An Economic Growth of Farmers Through Mechanization in Sugarcane Cultivation an Empirical Study in Erode District

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Abstract*—Agriculture in India is the backbone of the economy, providing livelihood to a large proportion of the population and contributing significantly to national income. It supports food security, raw materials for industries, and employment generation. Mechanization in sugarcane cultivation involves using modern machinery for planting, intercultural operations, harvesting, and transport, reducing labour dependency, saving time, and improving productivity. Mechanization in sugarcane cultivation enhances farmers' economic growth by increasing productivity, reducing labour costs, ensuring timely operations, improving yield quality, and raising income per acre, thereby supporting sustainable farm livelihoods. Although, high initial investment costs, limited access to credit, inadequate availability of machinery, lack of technical knowledge, and small landholdings restrict farmers in Erode from fully adopting mechanization, thereby constraining economic growth in sugarcane cultivation. In this junction, the study aimed to examine the economic growth of farmers through mechanization in sugarcane cultivation in Erode district, Tamil Nadu. A descriptive research design was employed to systematically fulfill the objectives of the study. The required data were gathered from both primary and secondary sources. The study population consisted of students from Arts and Science colleges in Erode, from whom 154 respondents were selected using a random sampling method. The primary data were collected through a structured questionnaire comprising socio-economic details and respondents' perceptions related to economic growth through mechanization in sugarcane cultivation, measured on a five-point Likert scale. The collected data were coded and processed using MS-Excel and analyzed through statistical techniques such as percentage analysis, mean, standard deviation and Analysis of Variance (ANOVA) with the assistance of SPSS version 26.0. The null hypotheses were formulated and tested to identify significant differences across selected independent variables. The analysis observed that high level of economic growth through mechanization in sugarcane cultivation is perceived by the farmers who belong to 30–40 years of age category, male, 11–15 years of experience, cultivating sugarcane for 7–9 acres and cultivating crystal sugarcane.

***Index Terms*—Sugarcane Cultivation, Farm Mechanization, Economic Growth, Farmers' Income, Cost of Cultivation, Labour Efficiency, Technological Adoption.**

I. INTRODUCTION

Agriculture is the primary economic activity involving cultivation of crops and rearing of livestock, providing food, raw materials, employment, and income, while supporting rural livelihoods and overall economic development. Indian agriculture is characterized by diverse climatic conditions, varied cropping patterns, and predominance of small and marginal farmers. Mechanization is crucial in the context of the growing commercialization of agriculture. The application of farm machineries is increasing continuously in Indian Agriculture as it contributed to the increase in productivity due to timeliness of operations and increased precision in input application. When compared to industrialized economies, where farm mechanization has exceeded 90%, India's farm mechanization level is still between 40 and 45%. The adoption of farm mechanization among the Indian farming community is highly imperative and need of the hour for continuing and sustainable development. The adoption of mechanized solutions in Indian agriculture is being driven by a number of macroeconomic and inherent factors,

including the growing population, urbanization, and surge in agri. exports like tractors, improved flow of agricultural credit, labour migration, and shortages, in addition to the agricultural, social, and economic growth drivers of mechanization. Particularly, mechanization in sugarcane cultivation significantly contributes to the economic growth of farmers by increasing productivity and operational efficiency. The use of modern machinery for planting, intercultural operations, harvesting, and transportation reduces labour costs and saves time. Mechanization ensures timely farm operations, leading to improved yield quality and higher output per acre. It also minimizes crop losses and lowers overall cost of cultivation. By enhancing profitability and reducing dependency on seasonal labour, mechanization strengthens farmers' income stability. Consequently, mechanized sugarcane cultivation supports sustainable livelihoods and promotes long-term economic development among farmers.

