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Decline in the Cultivation of Minor Millets in Tamil Nadu: A Time-Series Analysis of Cultivation Area, Production, and Productivity (1952-53 to 2021-22)

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Authors' contributions

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

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ABSTRACT

Aims: In India and Tamil Nadu, millets, often referred to as "smart food" for their nutritional, environmental, and agronomic benefits, have historically taken a back seat to other staple grains like rice and wheat. These resilient crops thrive in challenging conditions, requiring minimal resources. However, minor millets, a subset of these grains, have been overlooked in research despite their potential for climate-smart agriculture and superior nutrition.
Data: This study delves into time-series data spanning from 1952-53 to 2021-22, focusing on the cultivation area, production, and productivity of minor millets in both India as a whole and Tamil Nadu.

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Objective: To analyze historical trends, assess the impact of factors like rainfall on crop cultivation, and explore the relationships between key variables.
Methodology: A combination of methodologies was employed. Compound Annual Growth Rate (CAGR) analysis was conducted to assess the historical trends in minor millets cultivation, production, and productivity. Correlation coefficient analysis examined the relationship between rainfall and selected crop cultivation areas. The Cobb-Douglas production function was employed to model the relationship between production, rainfall, and cultivated area of minor millets, while regression analysis using an exponential function further explored the relationship between rainfall and crop cultivation of selected crops.
Results: The results reveal nuanced trends in minor millets cultivation, showing fluctuations in cultivation areas, production, and productivity over the years. The analysis underscores the impact of changing agricultural practices, preferences, and external factors such as climate variability on minor millets cultivation. Specifically, the correlation analysis highlights the varying sensitivities of different crops to rainfall patterns.
Conclusion: This comprehensive study provides critical insights into the historical dynamics and prospects of minor millets cultivation in India and Tamil Nadu. The findings offer valuable information for agricultural planning, resource allocation, and strategies to promote sustainable agriculture and nutrition in the region.

Keywords: Minor millets; compound annual growth rate; correlation; regression; Cobb-Douglas production function; Tamil Nadu.

1. INTRODUCTION

In India, millets cultivation, especially in regions facing water scarcity, holds significant economic importance. Despite its value, millets have received less attention compared to other staple grains such as rice and wheat [1]. These grains, often referred to as "smart food," encompass qualities beneficial for individuals, the planet, and farmers. Additionally, they are excellent in nutritional value including macronutrients namely, protein (7-13%), carbohydrates (60-70%), fat (1.5-5%), fiber (2-7%) and for micronutrients as well namely; iron, calcium, phosphorus, and magnesium, etc [2]. Millets are recognized for their resilience in challenging conditions, thriving in high temperatures and degraded soils while requiring minimal water, pesticides, and fertilizers [3]. However, minor millets remain relatively neglected in terms of research and development, even though their potential for climate-smart agriculture and enhanced nutrition remains underexplored. Despite contributing less than one per cent of global grain production, these millets are vital for food security in marginal agro-ecosystems [4]. Adapted to various growing conditions and capable of withstanding climatic extremes, minor millets mature rapidly and possess higher levels of micronutrients, antioxidants, vitamins, and usable protein compared to wheat, rice, or maize [5].

In the face of challenges posed by climate change, land degradation, and the pursuit of sustainable diets, diversifying crop production becomes imperative. Millets, with their resilience and nutritional prowess, offer a substantial combined potential to address these issues [6]. India stands as the largest producer of various millets types, often referred to as coarse cereals [7]. These minor millets serve as staple foods for millions, particularly among tribal populations in hot and arid regions [8]. Their remarkable nutritional content, containing essential amino acids and presenting diverse health benefits, underscores their significance in promoting well-being, including anti-diabetic, anti-tumorigenic, and antioxidant effects [9].

India's agricultural diversity, encompassing varying soils, rainfall, and climates, aligns with its abundant crop variety. Millets can be categorized into major and minor types, with major millets including widely-consumed crops like maize, sorghum, cumbu (pearl millet), and ragi (finger millet). In contrast, minor millets comprise lesser-known varieties such as panivaragu (proso millet), samai (little millet), tenai (foxtail millet), varagu (kodo millet), and kudiraivali (barnyard millet). Given that 60 per cent of India’s land is rainfed [10,11], millets play a vital role in these regions.

