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A study on resource use efficiency and economic returns for Tapioca in Namakkal district of Tamil Nadu, India

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Abstract
In this paper, an attempt was made to analyze the production of tapioca in the Namakkal District. Based on the area under tapioca, three blocks of Namagiripet, Paramathi, and Kabilarmalai were selected. The total sample size was 120 tapioca growers. The study revealed that a declining trend was observed during the 2009-2019 period in the area, production, and productivity of tapioca due to an increase in area under Sorghum and Maize and fluctuating prices for tapioca tubers in the study area. In the study area, tapioca growers were mostly using traditional varieties. It was observed that nitrogen fertilizer was over utilized in marginal and small farms. Whereas phosphorous and potassium fertilizers and machinery usage were less when compared to recommended farm input packages. Hence high yielding and quality setts might be popularized in the study area to improve the productivity and quality of tubers for enhancement of better income to the tapioca growers. Hence government should take necessary steps to strengthen transportation infrastructure and to facilitate the dissemination of market information through all possible mass media for the benefit of the farming community. Further, a suitable price policy would be implemented by the government to protect the poor tapioca farmers from the existing uncertainty in the tuber prices.

Keywords: tapioca, compound growth rate, CACP method, cobb douglas production function

1. Introduction
Tapioca has been used as a staple food in many countries in the world. Tapioca serves a high-calorie value and carbohydrate starchy food to almost 500 million people. Tapioca has other names such as cassava, manioc and mandioca. Tapioca cultivation was originated in Latin America before 4000 years and started cultivation in India in the 18th century. India ranks first in productivity of tapioca and 25th in the area under cultivation of tapioca in the world. In India, tapioca is cultivated in both irrigated and rain-fed conditions. Around 80 percent of total tapioca production in India was contributed by Tamil Nadu and Kerala State. In India, Tamil Nadu ranks First in Tapioca production followed by Kerala. The area and production of tapioca in India during the year 2019 was about 228 thousand hectares and 4472.09 thousand tonnes and in Tamil Nadu, they were about 81.12 thousand hectares and 3065.12 thousand tonnes respectively. The yield of tapioca in Tamil Nadu state is around 30.5 tonnes per hectare during 2019-2020. Around 72 percent of tapioca production in Tamil Nadu is carried out by Namakkal, Salem, Dharmapuri, Villupuram, and Erode districts. In that, Namakkal stands first in the production and productivity of tapioca in Tamil Nadu and shares about 20.15 percent of total production in the state. The higher productivity of tapioca in Namakkal was due to the most suitable soil condition and even distributed rainfall over the year. As Indian soils were higher in the availability of potassium there was much scope for tapioca cultivation in places of drought areas under rain-fed conditions. The study was carried out to unveil the answers for whether the farmer put forward to grow tapioca, the profitability of tapioca cultivation, yield performance of tapioca, and problems faced by them.

1.1 Objectives
The specific objectives of the study were as follows
- To analyse the growth in area, production and productivity of tapioca in Namakkal district of Tamil Nadu.
- To workout the cost and returns of tapioca production in Namakkal district.
- To assess the resource use efficiency in the production of tapioca.

- To identify the constraints in tapioca cultivation and suggest possible measures to overcome.

2. Review of Literature

Sood, Shivalika, Hari Singh, and Diksha Sethi (2020) [1] studied growth performance in pulses in Rajasthan. The results inferred that the there was a positive trend in area under pulses cultivation and expansion in area simultaneously increase the production of moong bean, chick pea and urd bean in the study area. Ragavi, G., Sanjay Kumar, and A. K. Rai (2019) [2] analysed the cost and returns of tapioca in Namakkal district of Tamil Nadu and concluded that the average cost of cultivation of tapioca was Rs.75,412 and the gross income was estimated to be Rs. 139,192 with average net income of Rs.59,970. Tirlapur, LAXMI N., and S. M. Mundinamani (2015) [3] analysed the resource use efficiency in major cultivating crops in Dharwad district. The results enumerated that chickpea farmers used machine hours, seed, plant protection chemicals and fertilizers were over utilized while farm yard manure and human labour were underutilized. They concluded that the inefficient and improper use of resources was the main reason for downfall growth in agriculture sector. Sowjanya, B., DV Subba Rao, and R. Vijaya Kumari (2016) [4] studied the resource use efficiency and marketing of Redgram. The study revealed that the ratio of MVP to MFC were positive indicating that these resources were underutilized. Since the resources should be used more to reach the optimum level. Redgram production was in the rational zone indicated decreasing returns to scale.