II. REVIEW OF LITERATURE

The researchers Kalpana and Prabakaran (2025) revealed that labour shortage during peak agricultural seasons has significantly affected timely field operations in sugarcane cultivation. Also, increased agricultural wages, driven by Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) and rural–urban migration, have intensified the dependence on mechanization whereas delays in cultivation and harvesting lead to reduced product quality and lower market prices for sugarcane farmers. Further, it was identified that farmers increasingly adopt mechanization, contract farming, and external labour to cope with seasonal labour scarcity. In case of Muruganandam (2024) assumed that sugarcane farmers in Erode district face multiple challenges that adversely affect productivity and profitability. It was observed that water scarcity and labour shortages are the most critical constraints in sugarcane cultivation. The findings noticed that high input costs significantly increase the financial burden on farmers. Inadequate access to institutional credit was identified as a major hurdle limiting timely investment in cultivation activities. The study of Manikandan and Kalaivani (2022) depicted that sugarcane farmers in the Sathyamangalam taluk of Erode district were economically inefficient in the use of farm resources. It was found that high costs of labour, fertilizers, seeds, and machine hours were the major factors contributing to inefficiency in sugarcane production. The result showed that efficient utilization of these inputs could significantly improve productivity and reduce production costs. Regarding the research from Bee and Rahman (2020) indicated that the positive compound annual growth rate for area, production, and productivity of sugarcane in India over the study period. Although the cultivated area increased steadily, production and yield exhibited a fluctuating trend due to monsoon variability and policy-related factors. Further, water scarcity and pricing policies were identified as major constraints affecting consistent growth.

According to Prasanna et al. (2019) observed that sugarcane was the major commercial crop in Kavindapadi-A village and plays a vital role in farmers' income generation. It was observed that harvesting cost constitutes the maximum share of total cultivation cost, mainly due to labour scarcity. The result mentioned that most farmers face difficulties in accessing modern technologies and timely availability of quality seeds and fertilizers. It was also identified that the minimum support price for sugarcane is perceived as inadequate by farmers. The researcher Saravanan (2016) mentioned that hired labour constitutes the largest share of total cost in sugarcane cultivation, accounting for 64.96 percent, followed by seed cost at 14.40 percent. It was found that expenditure on machinery remained relatively low at 5.67 percent, indicating limited mechanization during the study period. The analysis showed that sugarcane farmers realized a net return of Rs. 26,424 per acre, reflecting moderate profitability. The findings highlighted those economies of scale were maximized for farms with sizes between 5 and 7.5 acres. In view of Dhara (2014) depicted that the majority of sugarcane growers utilized farm equipment at a medium level in sugarcane cultivation. It was observed that mechanization significantly reduced labour requirement, drudgery, and cost of operations while ensuring timely completion of farm activities. The analysis obtained that factor such as education, farm size, farming experience, income, and availability of machinery positively influenced equipment utilization. The authors Govindarajan and Shanmugam (2013) assumed that the total cost of sugarcane cultivation in Tamil Nadu was relatively

high, with operational costs accounting for more than 80 per cent of the total cost. It was observed that human labour alone constituted a major share of the operational cost, highlighting the labour-intensive nature of sugarcane cultivation. The production function analysis revealed that labour, organic manure, fertilizers, and plant protection chemicals significantly influenced sugarcane productivity.

III. STATEMENT OF THE PROBLEM

Sugarcane cultivation is a major source of livelihood for farmers in the Erode District of Tamil Nadu and plays a vital role in the region's agricultural economy. In recent years, farmers have been increasingly encouraged to adopt mechanization to address issues such as labour shortages, rising wage rates, and delays in farm operations. However, the extent to which mechanization contributes to the economic growth of sugarcane farmers remains uneven and inadequately understood. Many farmers, particularly small and marginal cultivators, face constraints such as high initial investment costs, limited access to credit, lack of technical knowledge, and inadequate availability of farm machinery. These challenges delay the effective adoption of mechanization and restrict its potential benefits. Therefore, this study aimed to empirically examine how mechanization influences farmers' economic growth in sugarcane cultivation in Erode District.

IV. OBJECTIVES OF THE STUDY

- To present the socio-economic profile of the selected farmers who cultivate sugarcane in Erode district.
- To examine the economic growth through mechanization in sugarcane cultivation of selected farmers in the study area.