Against this backdrop, the study aims to comprehensively analyze time-series data for minor millets, specifically their area under cultivation, production, and productivity, for both all India and Tamil Nadu. This analysis spans a substantial period from 1952-53 to 2021-22, providing valuable insights into the trends and dynamics of these crucial crops. The data employed in this study has been meticulously sourced from a wide array of published materials originating from both all India and Tamil Nadu. This inclusive approach ensures the comprehensive coverage of information required for the analysis. Drawing from a diverse range of reputable sources enhances the accuracy and reliability of the findings, contributing to a more thorough understanding of the cultivation dynamics and trends pertaining to minor millets in these regions.

The International Year of Millets, as declared by the United Nations, celebrated the vital role of millets in global food security and sustainable agriculture in the year 2023. This initiative aimed to raise awareness about the nutritional benefits, resilience, and adaptability of millets in various agro-ecological zones, particularly in the face of climate change. Millets are not only nutritious but also require less water and can thrive in diverse environments, making them essential for promoting food security and supporting farmers' livelihoods worldwide. The International Year of Millets encouraged greater investment in research, production, and consumption of these drought-tolerant grains, contributing to healthier diets, biodiversity preservation, and more sustainable food systems on a global scale [12].

2. MATERIALS AND METHODS

2.1 Compound Annual Growth Rate (CAGR)

For this investigation, secondary data encompassing the area, production, and productivity of minor millets spanning from 1952-53 to 2021-22 were gathered. The primary sources of this data comprised the season and crop reports of Tamil Nadu, along with information from the Indiastat website [13]. The widely accepted methodology of calculating the Compound Annual Growth Rate (CAGR) was chosen as the analytical approach for this study.

The exponential compound annual growth rate is estimated using linear functions on time series data on minor millets' area, production, and productivity. The semi-log exponential functional form was used to analyze the trend in growth rate. It is one of the appropriate applicable forms to estimate the growth rate. The following semi-log functional form was used to estimate the growth rate.

$$Y_t = Y_o (1+r)^t \qquad \text{---------- (1)}$$

Where,

Y_t = Area under the crop at time t (ha)
r = Compound growth rate of Y
Y_o = Initial year area under the crop (ha)

By taking natural logarithm of (1),

$$\ln Y_t = \ln Y_o + t \ln (1+r) \qquad \text{---------- (2)}$$

Now letting,

$\beta_1 = \ln Y_o$
$\beta_2 = \ln (1+r)$

Equation (2) can be written as

$$\ln Y_t = \beta_1 + \beta_2 t \qquad \text{---------- (3)}$$

Adding the disturbance term to (3), it can be rewritten as

$$\ln Y_t = \beta_1 + \beta_2 t + U_i$$

Where,

Y_t = Area under crop at time 't' (ha)
t = time in years
β_1 = constant term
β_2 = regression co-efficient

This log linear function was fitted by using Ordinary Least Squares (OLS) method. The compound growth rate (r) was obtained using the formula [14].

$$r = (\text{Antilog of } \beta_2 - 1) \times 100$$

2.2 Correlation Coefficient

This study employs a correlation coefficient matrix to examine the connection between rainfall and selected crops cultivation area in Tamil Nadu. Historical data on these variables is collected and organized, followed by the calculation of Pearson correlation coefficients using their means, standard deviations, and the appropriate formula. The resulting coefficients offer insights into the strength and direction of the relationship: positive coefficients indicate parallel increases or decreases, negative coefficients signify opposite trends, and values closer to -1 or 1 denote stronger correlations. Additionally, a correlation matrix can visually represent these relationships if necessary. The findings help illuminate the interplay between rainfall and minor millets area, though it's important to note that correlation doesn't imply causation.

