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CONTENTS

Trends and instability in area, production and productivity of paddy across districts in Kerala, India

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ABSTRACT: Paddy is one of the important grains and staple food in Kerala. The diverse agro-climatic conditions prevailing in the state support wetland paddy cultivation. Significant societal developments put pressure on the land and gradually paved the way for the shifts in land use, resulting in a decline in paddy area. The present study was carried out to investigate the growth performance and instability in area, production and productivity of paddy across districts in Kerala using the Compound Annual Growth Rate (CAGR) and Instability Index based on secondary time series data collected from the official website of the Directorate of Economics and Statistics, Government of Kerala from 1985-86 to 2022-23. Bai-Perron test identified a structural break in area and production during 2007-08 and productivity during 2008-09, which could be attributed to the Kerala Conservation of Paddy Land and Wetland Act, 2008. The compound annual growth rate for area and production was negative, but the productivity was positive. During the overall study period, the highest instability index was reported in the paddy area compared to production and productivity. Rapid population growth, expansion of habitation on valuable land, industrialisation, urbanisation, conversion of paddy fields for non-agricultural uses and increasing factor costs paved the way for diminishing paddy lands. It is the need of the hour to implement appropriate policy measures to reduce the exacerbating effects of these factors and revive paddy production in the state.

Key words: Compound annual growth rate, instability, Kerala economy, land use change, paddy productivity, structural break

Kerala is among the top Indian states in per capita Gross State Domestic Product (GSDP), with an average income per person 1.5 times the national average in 2022-23. At the same time, the share of agriculture and allied sectors in the country's total Gross Value Added (GVA) has been declining in the last decade from 17.8 per cent in 2013-14 to 15.1 per cent in 2022-23 (GOK, 2024). As per the land use data of 2022-23, out of the total geographical area of 38.86 lakh hectares, the total cultivated area is 25.16 lakh hectares (64.75 per cent) and the net area sown is 19.9 lakh ha (51.20 per cent). Food crops comprising of rice, pulses, tapioca, ragi, minor millets, sweet potatoes and other tubers constitute only 10.34 per cent of the gross cropped area compared to 65.75 per cent of cash crops, which include cashew, rubber, pepper, coconut, cardamom, tea and coffee. Coconut occupies a significant percentage of the gross cropped area (30.2 per cent), followed by rubber (21.8 per cent) (GOK, 2024).

Kerala's economy has benefited enormously from agriculture, the primary source of employment and livelihood. It strengthens the rural economy's resilience and impacts job creation, food security, raw material supplies and means of subsistence. The diverse agro-climatic conditions prevailing in the state support the production of various crops, including plantation crops, cash crops, spices and food crops. However, the agricultural economy of Kerala has undergone considerable structural changes favouring cash crops.

The dominance of secondary and tertiary sectors, rapid urbanisation, enhanced standard of living, scattered landholdings, declining profitability, labour migration, high labour costs, high land prices and its conversion for non-agricultural use contributed to a rapid decline in area under cultivation (Maneesh and Deepa, 2016; Lekshmi and Venkataramana, 2020). The state with a food surplus has transformed into one with a food shortage, converting it into a consumer state. Agricultural land is being converted for the construction of roads, residential buildings,

commercial establishments, health care facilities and educational institutions throughout the state due to the increasing pressure of population growth and the development of the secondary and tertiary sectors, which in due course decreases the net area sown in the state (Thomas, 2004). This transformation resulted in tremendous change in the land utilisation pattern of the state over the past few decades (Mathew and Prema, 2022).

The steep decline in agricultural land area is primarily reflected in food grain production, particularly rice, which is the staple food of Kerala. Rice accounts for more than 90 per cent of the total food grains produced within the state. As per the Economic Review of Kerala 2022-23, rice constitutes only 7.6 per cent of the total cultivated area. The area under paddy cultivation declined from 8.7 lakh ha in 1970-71 to 1.9 lakh ha in 2022-23, accounting for nearly 80 per cent area decline. The production also declined from 12 lakh tonnes to 5.92 lakh tonnes in this period, but the productivity increased. Kerala is self-insufficient in production and still depends on neighbouring states for meeting its daily food grain requirements, leading to food shortage and food insecurity. According to Reddy (2015), rice yield converges across states in India, which is mainly helped by interactions in fertiliser, irrigation and farm machinery use. However, there was a widening gap between the bottom and top 25 per cent (based on farm size) of the farmers in terms of yields, gross returns and profitability. Thus, in Kerala, profitability is significantly influenced by scattered and small landholdings dominated by small and marginal farmers.

