



International Journal of Research in Agronomy

E-ISSN: 2618-0618
P-ISSN: 2618-060X
© Agronomy
NAAS Rating (2026): 5.20
www.agronomyjournals.com
2026; SP-9(5): 371-374
Received: 03-02-2026
Accepted: 10-03-2026

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Growth and instability in paddy farming: A district-level analysis of Kerala with special reference to Thrissur

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DOI: <https://www.doi.org/10.33545/2618060X.2026.v9.i5Se.5594>

Abstract

Paddy cultivation in Kerala has undergone significant structural changes over the past five decades, including a sharp decline in area and production and a steady improvement in productivity. Using district-level data from 1980–81 to 2021–22, this study conducts an analysis of the comparative growth and instability of Kerala with special reference to Thrissur. Employing Bai–Perron structural break tests, compound annual growth rate (CAGR), coefficient of variation (CV), and Cuddy–Della Valle Index (CDVI), the analysis identifies four major break points in paddy land use and assesses trends across five sub-periods. The results show that while Kerala as a whole experienced negative growth in area (-3.96%) and production (-2.49%), productivity improved (1.55%). Thrissur recorded sharper area declines (-4.51%) but achieved higher productivity gains (2.33%), reflecting the ecological resilience of the Kole wetlands. Variability measures indicate that Thrissur has a large volatility in area and production compared to the state average, although productivity has remained relatively stable. The recent period (2013–2021) marks a modest revival, with positive growth in Kerala and Thrissur. The findings highlight the paradox of declining paddy land use alongside increasing productivity, underlining the need for ecosystem-based interventions, mechanization support, and policies that balance farmer wellbeing with wetland conservation.

Keywords: Ecological services, instability index, paddy farming, productivity, structural breaks

Introduction

Paddy farming has historically been the backbone of the agrarian economy of Kerala by contributing to food security, rural livelihoods, and the ecological stability of wetlands. Over the past five decades, however, the state has witnessed a sharp contraction in paddy area and production, even as productivity has improved in certain districts. The sharp decline in the area under paddy cultivation and the quantity of paddy produced has had a significant impact on the economic, environmental and social development of Kerala (Thomas, 2011) ^[10]. The area under paddy declined from 8.74 lakh hectare in 1970-71 to 1.94 lakh hectare in 2021-22 reflecting the overall cumulative growth rate of paddy area in Kerala showed a moderate negative trend (-3.99 per cent) across the state (Economic Review, 2023) ^[4], although with significant variations across districts and time period. It is noteworthy that Kerala state produces only 16 per cent of the total requirement of paddy for consumption (Economic Review, 2023) ^[4]. Consequently, the state has supply induced regional food insecurity. This decline has raised concerns about the growing dependence on rice imports and the ecological degradation of its wetland ecosystems in Kerala (Das & Prema, 2024) ^[3]. Among the paddy producing districts, Palakkad, Alappuzha, Thrissur and Kottayam districts contribute approximately 81.2 per cent of the total rice production in the state. Palakkad district accounts for the largest share in paddy production (41%), followed by Alappuzha (16%), Thrissur (14%) and Kottayam (9%), respectively. Among these four districts, Thrissur district shows the highest productivity underscore the role of ecosystem services and hydrological services to sustain productivity (Prasad & Kuruvila, 2024) ^[7].

The Conversion of paddy fields to cash crops in Kerala is widespread. It adversely affected the food production capacity and various kinds of ecosystem services provided by the crop. Rice

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ecology in the state is varied and is strongly conditioned by local climate and land forms (Kumar & Kunhamu, 2021) ^[5]. The ecological and economic importance of Kole wetlands warrants more district-level attention. Valuation studies estimate the total ecosystem service value of the Kole wetlands at US\$54.24 million per year, with flood control, groundwater recharge, and paddy cultivation being the main contributors (Thamhankar, 2021) ^[9]. Stakeholder preference studies highlight a strong willingness to pay for wetland conservation, highlighting the socio-economic significance of these landscapes (Rose & Prema, 2024) ^[8]. Therefore, productivity resilience power of Thrissur district is not merely a statistical anomaly, but a reflection of the ecosystem services that sustain intensive farming practices.