3. Materials and Methods

Namakkal district was selected purposively for the study. Based on the area under tapioca cultivation, three blocks namely Namagiripet, Kabilarmalai, and Paramathi were chosen to conduct the study. Further, the total sample of 120 tapioca farmers was selected randomly in the study area. The trend analysis was estimated by data from secondary sources. The collected primary data was tabulated and processed. Cost of production and resource use efficiency were estimated from the collected data.

3.1 Compound Growth Rate analysis

Growth rate is the rate which explains the tendency of the variables increase or decrease or remaining constant over the period. The rate of change of Yt per unit of time expressed as a function of the magnitude of Yt itself is used as the CAGR

$Y = ab^t e$

In logarithm, it becomes logy=log a= t log b+ error it is further as $Ln(Y)= Ln(b_0)+b_1t$

Where t is the time variable, Y variable for growth is calculated and b_1 is the regression coefficient of t on Y. The expression is multiplied by 100 to estimate compound growth rate of Y in percentage term.

The mathematical form of log-linear function is CAGR (%) = (Antilog b_1-1) * 100

3.2 Cost and return analysis

CACP method was employed to calculate Cost A1, Cost A2, Cost B1, Cost B2, Cost C1, Cost C2 and Cost C3 respectively.

Cost A_1: Included cost of hired human labour and machine labour, sett cost, irrigation cost, cost of manures and fertilizers, Depreciation of fixed capital, Irrigation charges, Interest on working capital, Land revenue and other taxes

Cost A_2: Cost A_1 plus rent paid for leased in land

Cost B_1: Cost A_1 plus interest on fixed capital (excluding land)

Cost B_2: Cost B_1 plus rental value of owned land

Cost C_1: Cost B_1 plus imputed value of family labour

Cost C_2: Cost B_2 plus imputed value of family labour

3.3 Resource use efficiency

Cobb-Douglas production function[5] was utilized to analyze the resource use efficiency of tapioca production in the study area. Cobb-Douglas production function was fitted and the form of regression model made use as follows:

$$Y = a X_1^{\beta 1} X_2^{\beta 2} X_3^{\beta 3} X_4^{\beta 4} X_5^{\beta 5} X_6^{\beta 6} X_7^{\beta 7} e^U$$

Where, Y_L = Yield of tapioca in tonnes/ha

A = intercept

X_1 = Quantity of FYM (in tonnes/ha),

X_2 = Quantity of N (in kg/ha),

X_3 = Quantity of P (in kg/ha),

X_4 = Quantity of K (in kg/ha),

X_5 = Quantity of setts material (in number /ha.),

X_6 = Machine labour (in hrs/ha),

X_7 = Human labor (Man days/ha.) and

β_i = parameter to be estimated or regression coefficients (i = 1 to 7)

e = random error term

3.3.1 Marginal Productivities of factors

Estimates of the parameters $\beta_1...\beta_7$ were elasticity's of Y with respect to i^{th} input. The marginal products to the resources were derived from these elasticity coefficients. The marginal value products of significant inputs were worked out at its geometric mean level by using the formula

r = MVP/MFC,

MVP = MPP x P_y

MPP = β_i

Here, MVP_i = Marginal value product of the i^{th} input,

β_i = Estimated co-efficient (or) elasticity of the i^{th} input, and

P_y = Price of output

Marginal value product (MVP) of each input was compared with marginal input cost (MFC) i.e. (MVP/MFC ratio) in order to estimate the efficiency of resources. MVP indicates the changes to be made in the resource use to obtain the economic optimum situation.