V. HYPOTHESIS OF THE STUDY

- There is no significant difference in mean economic growth through mechanization in sugarcane cultivation with respect to farming experience of the farmers.
- There is no significant difference in mean economic growth through mechanization in sugarcane cultivation with respect to sugarcane cultivation area of the farmers.
- There is no significant difference in mean economic growth through mechanization in sugarcane cultivation with respect to type of sugarcane cultivated by the farmers.

VI. RESEARCH METHODS

This study adopted a descriptive research design with a quantitative approach to examine the economic growth of farmers through mechanization in sugarcane cultivation in Erode district. Data were collected from both primary and secondary sources. The primary data were obtained through a structured questionnaire designed to capture information on the socio-economic profile of farmers and their economic growth in sugarcane cultivation in Erode district. The questionnaire employed a 5-point Likert scale to measure farmers' responses. A sample of 154 sugarcane farmers were selected using a random sampling technique. The collected data were systematically organized in MS Excel and subjected to statistical analysis, including percentage analysis, mean score, standard deviation and Analysis of Variance (ANOVA), using SPSS version 26.0.

VII. RESULT AND DISCUSSION

7.1 Socio-Economic Profile of the selected Students and Economic Growth through Mechanization in Sugarcane Cultivation

The details about the selected farmers' socio-economic profile and their economic growth through mechanization in sugarcane cultivation are given in the following table.

Table 1: Socio-Economic Profile of the farmers and Economic Growth through Mechanization in Sugarcane Cultivation

No.	Variables Name	Number of Respondents	%	Mean	SD
1	Age				
	Below 30 Years	25	16.2	3.49	0.47

No.	Variables Name	Number of Respondents	%	Mean	SD
	30–40 Years	38	24.7	3.75	0.55
	41–50 Years	59	38.3	3.63	0.62
	Above 50 Years	32	20.8	3.71	0.49
	Total	154	100.0		
2	Gender				
	Male	93	60.4	3.84	0.45
	Female	61	39.6	3.32	0.54
	Total	154	100.0		
3	Farming Experience				
	Up to 10 years	27	17.5	3.55	0.53
	11–15 years	56	36.4	3.72	0.50
	16–20 years	49	31.8	3.67	0.58
	Above 20 years	22	14.3	3.69	0.62
	Total	154	100.0		
4	Sugarcane Cultivation Area				
	Up to 3 acres	45	29.2	3.63	0.64
	3–6 acres	61	39.6	3.44	0.48
	7–9 acres	28	18.2	3.92	0.49
	Above 10 acres	20	13.0	3.58	0.51
	Total	154	100.0		
5	Type of Sugarcane Cultivated				
	Chewing sugarcane	54	35.1	3.25	0.52
	Syrup Sugarcane	67	43.5	3.81	0.44
	Crystal sugarcane	33	21.4	3.89	0.47
	Total	154	100.0		

- From the above analysis, it is mentioned that 16.2% of the farmers are below 30 years, 24.7% of the farmers belong to the age group of 30–40 years, 38.3% of the farmers fall under 41–50 years and 20.8% of the farmers are above 50 years.
- It is displayed from the analysis that 60.4% of the farmers are male and 39.6% are female.
- From the analysis, it is noticed that 17.5% of the farmers have upto 10 years of farming experience, 36.4% of the farmers have 11–15 years of experience, 31.8% of the farmers have 16–20 years and 14.3% of the farmers have above 20 years of farming experience.
- It is inferred from the above analysis that 29.2% of the farmers cultivate sugarcane in upto 3 acres, 39.6% of the farmers cultivate 3–6 acres, 18.2% of the farmers cultivate 7–9 acres and 13.0% of the farmers cultivate sugarcane above 10 acres of land.
- From the analysis, it is confirmed that 35.1% of the farmers cultivate chewing sugarcane, 43.5% of the farmers cultivate syrup sugarcane and 21.4% of the farmers cultivate crystal sugarcane.

7.2 Economic Growth Through Mechanization in Sugarcane Cultivation

Mechanization in sugarcane cultivation contributes to economic growth by increasing yield efficiency and minimizing production losses. It supports sustainable farm income by optimizing resource use and improving overall cultivation performance. The analysis has developed eight statements related to the economic growth through mechanization in sugarcane cultivation and given in the following table.

