 1.11 per cent were illiterate. The average farming experience of the sample respondents in treated wastewater irrigated farms was 25.88 years which are slightly lower as compared to that of respondents in control farms with 28.79 years, which implied that most of the young farmers in the study area are ready to go with using treated wastewater in their farms. The average farm size of the sample respondents in treated wastewater irrigated farms was 1.66 hectare which was slightly higher than that of respondents in control farms (1.23). The availability of excess quantity of water encourages the farmers to use more unutilized land for perennial crops like casuarina, eucalyptus, fodder crops and coconut in the study area. The average gross income of sample farms using treated wastewater irrigated farm was high with ₹ 3,31,249 and in control farms it was about ₹ 2,60,264 [9].

3.2 Cost of Cultivation of Coconut

3.2.1 Inputs use pattern for the cultivation of Coconut

The total input utilized for the cultivation of coconut including both establishment and maintenance was presented in Table 2.

It could be seen from Table 2 that the average number of trees per hectare was 153 for the farms using treated wastewater and 176 for the control farms. The treated wastewater irrigated farm used 43.54 tons of farm yard manure, 196.43 kg of nitrogen, 203.12 kg of phosphorous, 64.43 kg of potassium, 5.3 litres of plant protection chemical, 350 man-days of total human labour and 22 hours of machine power. The total inputs utilized for the cultivation of coconut in the control farms were found to be 35.15 tons of farm yard manure, 367.56 kg of nitrogen, 316.30 kg of phosphorus, 85.20 kg of potassium, 2.2 litres of plant protection chemical, 276 man days of total human labour and 13 hours of machine power.

3.2.2 Cost of establishment of coconut

The establishment cost of coconut crop upto the bearing stage included all the costs incurred for the initial establishment: like land preparation, digging of pits, planting material, gap filling, cost of manure, fertilizer, plant protection chemicals, human labour, irrigation cost, rental value of owned land and land tax. The total establishment cost of coconut crop was worked out to be ₹ 1,30,926.09 for the farms using treated wastewater and ₹ 1,09,576.61 for the control farms. Out of which, rental value of owned land contributed more with 37.26 per cent and 33. 54 per cent for the farms using treated wastewater and fresh water, respectively.

3.2.3 Operation and Maintenance cost of coconut

The operation and maintenance costs were worked out and the results are presented in table 4. The total operation and maintenance cost per year after attaining bearing age for the farms using treated wastewater and control farms were found to be ₹ 33,905.26 and ₹ 31,239.65, respectively. Out of which, hired labour contributed more with 33.46 per cent in treated wastewater irrigated farm whereas family labour contributed more with 34.03 per cent in control farms. However, manure and chemical fertilizer cost was found to be more for the sample respondents using fresh water in control farms when compared with treated wastewater irrigated farm. This may be because the presence of organic and inorganic constituents in the treated sago industrial wastewater discharged from the sago units.

3.2.4 Cost and return analysis of coconut

The total cost of cultivation, gross return, net returns and B:C analysis were worked out and results are presented in Table 5.

Table 2. Inputs use pattern for the cultivation of Coconut (per ha)

S. No.	Inputs	Treated wastewater irrigated farms	Control farms (Fresh water)
1	Seedling (numbers)	153	176
2	Gap filling (no.of seedlings)	25	7
3	Manures (tons)	43.54	35.15
4	Fertilizer (kg)		
	i. N (kg)	196.43	367.56
	ii. P (kg)	203.12	316.3
	iii. K (kg)	64.43	85.2
5	Plant protection chemicals (lit)	5.3	2.2
6	Total human labour (man days)	350	276
	i. Family labour	160	167
	ii. Hired labour	190	109
7	Machine power (hrs)	22	13

Source: Field Survey, 2022

Table 3. Cost of establishment of coconut farm for eight years (per ha)

S. No.	Particulars	Treated wastewater irrigated farms	Per cent	Control farms (Fresh water)	Per cent
1	Land Preparation	2130.34	1.63	3120.45	2.85
2	Digging of pits	3855.67	2.94	4320.75	3.94
3	Planting material	3060.00	2.34	3520.00	3.21
4	Gap filling	500.00	0.38	140.00	0.13
5	Manure	8687.50	6.64	6427.50	5.87
6	Fertilizer cost	5275.08	4.03	8795.91	8.03
7	Plant protection chemical	1325.00	1.01	550.00	0.50
8	Human labour				
	i. Family Labour (Imputed value)	21304.50	16.27	20494.50	18.70
	ii. Hired labour	32958.00	25.17	20490.00	18.70
9	Irrigation	2450.00	1.87	4367.00	3.99
10	Rental value of owned land	48780.00	37.26	36750.50	33.54
11	Land tax	600.00	0.46	600.00	0.55
	Total establishment cost	130926.09	100.00	109576.61	100.00

Source: Field Survey, 2022

Note: Figures in parentheses indicate percentage to total.