As per the 2011 census, the total population of Kerala is 3.34 crores and is forecasted to increase to 3.69 crores by 2036 (DES, 2024). The total rice produced in the state is insufficient to meet the growing population. The gross cropped area under rice decreased drastically. There is a wide gap between the quantity demanded and supplied. Since the last decade, the highest share of area under paddy was recorded in 2020-21 with 2.02 lakh ha and production of 6.27 lakh tonnes. The farmers changed to producing more profitable, high-value cash crops like coconut and rubber.

To ensure food security and ecosystem balance by protecting the rice growing tracts from reclamation and conversion, the Government of Kerala introduced 'The Kerala Conservation of Paddy Land and Wetland Act' in 2008. As per this act, the government shall take appropriate action to assist the farmers in augmenting paddy production in the state. There shall be a local-level monitoring committee in each panchayat or municipality, presided by the panchayat president or municipal counsellor along with the agricultural officer, village officer and three farmer representatives to monitor the implementation of the provisions of this act (GOK, 2008).

Several government initiatives for sustaining paddy production in the state have been put forward, emphasising fallow land cultivation and promoting traditional paddy farming areas like *Pokkali, Kari* and *Kaipad* by assisting in production facilities. Other interventions include input assistance of ₹ 5500 per ha per season, paddy production bonus of ₹ 1000 per ha per season and free electricity to paddy farmers. Royalty to owners of paddy land at ₹3000 per ha was also introduced in 2020-21 for conserving paddy lands.

In this world of inevitable industrialisation, urbanisation and persistent population inflation, the need for food security has gained pace, necessitating trend and instability studies (Kumar *et al.,* 2021). Analysing the growth rate trends helps us identify the changing patterns of crops, land use patterns, and the rate of change in crop area, production and productivity (Dwivedi *et al.,* 2024). Further, it helps design the appropriate agricultural policy for a region or state. Instability in agricultural production increases production risks, affecting farmers' incomes and possibly their choices regarding new technological investments (Abu and Adakole, 2017). Considering these issues and initiatives, this study analyses the structural breaks, trends and instability in the area, production and productivity of paddy

across districts in Kerala.

MATERIALS AND METHODS

This study is entirely based on secondary data collected from the official website of the Directorate of Economics and Statistics, Government of Kerala. Time series data on the area, production and productivity of paddy across districts of Kerala from the agricultural year 1985-86 to 2022-23 was used for the analysis. The study intends to discover structural changes in area, production and productivity and analyse the trends followed. The structural break analysis identified different breakpoints, as shown in Table 1. Based on the Bayesian information criterion (BIC), an optimum of four break points and five phases were identified for the study: period I (1985-86 to 1989-90), period II (1990-91 to 1996-97), period III (1997-98 to 2002-03), period IV (2003-04 to 2007-08) and period V (2008-09 to 2022-23). This can be used to predict the future area and production of paddy. The data was then analysed using the Compound Annual Growth Rate (CAGR) and Instability Index to compute the growth pattern of the area, as well as the production and productivity of paddy in Kerala.

Structural break analysis: Bai-Perron test

A structural break occurs when a time series abruptly changes at a point in time. This change could involve a change in the mean or the other series parameters that can lead to severe forecasting errors and affect the reliability of the results. Structural break analysis helps us to determine when and whether there is a significant change in our data. This can be due to policy changes, economic crises, institutional changes and regime shifts (Bai and Perron, 2003). In this study, Bai-Perron test was employed to check for any structural break in the time series. Bai and Perron (1998; 2003) provide the foundation for estimating structural break models based on least squares principles. This study explored the Bai-Perron test in R Studio software to analyse structural breaks in area, production and productivity.