Table 2: Economic Growth Through Mechanization in Sugarcane Cultivation

S. No	Factors	Mean Score	SD
1	Mechanization has contributed to a reduction in cultivation time and increased crop yield.	3.58	1.26
2	Mechanized farming practices have reduced labor costs and improved profitability in sugarcane cultivation.	3.34	1.39
3	The use of modern machinery has enhanced the efficiency of harvesting and post-harvest operations.	3.79	1.08

S. No	Factors	Mean Score	SD
4	The adoption of mechanization in sugarcane cultivation has significantly increased overall farm productivity.	4.03	1.02
5	The use of mechanization has lowered production costs and improved the economic returns per acre.	3.49	1.37
6	Availability of sugarcane machines has enabled farmers to expand their cultivation area and output.	3.29	1.26
7	Investment in mechanization has led to better financial stability and long-term sustainability for farmers.	3.53	1.25
8	The economic growth of the sugarcane sector in my region is directly linked to the level of mechanization adopted.	4.02	1.08

The Cronbach Alpha value for the statements of economic growth through mechanization in sugarcane cultivation is 0.914 which shows the reliability is good and fit for analysis of this study. The analysis noticed that the highest mean scores were recorded for increased overall farm productivity through mechanization (4.03) and the strong linkage between regional economic growth of the sugarcane sector and the level of mechanization adopted (4.02), indicating a high level of agreement among farmers. On the other hand, the lowest mean scores were observed for the availability of sugarcane machines enabling expansion of cultivation area and output (3.29) and the reduction of labor costs and improvement in profitability through mechanized practices (3.34), suggesting relatively moderate perceptions on these aspects.

Testing of Hypothesis (ANOVA)

7.3 Relationship between Socio-Economic Profile and Economic Growth through Mechanization in Sugarcane Cultivation of farmers

This section has examined the relationship between the selected variables and economic growth through mechanization in sugarcane cultivation of farmers. In order to analyse the relationship between selected independent variables of the farmers and their economic growth through mechanization in sugarcane cultivation, hypotheses have been developed and examined by using ANOVA.

Farming Experience and Economic Growth through Mechanization in Sugarcane Cultivation

H_0: There is no significant difference in mean economic growth through mechanization in sugarcane cultivation with respect to farming experience of the farmers.

Table 3: Farming Experience and Economic Growth through Mechanization in Sugarcane Cultivation

	Sum of Squares	df	Mean Square	F	'p' value
Between Groups	0.627	3	0.209	0.685	0.562^{NS}
Within Groups	45.738	150	0.305		
Total	46.365	153			

Note: NS – Not Significant

From the above analysis, it is indicated that the 'p' value is greater than 0.05 (p = 0.562), hence the null hypothesis is accepted. Hence, there is no significant difference in mean economic growth through mechanization in sugarcane cultivation with respect to the farming experience of the farmers. Sugarcane

Cultivation Area and Economic Growth through Mechanization in Sugarcane Cultivation

H_0: There is no significant difference in mean economic growth through mechanization in sugarcane cultivation with respect to sugarcane cultivation area of the farmers.

Table 4: Sugarcane Cultivation Area and Economic Growth through Mechanization in Sugarcane Cultivation

	Sum of Squares	df	Mean Square	F	'p' value
Between Groups	5.886	3	1.962	7.270	0.000*
Within Groups	40.479	150	0.270		
Total	46.365	153			

Note: Significant at 1% level

From the above table, it is depicted that the 'p' value is lesser than 0.05 (p = 0.000), hence the null hypothesis is rejected. Therefore, there is a significant difference in mean economic growth through mechanization in sugarcane cultivation with respect to the sugarcane cultivation area of the farmers.

Type of Sugarcane Cultivated and Economic Growth Through Mechanization in Sugarcane Cultivation

H_0: There is no significant difference in mean economic growth through mechanization in sugarcane cultivation with respect to type of sugarcane cultivated by the farmers.