2.3 Regression Analysis (Exponential Function)

Regression analysis is a quantitative research method which is used when the study involves modelling and analysing several variables, where the relationship includes a dependent variable and one or more independent variables. In simple terms, regression analysis is a quantitative method used to test the nature of relationships between a dependent variable and one or more independent variables.

The basic form of regression models includes unknown parameters (β), independent variables (X), and the dependent variable (Y).

Regression model, basically, specifies the relation of dependent variable (Y) to a function combination of independent variables (X) and unknown parameters (β)

$$Y = f(X, \beta)$$

Regression equation can be used to predict the values of ‘y’, if the value of ‘x’ is given, and both ‘y’ and ‘x’ are the two sets of measures of a sample size of ‘n’. The formulae for regression equation would be as under:

$$Y = e^{a+bx}$$

2.4 Cobb-Douglas Production Function

This research study is centered on the production of minor millets in Tamil Nadu, utilizing the Cobb-Douglas production function to establish a mathematical relationship between production (the dependent variable) and two independent variables: rainfall and the area cultivated with minor millets. The study utilizes a comprehensive dataset comprising historical records of rainfall, minor millets cultivation area, and production over the past decade. The Cobb-Douglas model is employed to assess the quantitative impact of variations in rainfall and cultivated area on minor millets production. Through the estimation of the coefficients for rainfall and cultivation area, the study aims to elucidate the percentage change in production resulting from a one percent change in each of these independent variables. The results of this analysis provide valuable insights into the respective contributions of rainfall and cultivation area to minor millets production, thereby facilitating informed decision-making in the realm of agriculture in the region.

3. RESULTS AND DISCUSSION

The Compound Annual Growth Rate (CAGR) analysis assesses minor millets cultivation's area, production, and productivity in India and Tamil Nadu.

The analysis of data as presented in Table 1, spanning from 1952-53 to 2021-22, reveals nuanced trends in minor millets cultivation in Tamil Nadu. Cultivation area showed fluctuating trajectories, with early decades witnessing declines (CAGRs -0.937 per cent to -3.088 per cent). Subsequent periods intensified this decline (CAGRs -6.937 per cent to -8.283 per cent), although recent decades moderated the reduction (CAGRs -8.632 per cent to -2.677 per cent). Production followed suit, with early decades showing negative CAGRs (-1.079 per cent to -1.179 per cent), intensifying later (CAGRs -5.621 per cent to -8.559 per cent), but stabilizing or slightly improving recently (CAGRs -4.146 per cent to 0.387 per cent). Productivity trends shifted dramatically, with early decades struggling (CAGRs -0.241 per cent to -0.301 per cent). A positive shift occurred in 1973-1982 (CAGR 2.646 per cent), persisting (CAGRs 1.418 per cent to 4.934 per cent) in subsequent decades.

A distinctive trend is emerging between pre-green revolution period and post-green revolution period based on the growth trends. The pre-Green Revolution era (1952-1972) showcased gradual declines in area and production (CAGRs -1.721 per cent and -1.290 per cent), with productivity focus (CAGR 0.442 per cent). Post-Green Revolution (1973-2022) revealed pronounced shifts: steeper area decrease (CAGR -6.740 per cent), significant production decline (CAGR -5.394 per cent), and a sharp productivity drop (CAGR -1.443 per cent). These trends reflect the transformative impact of the Green Revolution on cropping choices, production priorities, and challenges in maintaining productivity.

Table 1. Compound annual growth rate of area, production and productivity of small millets in India and Tamil Nadu (1952-53 to 2021-22)