Growth Rate Analysis

Compound annual growth rate (CAGR) was computed to assess the trend in area, production and productivity of paddy in Kerala. The annual growth was estimated using the exponential growth function of the form:

$Y_t = a\, b^t e^u$

where,

Y_t = Dependent variable for which growth rate was estimated

a = Intercept

b = Regression coefficient

t = Time in years which take values 1, 2, ..., n

u = Error term for the year 't'

The equation was transformed into log-linear form and evaluated using the Ordinary Least Square (OLS) method in MS Excel. The CAGR in percentage was computed from the following relationship:

CAGR= [Antilog of b – 1] x 100

The statistical significance of the coefficients was examined using the student 't' test, calculated using the formula,

$$t = \frac{b_i}{se}$$

where, b_i = Regression coefficient

se = Standard error of bi

Instability index

The coefficient of variation (CV) was used to determine the variability in the area, production and productivity of paddy.

$$CV = \frac{\text{Standard Deviation}}{\text{Mean}} \times 100$$

The formula suggested by Cuddy and Valle (1978) was used to determine the instability index.

$$\text{Instability index} = CV \times \sqrt{1 - R^2}$$

where R^2 = Coefficient of determination

Values of the instability index falling between 0 and 15% signify low instability, between 15% and 30% suggest medium instability and over 30% indicate strong instability.

RESULTS AND DISCUSSION

Structural Break Analysis

The Bai-Perron test identified multiple break points during the study period, but this study considers only

the particular breakpoint when there was a positive impact in the different parameters. A structural break in the area and paddy production in Kerala concurred with the agricultural year ending 2007- 08, showcasing the effect of The Kerala Conservation of Paddy Land and Wetland Act of 2008, which was put forward to check the indiscriminate and unlawful conversion of paddy lands and wetlands. The public interest in supporting agricultural expansion and maintaining the state's ecological balance led to the creation of this act. It can be noted that there was a minor increase of 5327 ha in the paddy area, as shown in Table 2. A significant increase in the paddy area was observed in 2008-09, just opposite to the decreases in the past, even though the increase was slight. Due to the immediate implementation of the act and strict monitoring mechanism to oversee compliance and to take action against illegal conversion, there has been a slight positive change in the area during this period. The increase in the area under paddy cultivation also positively influenced the overall paddy production. There was a phenomenal increase of around 61753 t in 2008-09 and 69851 t in 2009-10 in paddy production compared to 2007-08. These results matched the findings of Lekshmi and Venkataramana (2020) and Thomas (2011). Additional support was provided for upland rice cultivation in potential areas for the first time in 2009-10. A scheme for ₹ 36 crores was also launched in 2009-10 for rice development in the state as part of a food security project. As part of the project, regional subprojects were launched with additional incentives, interest-free loans, project-based support for fallow land cultivation and a package of support measures. The procurement price was also enhanced to ₹ 13/kg by the Government of Kerala. A modernization programme for lift irrigation was also initiated as part of the food security project and Malabar package. Thus, a perceptible improvement in the area and production was visible in paddy cultivation in the state.

In contrast to the area and production, a break in productivity was observed during 2008-09. There was a remarkable increase of around 0.212 t/ha in 2008-09 and 0.249 t/ha in 2009-10 in paddy productivity compared to 2007-08. This increase can also be attributed to the Kerala Conservation of Paddy Land and Wetland Act, 2008. Following the act, the government launched several initiatives to support paddy farming. These included awareness campaigns about protecting wetlands and paddy land and seasonal training programs focusing on rice-based integrated farming systems. Importance was given to designing incentive systems to promote productivity by exploiting the potential of agro-ecological zones rather than providing area-based subsidies. These government interventions significantly increased paddy productivity.

Growth rate and Instability analysis

The trend and instability in area, production and productivity under paddy cultivation across districts in Kerala were assessed for 1985-2023. The dynamics of area, production and productivity in paddy cultivation in Kerala are portrayed in Table 3. Evidently, the paddy area decreased to almost one-third (66.4% decrease) and production decreased to almost half (43.7% decrease) in TE 2022-23 compared to TE 1989-90, but the paddy productivity almost doubled (67.5% increase).