MVP/ MFC= 1 ---------- Optimum use of resource

MVP/ MFC< 1 ---------- excess use of resources

MVP/ MFC > 1 ---------- Under use of resources

3.4 Constraints

Garrett ranking method was employed to study the constraints faced by tapioca farmers. The farmer respondents were asked to rank their constraints and problems and then this order of merit was converted into ranks using the following formula:

Percent position = $100 (r_{ij} – 0.5) / n_j$

where,

R_{ij} = rank given for i^{th} factor j^{th} individual

N_j = number of factors ranked by j^{th} individual.

4. Results and Discussion

4.1 Estimation of Compound growth rate

For analyze the growth of area, production and productivity of tapioca crop in study area, the total period can be divided into two periods i.e.; Period I(1998-2009) and Period II(2009-2020). The results were shown in the table 1

Table 1: CGR of area, production and productivity of tapioca during 1998-2008 and 2009-2019

Particulars	Area (in lakh hectares)	Production (In lakh Tonnes)	Productivity (Tonnes/ hectare)
CGR (1998-2008)	7.65	10.11	2.25
CGR (2009-2019)	-5.37	-7.98	-2.75

The results showed that the compound growth rates of area, production, and productivity of tapioca during the 1998-2008 period were found to be 7.65 per cent, 10.11 per cent, and 2.25 per cent respectively. Due to the interest shown by farmers and the adoption of new high-yielding varieties like Mulluvadi and Kunguma Rose, there increase in the production of tapioca tubers. During the 2009-2020 period the compound growth rates of area, production, and productivity of tapioca were found to be -5.37 per cent, -7.98 per cent, and -2.75 per cent respectively. The results indicated that there was a progressive downfall trend in the area, production, and productivity over the time.

4.2 Estimation of cost and return in tapioca production

The analysis of the cost of cultivation using CACP cost concepts was carried out and given below. These costs were worked out on a per hectare basis and were presented in Table 2. The cost and return was calculated for different groups of farmers' namely marginal farmers, small farmers, and medium farmers.

To estimate the cost and returns in tapioca production, the variable cost and fixed cost were taken. It could be observed that the majority share in the variable cost was taken up by human labour. This was due to the need for labour was more in the production of tapioca so-called a labor-intensive crop. The average gross income from tapioca production per hectare was Rs.1,74, 677. The average net income obtained by tapioca growers was Rs. 84,501.

In the case of marginal farmers, it was observed that Cost A1 was accounted for Rs.69,623. Whereas Cost B1 was estimated to be Rs.74,843. Cost C2 was added up to Rs.89,031. Comparatively marginal farmers spent less on machine labour and plant protection chemicals than small and medium farmers. The gross income has amounted to Rs.1,75,370 while the net income was observed to be Rs.86,339.

In the case of small farmers, Cost A1 has amounted to Rs.68,893. Cost B1 was estimated to be Rs.75,432. Cost C2 was added up to Rs.89,730. In the study area, the small farmers were more economically balanced and they are advised to go for improved irrigation structures. So they can reduce the cost of human labour in all stages of production. Continues cropping of tapioca for more than two years leads to soil nutrition exhaustion so the small farmers shift their cropping to other crops more often than medium and small farmers. The gross income amounted to Rs.1,74,525 while the net income was observed to be Rs.84,795.

In the case of medium farmers, based Cost A1 was estimated to be Rs.73,323. Cost B1 was amounted to be Rs.79,829. Cost C2 was added up to Rs.93,871. The share of human labour cost and cost of fertilizers were found to be higher in the total cost in cultivation. The increased cost of fertilizers was due to the over-application of fertilizers in the field. Due to higher levels of owned machinery and farm implements, the cost of depreciation on fixed capital was relatively higher than other groups of farmers. The gross income amounted to Rs.1,74,135 while the net income was observed to be Rs.80,264.