S. No	Particulars	Tamil Nadu			India		
		Area (ooo ha)	**Production (ooo tons)**	**Productivity (Kg/ha)**	**Area (ooo ha)**	**Production (ooo tons)**	**Productivity (Kg/ha)**
1	1952-53 to 1961-62	-2.803**	-1.079	1.785**	-1.220	0.376	-0.260
2	1962-63 to 1971-72	-0.937**	-1.179***	-0.241	-0.018	-0.613	-0.627
3	1972-73 to 1981-82	-3.088	-0.526	2.646	-1.678**	-0.181	0.756
4	1982-83 to 1991-92	-6.937***	-5.621**	1.418	-5.156	-3.021*	2.242*
5	1992-93 to 2001-02	-8.283	-8.559***	-0.301	-4.303	-5.134	-0.845
6	2002-03 to 2011-12	-8.632	-4.146	4.934**	-4.918	-1.809	3.265***
7	2012-13 to 2021-22	-2.677**	0.387	3.153*	-6.192	-2.230**	4.223***
	All decades	-5.404	-4.689	0.756	-3.799	-3.038	0.821
Pre-Green Revolution period (1952-53 to 1971-72)		-1.721	-1.290***	0.442*	-1.034	-1.403**	-0.436
Post-Green Revolution period (1972-73 to 2021-22)		-6.740	-5.394	-1.443	-5.042	-3.859	1.322

Source: www.indiastat.com

*(Note: ***, **, *, 1 per cent significant level, 5 per cent significant level, and 10 per cent significant level)*

The trends observed in Tamil Nadu is also seen at the all-India data series. Over the span of seven distinct ten-year periods, the cultivation area of small millets in India exhibited varying trajectories. The initial decades registered a Compound Annual Growth Rate (CAGR) of -1.220 per cent, followed by a slight dip with a CAGR of -0.018 per cent during 1963-1972. Subsequent intervals highlighted more pronounced declines: CAGRs of -1.678 per cent (1973-1982), -5.156 per cent (1983-1992), -4.303 per cent (1993-2002), -4.918 per cent (2003-2012), and -6.192 per cent (2013-2022). These fluctuations underscore the challenges and shifts characterizing the landscape of small millets cultivation areas across India. Regarding production trends, diverse trajectories were evident. The initial decades exhibited marginal positive and negative CAGRs (-0.376 per cent to 0.613 per cent), while subsequent periods witnessed minor negative CAGRs (-0.181 per cent in 1973-1982), followed by more pronounced declines: CAGRs of -3.021 per cent (1983-1992), -5.134 per cent (1993-2002), -1.809 per cent (2003-2012), and -2.230 per cent (2013-2022). These fluctuations reflect the changing dynamics of production over time. In terms of productivity, a complex pattern emerged. Initial decades presented mixed CAGRs (0.260 per cent to -0.627 per cent). Subsequent periods showcased growth: CAGRs of 0.756 per cent (1973-1982), 2.242 per cent (1983-1992), fluctuating to -0.845 per cent (1993-2002), surging at 3.265 per cent (2003-2012), and peaking at 4.223 per cent (2013-2022). These trends illustrate the evolving efforts to optimize yields and productivity in small millets cultivation.

The rate of decline in the cultivation area of minor millets in Tamil Nadu surpasses the national data, as depicted in Fig. 1.

The rate of decline in minor millets production in Tamil Nadu is more pronounced when compared to the all India data, as illustrated in Fig. 2. There is a faster decline in the production of millets in Tamil Nadu mainly due to shifts observed in the cropping patterns when compared to all India.

Tamil Nadu continues to maintain its lead position in the productivity of minor millets when compared to all India, as depicted in Fig. 3.

From the above trends, there is a definitive shift in the production trends in the case of minor millets at both Tamil Nadu and all India, between pre and post green revolution periods. When comparing the pre-Green Revolution period (1952-1972) to the post-Green Revolution era (1973-2022), a noticeable transformation in overall cultivation patterns is evident. The pre-Revolution phase experienced moderate declines in cultivation area and production (CAGRs -1.034 per cent and -1.403 per cent), alongside a negative productivity growth (CAGR -0.436 per cent). In contrast, the post-Revolution period shows more significant shifts, with sharper reductions in cultivation area and production (CAGRs -5.042 per cent and -3.859 per cent), while productivity exhibited positive growth (CAGR 1.322 per cent), highlighting the impact of changing agricultural practices and priorities.