The dynamics of the district-wise paddy area and production revealed that its share was dwindling in TE 2022-23 compared to TE 1989-90, as shown in Figure 1, the results matching the findings of Abraham (2019). The highest percentage decrease in the paddy area in TE 2022-23 was noticed in Ernakulam (93.6%), followed by Kollam (92.9%), Thiruvananthapuram (91.3%) and Idukki (89.2%) compared to TE 1989-90. The least decrease in the area was noticed in Kottayam (35.3%), followed by Alappuzha (38.9%). Compared to the TE 2011-12, an increase in paddy area was visible in TE 2022-23 in five districts, viz., Pathanamthitta (24%), Malappuram (14.4%), Kottayam (10.8%), Alappuzha (8.4%) and Thrissur (5.4%). Of all the 14 districts in Kerala, only Kottayam district witnessed an increase in paddy area (10.1%) in TE 2011-12 compared to TE 2000-01.

It is evident from the data that paddy production almost halved during the study period. However, compared to TE 2011-12, there was a slight increase

in the overall paddy production in Kerala by 33871 t (6%) in TE 2022-23. The highest percentage decrease in paddy production was noticed in Kollam (91.1%), followed by Ernakulam (90.8%), Idukki (88.6%) and Thiruvananthapuram (87.1%) compared to TE 1989-90. The least decrease in production was noticed in Alappuzha (13.2%), followed by Kottayam (15.8%) and Palakkad (16.5%). There was a significant increase of 12076 t (60.8%) paddy production in Malappuram during TE 2022-23 compared to TE 2011-12. Other districts that showed an increase in paddy production during the same period were Pathanamthitta (35.5%), Thrissur (33.1%), Kottayam (15.8%), Alappuzha (12.8%) and Palakkad (2.3%). Only Alappuzha (4.8%) and Kottayam (19.8%) showed increased paddy production in TE 2011-12 compared to TE 2000-01.

The increase in paddy productivity was seen in almost all districts. The highest productivity was seen in Thrissur (3.39 t/ha) and the lowest in Kozhikode (1.29 t/ha). The overall paddy productivity in Kerala increased from 1.81 t/ha in TE 1989-90 to 3.02 t/ha in TE 2022-23. This revealed that even though the area and production under paddy declined, productivity enhanced due to the incorporation of mechanisation, optimum use of fertilisers, reducing overuse of inputs, development of high-yielding varieties of seeds and introduction of new schemes and policies by policymakers. The decline in paddy production would have been much higher had there been no positive change in productivity.

Trend in paddy area

Considering the structural breaks, the annual growth rate for the paddy area was found for each of the five periods, including the overall period, as shown in Table 4. It aids in assessing the changes in the paddy area across districts in Kerala during the study period to achieve adequate planning of productive areas across regions. Kerala witnessed a drastic decline in the paddy area from 621422 ha in period I (1985-86 to 1989-90) to 202717 ha in period V (2008-09 to 2022-23). The compound annual growth rate for the paddy area for the overall period was negative at 3.78 per cent. The area diminished during all periods, but the highest negative annual growth rate of 5.35 per cent was observed during period IV (2003-04 to 2007-08). However, in period V, the negative growth rate decreased to 1.06 per cent, which was the least during all periods. This can be attributed to the implementation of the Kerala Conservation of Paddy Land and Wetland Act, 2008, which prevents the unchecked and illegal conversion

Table 1: Breakpoints identified using structural break analysis

Breaks	Break Year						BIC value
1	2003						251.6
2	1996	2009					228.1
3	1993	2000	2012				213.5
4	1989	1996	2002	2008			203.7
5	1990	1996	2002	2008	2015		204.0
6	1989	1995	2001	2006	2012	2017	204.8

Table 2: Structural breaks in area, production and productivity of paddy

Particulars	Break Year	Year	Values	Change from the previous year
Area (ha)	2007-08	2007-08	228938	-34591
		2008-09	234265	5327
		2009-10	234013	-252
Production (t)	2007-08	2007-08	528488	-113087
		2008-09	590241	61753
		2009-10	598339	8098
Productivity (t/ha)	2008-09	2007-08	2.31	-0.13
		2008-09	2.52	0.21
		2009-10	2.56	0.04