Table 2: Cost and returns of Tapioca in different size of farm groups in Namakkal (in Rs per hectare)

S. No	Particulars	Marginal	Small	Medium	Average
1	**Cost A1**				
	Value of human labour	23487	22285	21097	22290
	Value of Machine labour	5326	5787	7456	6190
	Value of setts	2657	2680	2695	2677
	Value of organic manure	10400	9652	10542	10198
	Value of Irrigation	4955	5325	5200	5160
	Value of fertilizers	14126	13965	16475	14855
	Value of pesticides and weedicides	3650	4150	4524	4108
	Depreciation on fixed capital	463	542	562	522
	Interest on working capital	4522	4469	4735	4575
	Land tax	36.75	36.75	36.75	37
	Total	69623	68893	73323	70613
2	**Cost A2**				
	Cost A1+ Rent paid for leased in land	69623	68893	73323	70613
3	**Cost B1**				
	Cost A1 + Interest on fixed capital (excluding land)	74843	75432	79829	76701
4	**Cost B2**				
	Rental value of owned land	12500	12500	12500	12500
	Cost B1+ Rental value of owned land	87343	87932	92329	89201
5	**Cost C1**				
	Imputed value of family labour	1688	1798	1542	1676
	Cost B1 + Imputed value of family labour	76531	77230	81371	78377
6	**Cost C2**				
	Cost B2 + Imputed value of family labour	89031	89730	93871	90877
7	Yield (t)	26.98	26.85	26.79	27

8	Price (Rs/t)	6500	6500	6500	6500
9	Gross income	175370	174525	174135	174677
10	Net income	86339	84795	80264	84501
11	cost of production (Rs per kg)	3.31	3.34	3.50	3.38

4.3 Resource use efficiency in tapioca cultivation

Resource use efficiency was estimated using Cobb-Douglas production function for marginal and small farm sized tapioca farms.

4.3.1 Estimation of resource use efficiency for marginal farmers

The values of multiple determinations (R^2) implied that 79 percent of the total variation in the dependent variable was explained by variation in the independent variables. The results were given in the table 3.

Table 3: Resource use Efficiency of Tapioca crop of marginal farmers in Namakkal

Variables	Parameter	Regression coefficient	Standard error	$\frac{MVP}{MFC}$	Status
Intercept	β_0	3.24*	5.723	-	
FYM(t/ha)	β_1	0.003 ^{NS}	0.035	-	
N (Kg/ha)	β_2	0.369*	0.152	0.71	Over utilized
P (Kg/ha)	β_3	-0.316 *	0.137	-5.74	Over Utilized
K (Kg/ha)	β_4	0.541**	0.114	1.38	Under Utilized
Setts (Number per ha)	β_5	-0.608 ^{NS}	0.581	-	
Machine labour (hrs/ha)	β_6	0.098 *	0.041	1.27	Under Utilized
Human Labour (man days/ha)	β_7	0.228*	0.104	0.12	Over Utilized

N = 56; R^2: 0.79, *5% significance level, ** 1% significance level.

In marginal-sized farms, the independent variables nitrogen, potassium, machine hours, and human labour were positive and significantly influence the yield and a one percent increase in the use of these inputs increased the yield of tapioca by 0.37, 0.54, 0.10, and 0.23 percent respectively. Thus by adding all the coefficients of variable, the value was found to be 0.315 for marginal-sized farms indicated decreasing returns to scale which implied that a one percent increase in each of these resources would increase the yield by less than one percent. Likewise, the efficiency ratio of the inputs like potassium fertilizer and machine hours were found to be more than one indicating that these resources were underutilized in the study area and need to be increased in their usage to enhance the production of tapioca for marginal farms.

4.3.2 Estimation of resource use efficiency for small farmers

The coefficient of multiple determinations (R^2) was estimated to be 0.842 which meant 84 percent of the total variation in the dependent variable was explained by variation in the independent variables. The results were discussed in the table 4.

Table 4: Resource use efficiency of tapioca crop of small farmers in Namakkal district

Variables	Parameter	Regression coefficient	Standard error	$\frac{MVP}{MFC}$	Status
Intercept	β_0	-2.95	8.706	-	
FYM(t/ha)	β_1	0.050^{NS}	0.042	-	
N (Kg/ha)	β_2	0.462*	0.172	0.78	Over utilized
P (Kg/ha)	β_3	-0.275 ^{NS}	0.160	-	
K (Kg/ha)	β_4	0.457**	0.142	1.20	Under Utilized
Setts (Number per ha)	β_5	0.167 ^{NS}	0.901	-	
Machine labour (hrs/ha)	β_6	0.118 *	0.055	1.88	Under Utilized
Human Labour (man days/ha)	β_7	0.278*	0.117	0.24	Over Utilized

N = 39; R^2: 0.84, *5% significance level, ** 1% significance level.