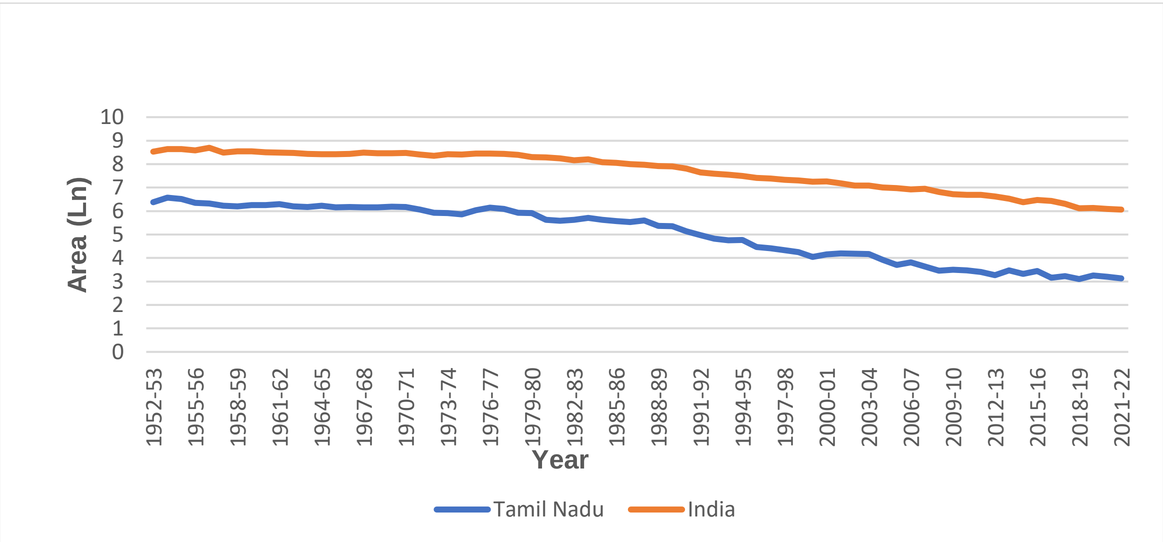

Fig. 1. Area grown under Minor Millets in India and Tamil Nadu from 1952-53 to 2021-22

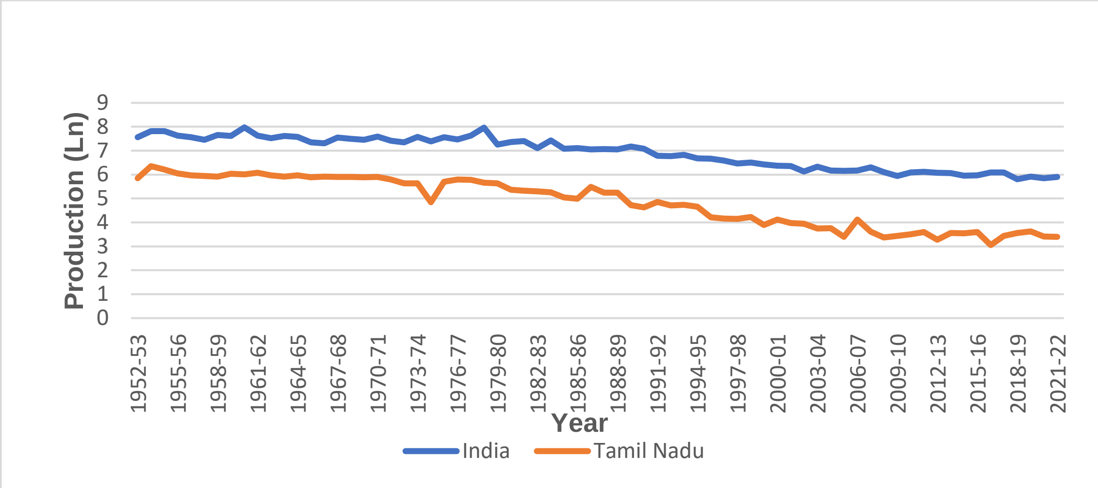

Fig. 2. Production of Minor Millets in India and Tamil Nadu from 1952-53 to 2021-22