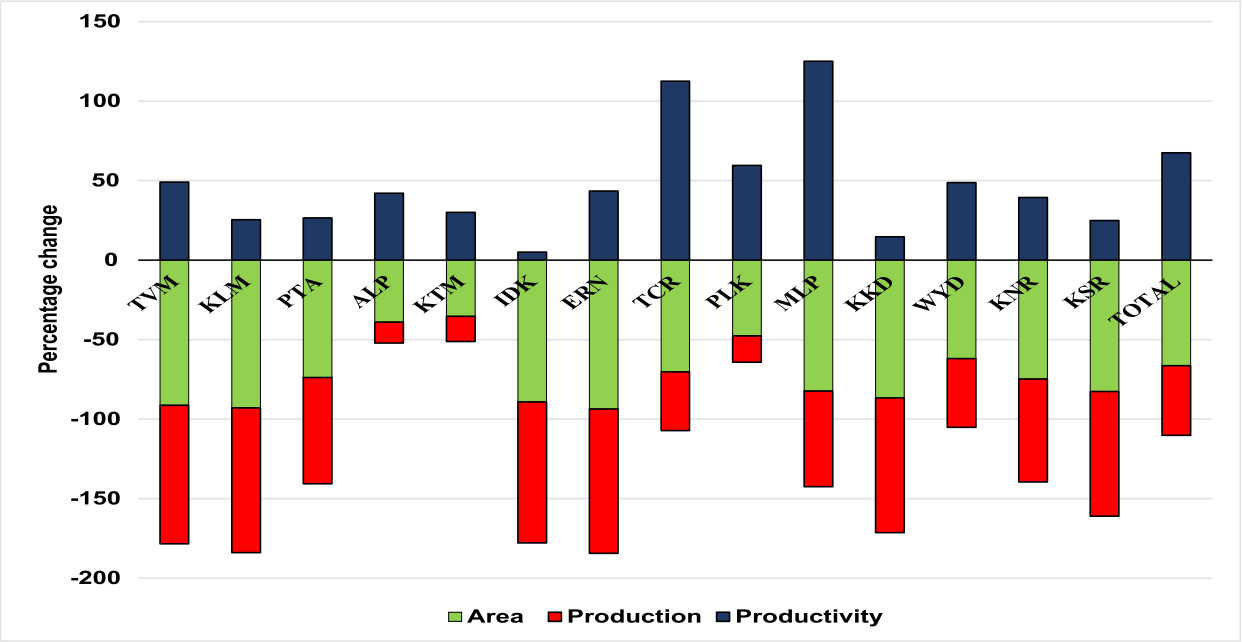

Fig. 1: District-wise percentage change in area, production and productivity of paddy in TE 2022-23 compared to TE 1989-90

of paddy lands and wetlands and the promotion of fallow land cultivation.

During the study period, Palakkad (109876 ha) had the highest mean area under paddy cultivation, followed by Thrissur (42248 ha) and Alappuzha (42057 ha). Idukki (3061 ha) had the lowest mean area. The highest negative growth rate was seen in Kollam (9.7%), followed by Ernakulam (9.25%) and Thiruvananthapuram (8.39%) and the lowest negative growth in Kottayam (1.42%). Considering the different breaks, the highest negative growth rate was observed in Kollam (22.91%), followed by Pathanamthitta (22.91%) and Ernakulam (22.91%), coinciding during period IV (2003-04 to 2007-08). In light of the various districts, the highest negative growth rates of Thiruvananthapuram, Kollam, Pathanamthitta, Ernakulam, Thrissur and Malappuram occurred during period IV, Kottayam, Idukki, Palakkad, Kozhikode, Wayanad, Kannur and Kasaragod occurred during period I and Alappuzha during period III. It can also be seen that Kottayam (2.45%), Pathanamthitta (2.39%), Alappuzha (1.03%) and Malappuram (0.43%) had positive growth rates in the paddy area during period V (2008-09 to 2022-23). None of the districts had the highest negative growth rate during this period V, highlighting the significance of the Kerala Conservation of Paddy Land and Wetland Act. Alappuzha has also shown positive growth rates in periods I and IV, Palakkad during period III and Wayanad during period IV.