In the case of small-sized farms the independent variables nitrogen, potassium fertilizer, machine hours, and labour man-days were positive and significantly influence the yield. Hence one percent increase in the use of nitrogen, potassium fertilizer, machine hours, and labour man-days increased the yield of tapioca by 0.46, 0.45, 0.12, and 0.29 percent respectively. By adding all the coefficients of variable, the value was found to be 1.257 indicated increasing returns to scale which implied that one percent increase in each of these resources would increase the yield by more than one percent, the efficiency ratio of potassium fertilizer and labour man-days were found to be more than one indicated that these resources were underutilized in the study area and need to be increased in their usage to increase the production of tapioca. Whereas, the efficiency ratio of Nitrogen and labour man-days were found to be less than one indicated that these resources were over-utilized in the study area and need to be reduced in their usage to increase the production of tapioca in small farms.

4.4 Constraints in production of Tapioca

The farmers in the study area faced several constraints in the production of the tapioca. Those constraints were ranked using Garrett's ranking technique and the results are given in the Table 5.

Table 5: Constraints of farmers in Tapioca Production

Sl. No.	Constraints	Mean Score	Rank
1.	Pest and disease incidence	71.52	I
2.	Labour scarcity	68.60	II
3.	Unavailability of quality sett material	63.12	III
4.	Delay in Harvest after maturity	54.57	IV
5.	rainfall at time of harvest	45.85	V

The major constraint identified was the pest and disease incidence with a mean score of 71.52. This was mainly due to the inhibition of the pests such as spiraling whitefly, mites, and diseases notably mosaic and tuber rot, which leads to the decrease in the productivity of tubers. The second reported constraint was the limited availability of labour with a mean score of 68.60.

5. Conclusion and Suggestions

It was observed from the study that area and production and productivity of tapioca for Namakkal district during the period 1998-2008 was found increasing rate accounting for 7.65 percent, 10.11 percent, and 2.25 percent respectively. This was due to the application of high-yielding varieties like Mulluvadi and Kunguma Rose. Whereas the declining trend was observed 2009-2019 period in area and production and productivity of tapioca due to increase in area under Sorghum and Maize and fluctuating prices for tapioca tubers in the study area. These crops were cultivated to meet out increasing demand for poultry and cattle feed.

It was further inferred from the study that tapioca growers were mostly using traditional varieties. The use of setts has negatively influenced the yield (-0.434) for marginal farmers. Hence high yielding, climate-resilient with good culinary characters and high starch content tapioca varieties would be popularized for improving productivity. It was observed that nitrogen fertilizer was over-utilized in marginal and small farms. Whereas phosphorous and potassium fertilizers and machinery usage were less when compared to recommended farm input packages.

It was reported that pest and disease incidence, limited availability of labour were found the major constraints in tapioca production with mean values 71.52 and 68.60 respectively. Whereas constraints in the marketing of the tapioca were identified as price fluctuations, malpractices in marketing with mean values of 66.05 and 58.45 respectively.

From the study results the following suggestions were drawn:

It was observed from the study that traditional tapioca setts were used by the farmers. Hence high yielding and quality setts might be popularized in the study area to improve the productivity and quality of tubers for enhancement of better income to the tapioca growers.

It was indicated that the area under tapioca was decreasing and farmers were shifting cultivation to sorghum and maize for better opportunities. Hence suitable price policy would be implemented by the government to protect the poor tapioca farmers from the existing uncertainty in the tuber prices. Once the minimum returns are assured, farmers might even go for capital investment in the form of developing irrigation infrastructures, etc.

It was observed that there were production and marketing constraints that persisted in the study area. Hence government should take necessary steps to strengthen transportation infrastructure and to facilitate the dissemination of market information through all possible mass media for the benefit of the farming community. Further facilitating start-up production units on tapioca value addition at cottage/community level with better value addition technologies might be strengthened in the study area.

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