Table 4. Operation and Maintenance Cost of coconut farm (per ha)

S. No.	Particulars	Treated wastewater irrigated farms	Per cent	Control farms (Fresh water)	Per cent
1	Fertilizer cost	5936.09	17.51	8994.56	28.79
2	Human labour				
	i. Family Labour (Imputed value)	6289.50	18.55	10629.50	34.03
	ii. Hired labour	11344.50	33.46	2947.50	9.44
3	Manure	4834.50	14.26	5192.00	16.62
4	Machine power	1875.50	5.53	1397.00	4.47
5	Plant protection chemical	960.17	2.83	554.09	1.77
6	Land tax	75.00	0.22	75.00	0.24
7	Miscellaneous charges	2590.00	7.64	1450.00	4.64
	Total operational and maintenance cost	33905.26	100.00	31239.65	100.00

Source: Field Survey, 2022

Note: Figures in parentheses indicate percentage to total

Table 5. Cost and Return Analysis of coconut (per ha)

S. No.	Particulars	Treated wastewater irrigated farms	Per cent	Control farms (Fresh water)	Per cent
I	**Fixed cost**				
1	Amortized Annual share of establishment cost	26834.97	31.47	22459.12	31.22
2	Depreciation	4640.00	5.44	3298.76	4.59
3	Interest on fixed capital	3760.00	4.41	1947.67	2.71
4	Rental value of owned land	9689.13	11.36	7671.45	10.66
	Total Fixed cost	44924.10	52.68	35377.00	49.18
II	**Variable cost**				
1	Total operational and maintenance cost	33905.26	39.76	31239.65	43.43
2	Interest on working capital	6450.00	7.56	5320.13	7.40
	Total Variable cost	40355.26	47.32	36559.78	50.82
III	**Total cost (I+II)**	85279.36	100.00	71936.78	100.00
	Yield (in nuts)	12540.00		12245.00	
	Price per unit	10.20		8.50	
	Value of main-product	127908.00		104082.50	
	Total by-product income	3500.00		2100.00	
IV	**Gross income**	131408.00		106182.50	
V	**Net income**	46128.64		34245.72	
VI	**Benefit cost ratio**	1.54		1.48	

Source: Field Survey, 2022

Note: Figures in parentheses indicate percentage to total

The total cost of cultivation of coconut crop per hectare per year was worked out to be ₹ 85,279.36 and ₹ 71,936.78 for the farms using treated wastewater and control farms, respectively. In treated wastewater irrigated farm, the total fixed cost was found to be ₹ 44,924.10 per hectare which contributes 52.68 per cent of total cost. Out of which, the amortized annual share of establishment cost was contributed the maximum share with ₹ 26,834.97 per hectare. The total variable cost was found to be ₹ 40,355.26 per cent per hectare which contributes 47.32 per cent. In control farms, the total fixed cost and total variable cost were found to be ₹ 35,377 per hectare and ₹ 36,559.78 per hectare which contributed about 49.18 per cent and 50.82 per cent, respectively. The yield obtained was 12,520 nuts per hectare for treated wastewater irrigated farms and 12,245 nuts per hectare for the control farms. The price per nuts was found to be ₹ 10.20 for the farms using treated wastewater and ₹ 8.50 for the control farms. The total value of main product was found to be ₹ 1,27,908 for the farms using treated wastewater and ₹ 1,04,082.50 for control farms. The total gross return including both the income from main product and by-product realised per hectare was ₹ 1,31,408 and ₹ 1,06,182.50 for the farms using treated wastewater and control farms, respectively. The net income per hectare of coconut was ₹ 46,128.64 and ₹ 34,245.72 for the farm using treated wastewater and control farms. The B:C ratio was found to be 1.54 and 1.48 for the farm using treated wastewater and control farm, respectively. The result of the B:C analysis clearly establishes the advantages of the farms receiving treated sago industrial wastewater for irrigation.

4. CONCLUSION

The major finding of economic analysis of coconut cultivation revealed that the gross income of the respondents of the sample farm using treated sago industrial wastewater was high at ₹ 1,31,408.00 as a result of better yield of nuts (12540) as compared to that obtained by irrigation with freshwater in control farms (12245). The net income per hectare of coconut was ₹ 46,128.64 and ₹ 34,245.72 for the farm using treated wastewater and control farms, respectively. The study; therefore could establish that using treated industrial waste water for irrigation will be advantageous in terms of net returns and to an extent substitute use of fresh water for irrigation, besides helping to save on the use of and expenditure on organic and inorganic fertilizers. However, coconut is a perennial crop and the treated wastewater is used for irrigation continuously in the long run, it is necessary to take investigations for the presence of heavy metals in the soil, water and

crop plants and their produce. This will allow for necessary further action in term of changes in crops cultivated and methods of irrigation. Thus, Government may also bring in policies to encourage the use of treated sago wastewater for irrigation of seasonal or annual crops instead of perennial crops.

ACKNOWLEDGEMENT

I sincerely thank ICSSR (Indian Council of Social Science Research) for providing financial assistance to the study.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/98584