In Kerala, land is in high demand for infrastructure, residential and other non-agricultural purposes. Within the land used for agricultural purposes, there was a shift from food grain towards non-food-grain crops. From about 9.5 lakh ha in 1970- 71, the area under food grain fell to 2.9 lakh ha in 2004-05 and 1.9 lakh ha in 2022-23. With the growth of the population and the shifts in people's socio-economic conditions, there has been an expansion in trade, industry, transportation, etc. Agricultural activities of labour-intensive paddy production are adversely affected due to high labour costs and shortages, demanding rapid mechanisation. Thus, shifting the labour force from primary to secondary and tertiary sectors paved the way for the decline in the paddy area in Kerala. These trends will probably persist and worsen over the next decade unless agricultural returns increase more quickly than non-agricultural land returns.

Table 4: Trend in paddy area across districts in Kerala (ha)

District/State	Period I 1985-86 to 1989-90	Period II 1990-91 to 1996-97	Period III 1997-98 to 2002-03	Period IV 2003-04 to 2007-08	Period V 2008-09 to 2022-23	Overall period 1985-86 to 2022-23
Thiruvananthapuram	23501	18004	8194	4398	2129	9121
	-6.11***	-5.77***	-10.84***	-14.41**	-3.42***	-8.39***
Kollam	31359	26292	15479	7078	2168	13201
	-3.82	-4.93***	-11.38***	-22.91***	-2.7	-9.70***
Pathanamthitta	13843	12194	6568	3502	2979	6741
	-0.47	-4.59***	-8.88***	-21.65***	2.39***	-5.29***
Alappuzha	62717	51588	35693	31481	36793	42057
	2.33	-5.51***	-5.55**	0.42	1.03**	-1.49***
Kottayam	30813	24334	14693	12401	17495	19394
	-2.73	-2.54	-0.99	-0.46	2.45**	-1.42***
Idukki	6165	4633	3867	2879	1030	3061
	-12.58**	-0.01	-0.03	-8.34**	-10.06***	-7.09***
Ernakulam	77301	60866	40198	23362	6203	33253
	-5.02***	-2.97***	-8.72***	-18.07**	-5.58***	-9.25***
Thrissur	84446	63736	39458	30663	23132	42248
	-6.00***	-5.18***	-2.07	-9.13**	-0.37	-4.21***
Palakkad	149883	140382	114749	107692	81083	109876
	-2.65*	-2.06***	0.28	-1.32	-1.78***	-2.25***
Malappuram	58331	44018	23622	14782	8584	24847
	-5.13**	-7.88***	-5.81**	-12.59*	0.43	-6.41***
Kozhikode	16007	10005	6592	4521	2641	6628
	-8.35**	-6.59***	-6.68**	-6.72**	-4.55***	-6.05***
Wayanad	24698	20321	15286	11883	9416	14687
	-10.83**	-1.31	-6.47**	0.54	-3.68***	-3.45***
Kannur	23904	17989	12556	8772	5757	11868
	-8.2**	-4.05***	-6.39**	-5.51*	-2.33**	-4.88***
Kasaragod	18454	12981	8025	5691	3300	8138
	-8.57*	-4.15***	-1.88	-4.4*	-4.81***	-5.97***
KERALA	621422	507355	344979	269105	202717	345125
	-4.31**	-3.95***	-3.86***	-5.35**	-1.06**	-3.78***

*** denotes significant at 1% level ** denotes significant at 5% level * denotes significant at 10% level

Trend in paddy production

The annual growth rate for paddy production was found for each of the five periods, including the overall period, as illustrated in Table 5. The state witnessed a significant drop in paddy production from 1098660 t in period I (1985-86 to 1989-90) to 745989 t in period V (2008-09 to 2022-23). During the overall period, paddy production had a negative compound annual growth rate of 2.29 per cent. The production diminished during all periods except period V, with the highest negative annual growth rate of 3.45 per cent observed during period II (1990-91 to 1996-97). A positive growth rate of 0.27 per cent was observed in period V, which can be attributed to the act implemented in 2008.