Table 5: Type of Sugarcane Cultivated and Economic Growth Through Mechanization in Sugarcane Cultivation

	Sum of Squares	df	Mean Square	F	'p' value
Between Groups	12.030	2	6.015	26.455	0.000*
Within Groups	34.334	151	0.227		
Total	46.365	153			

Note: Significant at 1% level

From the above table, it is proved that the 'p' value is lesser than 0.05 (p = 0.000), hence the null hypothesis is rejected. So, there is a significant difference in mean economic growth through mechanization in sugarcane cultivation with respect to the type of sugarcane cultivated by the farmers.

VIII. FINDINGS

- It is observed from the analysis that majority (38.3%) of the farmers belong to the age group of 41–50 years. The analysis displayed that farmers aged 30–40 years have maximum level of economic growth through mechanization in sugarcane cultivation with the mean score (3.75).
- It is indicated from the analysis that male farmers constitute the majority (60.4%). The analysis revealed that male farmers have maximum level of economic growth through mechanization in sugarcane cultivation with the mean score (3.84).
- It is examined from the analysis that majority of the farmers fall under the 11–15 years experience category. The analysis measured that farmers with 11–15 years of experience show higher level of economic growth through mechanization with the mean score (3.72).
- It is assessed from the analysis that majority (39.6%) of the farmers cultivate sugarcane in 3–6 acres of land. The analysis showed that farmers cultivating sugarcane for 7–9 acres have maximum level of economic growth through mechanization with the mean score (3.92).
- It is assessed from the analysis that syrup sugarcane (43.5%) is the predominant type cultivated by the farmers. The analysis depicted that farmers cultivating crystal sugarcane have maximum level of economic growth through mechanization with the mean score (3.89).
- From the mean score analysis, it is observed that the highest mean scores were recorded for increased overall farm productivity through mechanization (4.03) and the strong linkage between regional economic growth of the sugarcane sector and the level of mechanization adopted (4.02), indicating a high level of agreement among farmers.
- The Anova test displayed that there is no significant difference in mean economic growth through mechanization in sugarcane cultivation with respect to the farming experience of the farmers.
- From the 'F' test, it is mentioned that there is a significant difference in mean economic growth

through mechanization in sugarcane cultivation with respect to the sugarcane cultivation area of the farmers.

- It is justified from the Anova test that there is a significant difference in mean economic growth through mechanization in sugarcane cultivation with respect to the type of sugarcane cultivated by the farmers.

IX. SUGGESTIONS

- The findings illustrated that farmers aged 30–40 years show higher level of economic growth through mechanization. Hence, this study suggested that targeted training and support programs should be extended to all farmers to enhance their adoption of mechanized practices.
- It is mentioned from the study that male farmers show a higher level of economic growth through mechanization. Therefore, it is suggested that special awareness and subsidy schemes should be introduced to encourage greater participation of female farmers in mechanized sugarcane cultivation.
- From the study, it is revealed that farmers with 11–15 years of experience benefit more from mechanization. So, skill development and capacity-building programs should be provided to less-experienced farmers to improve their mechanization efficiency.
- It could be observed from the findings that farmers cultivating 7–9 acres achieve maximum economic growth through mechanization. Hence, it is suggested that small and marginal farmers should be supported through custom hiring centers and shared machinery facilities to enable effective mechanization.
- The research indicated that farmers cultivating crystal sugarcane attain higher economic growth through mechanization. Therefore, the authors suggested that extension services should promote suitable mechanization techniques and best practices for other sugarcane varieties to enhance their economic performance.

X. CONCLUSION

This study aimed to examine the economic growth of farmers through mechanization in sugarcane cultivation in Erode district. Economic growth through mechanization in sugarcane cultivation enhances productivity by reducing labor dependency and improving operational efficiency which increases farmers' income by lowering cultivation costs and enabling timely farm operations. This study confirmed that there is a significant difference in mean economic growth through mechanization in sugarcane cultivation with respect to the selected variables namely sugarcane cultivation area and type of sugarcane cultivated of the farmers in Erode district.

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