According to overall data, paddy cultivation showed a decline over a long period of time, while district-level trends are different and highly uneven. Although Thrissur, which is full of Kole wetlands, has achieved relatively better growth compared to other districts, the decrease in paddy land has not fully offset the increase in productivity. Understanding these spatial inequalities is essential for designing targeted interventions that balance environmental sustainability and farmer wellbeing. Existing research has largely focused on state-level trends, overlooking differences in growth and instability across districts. There are very few analyses that systematically apply statistical measures such as CAGR, CV, and CDVI to compare the overall trajectory of Kerala with specific districts such as Thrissur. This study conducts a comparative analysis of Kerala and Thrissur using district-wise data from 1980-81 to 2021-22. By applying measures of growth and instability, the study identifies structural gaps, resilience patterns, and policy implications for sustaining paddy cultivation in Kerala.

Materials and Methods

The study is based on secondary data collected from Economic Review, and various reports of Directorate of Economics and Statistics, Kerala, covering the period 1980–81 to 2021–22. The dynamics of paddy farming were examined by identifying the structural break during the 40 years of farming. Bai and Perron test (2003) ^[1] have been employed to identify long term structural multiple breaks in agricultural trajectories (Lekshmi & Venkitaramana, 2020) ^[6]. Using this test, four statistically significant breakpoints were identified, which corresponded to significant changes in the policies and economy of Kerala's agricultural sector. Using these breakpoints, it was possible to examine the growth and volatility of the research period across sub-periods by dividing it into distinct phases. District-wise area, production, and productivity statistics on paddy were compiled to capture long-term trends. Thrissur was selected as a focal district due to its relative resilience in paddy cultivation, particularly in the Kole wetlands. The growth and performance of paddy farming and the degree of variability within the break period in Kerala and Thrissur were assessed by using the Compound Annual Growth Rate, Coefficient of Variation and Cuddy Della Valley Index. CAGR was worked out by fitting exponential function as given below

$$Y_t = ab^t$$

Where, Y_t = Dependent variable on area, production and

productivity in the year 't'

a = Constant

b = Regression coefficient;

t = Time element which takes the value 1, 2, 3... 42

After transforming the model into a linear form by taking ln (natural logarithms), we get $\ln Y_t = \ln a + t \ln b$

The 'a' and 'b' are calculated by applying the method of Least Squares. Finally, the compound annual growth rates were worked out as;

Compound Annual Growth Rate: CAGR (%) = (Antilog b - 1) x 100

Coefficient of Variation (CV) is used to measure the relative instability in the area, production, and productivity of paddy crops during the study period. The formula for CV = (Standard Deviation/Mean) x 100.

Cuddy Della Valle (1978) ^[2] index is used as a measure of variability in time-series data. This index corrects the over estimation problem of simple Coefficient of Variation (CV). The formula for calculating CDVI = $CV \sqrt{1 - R^2}$ where CV is coefficient of variation, R^2 is the coefficient of determination from a time-trend regression adjusted by the number of degrees of freedom.

Results

The Bai–Perron multiple structural break test identified four break points or years in paddy land use pattern of Kerala and Thrissur resulting the entire study period divided into five periods: Period I: 1980-81 to 1987-88, Period II: 1988-89 to 1997-98, Period III: 1998-99 to 2007-08, Period IV: 2009-10 to 2012-13, Period V: 2013-14 to 2023-24. These break periods reflect significant structural changes in paddy cultivation related to technological, institutional, economic, and policy-related transformations. The CAGR of paddy area, production and productivity of major paddy producing districts in Kerala are presented in Table 1 and the instability pattern of paddy production in Kerala and Thrissur are illustrated in Table 2.

Period I (1980–81 to 1987–88)

During Period I, Kerala witnessed a significant decline in paddy area (-3.95%) and production (-3.02%), while productivity recorded a marginal positive growth (0.96%). A similar trend was observed in Thrissur, where area declined by -4.13% and production by -1.47%, whereas productivity increased considerably by 2.77%. However, the other two districts, Alappuzha and Palakkad, which play a major role in paddy production in Kerala, show the highest negative trend in area and production, while Alappuzha district shows the lowest positive growth and Palakkad district shows negative growth in productivity.

The instability indices showed relatively low fluctuations during this period. The state level average recorded a moderate instability in area (CDVI: 2.18) and production (3.83), while Thrissur district showed slightly higher instability in production (4.09). The instability indices of Productivity were relatively low in both regions, indicating some degree of technological stability in farming practices during this period.