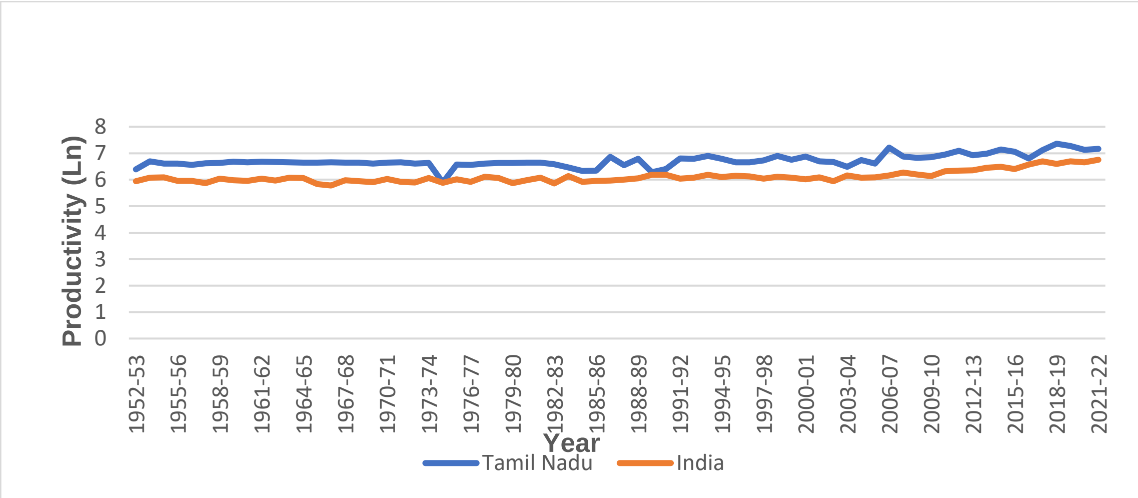

Fig. 3. Productivity of Minor Millets in India and Tamil Nadu from 1952-53 to 2021-22

The reduction in cultivation areas for minor millets can be attributed to a host of factors. Evolving agricultural preferences, rapid urbanization, and industrialization have potentially diverted attention from minor millets cultivation. The advent of high-yield crop varieties and mechanized techniques during the Green Revolution period might have influenced farmers' decisions, leading to a potential decline in minor millets cultivation due to their historically lower yields compared to major cereal crops. Socioeconomic shifts, changing dietary habits, and market dynamics have also contributed to reallocating land for other crops, contributing to the decrease in minor millets cultivation areas as shown in Table 2.

The data in Table 2 reveals a consistent decline in the cultivation area of minor millets in Tamil Nadu from 2012-13 to 2021-22, with the smallest acreage recorded in the latter years. The relationship between this decline and rainfall is apparent, as minor millets cultivation has faced a diminishing presence alongside fluctuating precipitation levels. This trend could be attributed to several factors, including the preference of farmers for crops with higher economic returns, adaptability to varying water availability, and changing market demands. Meanwhile, rice, being the dominant crop, appears to have expanded its cultivation area over the same period, suggesting that the area vacated by minor millets might have been absorbed by rice cultivation. Other crops such as maize, jowar, and bajra may also have contributed to the shift in cropping patterns, albeit to a lesser extent. Further detailed analysis and on-ground investigations are necessary to gain deeper insights into the factors driving these changes in Tamil Nadu's crop cultivation landscape.