Table 1: CAGR of Major Paddy Producing District in Kerala

Attributes	District	Period I	Period II	Period III	Period IV	Period V	Over all Period
Area	Alappuzha	-5.35	-4.92	-1.65	1.99	1.9	-2.08
	Kottayam	-1.1	-5.59	-3.17	13.55	2.67	-1.95
	Thrissur	-4.13	-5.84	-5.16	-5.48	0.17	-4.52
	Palakkad	-3.14	-1.76	-4.8	-5.52	-0.81	-2.4
	KERALA	-3.95	-4.07	-4.4	-4.5	0.04	-3.99
production	Alappuzha	-14.68	-3.9	-3.34	1.41	1.28	-0.41
	Kottayam	-0.04	-6.17	-3.01	15.04	1.22	-0.97
	Thrissur	-1.47	-3.27	-2.99	-1.48	1.51	-2.3
	Palakkad	-4.96	-1.34	0.29	-6.27	1.33	-1.33
	KERALA	-3.02	-3.22	-2.87	-3.43	1.24	-2.49
Productivity	Alappuzha	0.87	1.07	-1.73	-0.57	-0.05	1.35
	Kottayam	1.07	-0.62	0.17	1.33	-1.2	1.02
	Thrissur	2.77	2.73	2.29	4.23	1.37	2.33
	Palakkad	-1.88	0.43	1.02	-0.79	2.17	0.97
	KERALA	0.97	0.89	1.6	1.12	1.2	1.57

Source: Computed by the author from Directorate of Economics and Statistics, Kerala

Table 2: Growth and Instability of paddy production in Kerala and Thrissur district

Break Period	Attributes	Kerala			Thrissur		
		Area	Production	Productivity	Area	Production	Productivity
Period I	CV	9.28	7.73	2.74	9.89	5.01	6.88
	CDVI	2.18	3.83	1.82	3.03	4.09	3.16
Period II	CV	11.94	10.68	3.8	17.03	11.05	7.89
	CDVI	3.42	6.16	3.08	4.78	5.98	2.87
Period III	CV	12.9	10.98	5.52	15.62	12.68	7.17
	CDVI	2.82	6.39	4.45	6.41	10.3	3.68
Period IV	CV	6.72	6.47	3.62	11.91	9.85	6.73
	CDVI	2.01	4.87	3.75	9.8	11.07	3.72
Period V	CV	4.7	9.14	5.69	5.09	11.05	7.67
	CDVI	4.93	9.12	5.28	5.42	11.04	7.24
Over all Period	CV	50.28	33.05	19.23	59.15	32.35	28.17
	CDVI	14.48	11.6	4.9	20.65	14.55	6.28

Source: Computed by the author from Directorate of Economics and Statistics, Kerala

Period II (1988-89 to 1997-98)

The second period showed a sharp decline in paddy cultivation in the entire area of the state. The area and production in Kerala were declined by 4.07 per cent and 3.22 per cent respectively, while in Thrissur district were declined considerably with 5.90 per cent and 3.45 per cent respectively. However, productivity growth continues to be positive, with an average of 0.89% in Kerala and 2.60% in Thrissur district.

There was also more instability during this time. The instability in production in Kerala increased significantly (CDVI: 6.16) and Thrissur had higher instability in production (5.98) and area (4.78). The greater the variation, the more uncertain the market conditions, climatic variations, production technologies are in use and so on.

This period coincided with a more rapid rate of land conversion, increasing paddy cultivation expenses, and falling profitability of paddy production. The greater fall experienced by Thrissur indicates that the agricultural land pressures were higher at the district level than the State average.

Period III (1998-99 to 2007-08)

The poor performance of paddy cultivation continued in the third period as well. Kerala recorded the highest negative growth with an annual decrease in area of 4.40 per cent, while Thrissur recorded a negative growth rate of 5.16 per cent which was higher than the state average. Moreover, there was a decrease in production in the state average (-3.21%). Thrissur district alone exhibited a negative decrease of (-2.28%). However, there was a slight increase in productivity growth in Kerala at 1.24% and Thrissur at 2.28%. In spite of productivity improvements, the rate of cultivated area reduction was too fast to be matched by

production increase. The continuing decline of areas suggests structural changes that favour more profitable alternative crops or non-farm activities.

During this period the level of instability was relatively high, especially in production. The instability in the production (CDVI) was highest in Thrissur (10.30), which showed that production fluctuated considerably. The state of Kerala as a whole also had high instability of production (6.39) and productivity (4.45). These changes could have been driven by climate variability, flooding, labour shortages, and poor policy support.

Period IV (2009-10 to 2012-13)

During the fourth period, area and production remained at a downward trend. Negative growth was observed in the area (-4.50%) and production (-3.43%) in Kerala whereas area decreased by -5.48% in Thrissur. But the rate of productivity growth has increased considerably in Thrissur at 4.24% highest compared to all the periods. The increase in productivity of the area may be related to mechanization, better irrigation methods and the use of modern inputs in Thrissur. However, the increases in production were not able to offset the ongoing reduction in area.

The instability patterns during this period showed a mixed trend. Kerala state had exhibited relatively low instability in area (2.01) and moderate instability in production (4.87). Conversely, Thrissur district showed very high instability in area (9.80) and production (11.07) during this period. Such fluctuations maybe attributed to highly volatile cultivation decision and production of this area.

Period V (2013-14 to 2023-24)

Paddy sector of Kerala showed a major transformation during this period. The area, production and productivity showed positive growth simultaneously for the first time during this study period. The growth rates of Kerala were 1.27% in production, 0.34% in area and 1.09% in productivity. Likewise, the area, production and productivity of Thrissur showed positive growth of 0.17%, 1.51% and 1.37% respectively.

The declines seem to have reversed, which could be associated with more effective government policies and actions such as paddy conservation policies, more effective procurement support, promotion of mechanisation and better awareness of food security and wetland conservation.

But the instability indices were still relatively high during this period, particularly in production. Production instability in Kerala was recorded as 9.12 while Thrissur was at 11.04. This means that although growth has resumed, the sector still experiences a lot of variations related to climatic risks, floods, irregular rainfalls and market uncertainties. Such fluctuations may be possibly due to increasing ecological stress, irregular flooding, and changing hydrological conditions within the wetland agroecosystem.

Over all Analysis (1980-81 to 2023-24)

During the study period, Kerala had significant negative growth in paddy areas (-3.96%) and production (-2.49%) with moderate positive growth in productivity (1.55%). The area as well as production in Thrissur decreased by 4.51% and 2.29% respectively, while productivity rose considerably by 2.33%. The overall results indicate that productivity gains were able to offset some of the area reduction, but not enough to maintain the total production. The state average productivity growth is lower than the productivity growth in Thrissur, showing better adaptability to technology in the urban district.

Instability analysis also indicates that Thrissur had more variations as compared to Kerala in almost all indicators. The overall CDVI values of area (20.65) and production (14.55) in Thrissur was significantly higher than Kerala, which shows that the district is more vulnerable for structural and environmental changes of paddy sector in the region.

Although important paddy producing districts shows instability in growth of area, production and productivity, Thrissur district shows stable share and growth in area, production and productivity in tune with state average. The paddy land use dynamics in Kerala revealed a massive scale of conversion of paddy land towards non-agricultural uses which represents a permanent loss of agricultural potential and ecological services.

Discussion

The evidence from Kerala and Thrissur reveals a structural paradox: shrinking paddy area and declining production alongside rising productivity. In all districts, including Thrissur, the decline in paddy cultivation has been exacerbated by fragmented farming, labour-intensive farming and the attraction of high-yielding commercial crops. The Wetland Paddy Conservation Act (2008) has slowed but not reversed this trend as non-agricultural farming practices have continued. Thrissur has seen a steeper decline in area than the state average, reflecting the intense pressure on the Kole wetlands. Thrissur is notable for its productivity growth (CAGR 2.33%), far exceeding the state average (1.55%). With their unique hydrological and ecological characteristics, Kole wetlands, have enabled intensive farming practices that offset area losses. This implies that ecosystem services play a critical role in sustaining yield levels despite structural decline. Compared to Kerala as a whole, Thrissur has higher variability indices (CV and CDVI) in

area and production, indicating greater volatility. This volatility reflects the potential for changes in legislation, weather patterns, and market forces. However, relatively stable productivity in Thrissur, demonstrating resilience based on farmer adaptation and natural advantages. There was a slight recovery between 2013 and 2021, with positive growth in area and production. This reversal shows that despite the vulnerability, some initiatives such as farmer incentives, mechanization assistance, and wetland restoration can sustain paddy cultivation.

Conclusion

The study reveals that paddy cultivation in Kerala is at a crossroads due to structural decline in land use and environmental resilience in productivity. While the decline in area and production reflects structural weaknesses in land tenure patterns, labour costs and crop substitution, the steady increase in productivity highlights the potential of ecological systems and improved methods to sustain production. Compared with the steady productivity gains in Thrissur district, the structural decline in paddy land use across Kerala highlights the vulnerability and potential of Kerala's agricultural system. Future strategies should focus on ecosystem-based interventions, mechanisation in fragmented farms, and incentives for multi-season crops to balance farmer welfare and environmental sustainability. Without such measures, Kerala will further erode its agricultural base and become more dependent on rice imports, undermining food security and the wetland ecosystem.

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