Table 2. Area (ha) under major crops (2012-13 to 2021-22 years) in Tamil Nadu

Year	Rice	Jowar	Bajra	Maize	Ragi	Minor Millets	Total Cereals and Millets	Rain fall (mm)
2012-13	1493359 (69.95)	210893 (9.88)	42928 (2.01)	291052 (13.63)	70294 (3.29)	26410 (1.24)	2134936 (100.00)	743.1
2013-14	1725742 (64.91)	347131 (13.06)	54412 (2.05)	380429 (14.31)	118699 (4.46)	32404 (1.22)	2658817 (100.00)	790.6
2014-15	1794998 (65.95)	415103 (15.25)	57708 (2.12)	321952 (11.83)	104426 (3.84)	27649 (1.02)	2721836 (100.00)	987.9
2015-16	2000222 (69.73)	339166 (11.82)	52606 (1.83)	355064 (12.38)	89986 (3.14)	31286 (1.09)	2868330 (100.00)	1118
2016-17	1442848 (66.76)	268391 (12.42)	49673 (2.30)	315030 (14.58)	61632 (2.85)	23561 (1.09)	2161135 (100.00)	598.1
2017-18	1828930 (67.47)	385646 (14.23)	63029 (2.33)	321518 (11.86)	86513 (3.19)	25267 (0.93)	2710903 (100.00)	1017.2
2018-19	1721273 (65.07)	385842 (14.59)	46882 (1.77)	390602 (14.77)	78593 (2.97)	22243 (0.84)	2645435 (100.00)	960
2019-20	1907418 (66.49)	450000 (15.69)	67492 (2.35)	333565 (11.63)	84545 (2.95)	25844 (0.90)	2868864 (100.00)	985.8
2020-21	2036239 (67.50)	405425 (13.44)	67408 (2.23)	400210 (13.27)	82919 (2.75)	24482 (0.81)	3016683 (100.00)	1232.8
2021-22	2217269 (69.90)	397223 (12.52)	59956 (1.89)	400076 (12.61)	74434 (2.35)	22995 (0.72)	3171953 (100.00)	1401.1
Average	1816830 (67.39)	360482 (13.37)	56209.4 (2.09)	350949.8 (13.02)	85204.1 (3.16)	26214.1 (0.97)	2695889 (100.00)	983.46

Source: Season and Crop report of Tamil Nadu (2012-13 to 2021-22)
Note: Figures in brackets indicate percentage to the total

In order to ascertain the association between average rainfall and the area under different crops, an attempt is made to find correlation between these two variables across different crops in Tamil Nadu. The results are presented in Table 3.

Table 3. Corelation coefficient for rainfall and area under crops from 2012-13 to 2021-22

S. No	Area under different Crops	Correlation Coefficient
1	Rice	0.97
2	Jowar	0.64
3	Bajra	0.58
4	Maize	0.64
5	Ragi	0.06
6	Minor Millets	-0.17

The correlation coefficient analysis conducted for Tamil Nadu's agricultural data spanning from 2012-13 to 2021-22 unveils distinctive relationships between rainfall and the cultivation of selected crops. Notably, there exists an exceptionally strong positive correlation (0.97) between rainfall and the area under rice cultivation, indicating that increased rainfall significantly boosts rice production. Jowar and Maize also exhibit moderately positive correlations (0.64), suggesting that higher rainfall contributes to expanded cultivation of these crops. Bajra shows a substantial positive correlation (0.58), emphasizing the beneficial impact of increased rainfall on Bajra cultivation. In contrast, Ragi displays a weak positive correlation (0.06), signifying its relative resilience to rainfall fluctuations, while Minor Millets reveal a weak negative correlation (-0.17), implying a slight decrease in their cultivation area with higher rainfall. One per cent increase in rainfall results in 3 per cent decline in the cultivable land under millets, this implies that the farmers cultivating minor millets may switch over to other crops if rainfall is more. The correlation coefficient of 0.38 between rainfall and minor millet production in Tamil Nadu indicates a modest positive relationship. This suggests that when there is more rainfall, there is a slight increase in minor millets production, although other factors also influence production levels. These findings underscore the varying sensitivities of different crops to rainfall patterns, providing valuable insights for agricultural planning and adaptation strategies in Tamil Nadu.

To further ascertain the strength of the relationships between rainfall and area under cultivation, regression analysis is attempted between various crops and rainfall in Tamil Nadu and the results are presented in Table 4.

Table 4. Regression analysis (exponential function) for area under selected crops and rainfall from 2012-13 to 2021-22

S. No	Area under different Crops	Coefficient Values
1	Rice	0.52***
2	Jowar	0.63**
3	Bajra	0.37*
4	Maize	0.28*
5	Ragi	0.17*
6	Minor Millets	0.17

*(Note: ***, **, *, 1 per cent significant level, 5 per cent significant level, and 10 per cent significant level)*

The regression analysis conducted for Tamil Nadu's agricultural data from 2012-13 to 2021-22 reveals significant insights into the relationship between rainfall and the cultivation of specific crops. Notably, rice cultivation exhibits a strong positive correlation with rainfall, with one per cent increase in rainfall associated with a 0.52 per cent increase in rice cultivation area, signifying a highly significant relationship at the one percent significance level. Jowar also shows a positive correlation, with a coefficient of 0.63, significant at the five percent level. Bajra, Maize and Ragi exhibit positive relationships, but with coefficients of 0.37, 0.28, and 0.17 respectively, and are significant at the ten percent level. Minor Millets have positive coefficient as well, but they are not statistically significant at conventional levels. Minor millets are not so much rainfall sensitive compared to other crops, as these crops are grown in rainfed areas. These findings suggest that variations in rainfall significantly impact the cultivation of certain crops in Tamil Nadu, providing valuable insights for agricultural planning and management.

To further ascertain the simultaneous strength of the relationship between production of millets and area under cultivation and rainfall, Cobb-Douglas production function is estimated and the results are presented in Table 5.

The Cobb-Douglas production function analysis for minor millets in Tamil Nadu from 2012-13 to 2021-22 reveals key insights into the factors influencing production. It indicates that both rainfall and the cultivated area significantly contribute to minor milletss production. The positive coefficient (0.414) for rainfall implies that increased rainfall positively impacts production, with each unit of increased rainfall estimated to raise production by approximately 0.414 units. Additionally, the positive coefficient (0.709) for the cultivated area indicates that a larger cultivation area has a positive effect on production, with each percentage increase in cultivated area associated with an estimated 0.709 per cent increase in production. These relationships are statistically significant, as indicated by the associated T-values along with asterisks, with rainfall being more statistically significant than the cultivated area. The model as a whole is also statistically significant, suggesting that both variables explain combined variation and a noteworthy portion of the variability in minor millets production. These findings offer valuable insights for agricultural planning and resource allocation strategies in Tamil Nadu.

Table 5. Cobb-Douglas production function of minor millets in Tamil Nadu (2012-13 to 2021-22)

Variables	Co-efficient	T-value
Rainfall (X1)	0.414	2.308**
Area (X2)	0.709	1.982***
	F-value	4.156***

(Source: Season and Crop Report)
*(** significant at 5 per cent level, *** significant at 10 per cent level)*

4. CONCLUSION

This study has scrutinized the cultivation trends and factors influencing minor millets in India and Tamil Nadu from 1952-53 to 2021-22. It revealed complex patterns in cultivation areas, production, and productivity, influenced by changing agricultural priorities and external factors like rainfall. The correlation analysis highlighted varying crop sensitivities to rainfall. Additionally, regression and Cobb-Douglas production function analyses underscored the significance of rainfall and cultivation area in affecting production. Recognizing the potential of minor millets in addressing climate challenges, sustainable agriculture, and nutrition is vital. Policymakers and stakeholders can use these findings to promote these resilient "smart foods" for a more sustainable and diverse food future. In order to promote these crops as healthy food crops for combating diabetes and other life style diseases, a strong promotional campaign for these crops are essential measures like crop insurance, finance, support price, subsidies etc, to the attempted by the government and its agencies.

5. POLICY SUGGESTION

To identify low rainfall or drought-prone districts, zones, and states across India and specifically target these areas which are rainfed and dry lands for the cultivation of minor millets. Given that minor millets are rainfed crops and well-suited to such conditions, focusing on drought-prone regions can help improve food security in these vulnerable areas. Additionally, provide subsidies and support programs to farmers in these drought-affected regions to encourage the adoption of minor millets cultivation, further enhancing their resilience and sustainability. This underscores the importance of tailoring strategies to specific regional challenges and highlights the role of targeted support in promoting minor millets cultivation in areas prone to water scarcity.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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