During the study period, Palakkad (258078 t) had the highest mean paddy production, followed by Alappuzha (103166 t) and Thrissur (89546 t). Idukki (7228 t) had the lowest mean production. The highest negative growth rate was observed in Kollam (9.1%), followed by Ernakulam (8.23%) and Thiruvananthapuram (7.13%) and the lowest negative growth in Alappuzha (0.3%). In view of the different breaks, the highest negative growth rate was observed in Kollam (22.58%), followed by Pathanamthitta (21.54%) and Ernakulam (16.5%), coinciding during period IV (2003-04 to 2007-08). In light of the various districts, the highest negative growth rates of Thiruvananthapuram, Kollam, Pathanamthitta, Ernakulam, Thrissur, Malappuram and Kozhikode occurred during period IV, Alappuzha, Kottayam and Palakkad occurred during period II, Wayanad, Kannur and Kasaragod during

Table 3: Dynamics of paddy area, production and productivity in Kerala

District/State	TE 1989-90			TE 2000-01			TE 2011-12			TE 2022-23		
	Area(ha)	Production (t)	Productivity (t/ha)	Area(ha)	Production (t)	Productivity (t/ha)	Area(ha)	Production (t)	Productivity (t/ha)	Area(ha)	Production (t)	Productivity (t/ha)
Thiruvananthapuram (TVM)	21903(3.73)	37179(3.51)	1.70	8187(2.34)	16569(2.22)	2.02	2751(1.26)	6875(1.23)	2.50	1896(0.97)	4796(0.81)	2.53
Kollam (KLM)	29726(5.06)	52854(4.98)	1.78	16645(4.76)	33069(4.42)	1.99	2964(1.36)	6623(1.18)	2.23	2109(1.07)	4702(0.79)	2.23
Pathanamthitta (PTA)	13863(2.36)	31834(3.00)	2.30	6831(1.96)	18422(2.46)	2.70	2928(1.35)	7785(1.39)	2.66	3632(1.84)	10553(1.77)	2.91
Alappuzha (ALP)	63234(10.75)	130659(12.31)	2.07	36064(10.31)	95771(12.78)	2.66	35584(16.29)	100427(17.83)	2.82	38604(19.55)	113372(18.99)	2.94
Kottayam (KTM)	29526(5.02)	66072(6.23)	2.24	15631(4.47)	40048(5.35)	2.56	17220(7.89)	47987(8.52)	2.79	19093(9.67)	55594(9.31)	2.91
Idukki (IDK)	5163(0.88)	11144(1.05)	2.16	3653(1.05)	8648(1.16)	2.37	1804(0.83)	4672(0.83)	2.59	557(0.29)	1262(0.22)	2.27
Ernakulam (ERN)	73628(12.52)	119492(11.26)	1.62	43352(12.39)	77387(10.33)	1.79	9178(4.21)	18473(3.28)	2.01	4698(2.38)	10944(1.84)	2.33
Thrissur (TCR)	79163(13.46)	126160(11.88)	1.59	40495(11.58)	82835(11.06)	2.05	22290(10.21)	59750(10.61)	2.68	23500(11.90)	79580(13.33)	3.39
Palakkad (PLK)	144566(24.58)	289540(27.27)	2.00	111957(32.00)	250291(33.40)	2.24	90677(41.51)	236266(41.94)	2.61	75627(38.30)	241763(40.49)	3.20
Malappuram (MLP)	54628(9.29)	80212(7.56)	1.47	23487(6.72)	42752(5.71)	1.82	8438(3.87)	19846(3.53)	2.35	9657(4.89)	31922(5.35)	3.31
Kozhikode (KKD)	14388(2.45)	16169(1.53)	1.12	6692(1.92)	8533(1.14)	1.28	3067(1.41)	4130(0.74)	1.35	1921(0.98)	2477(0.42)	1.29
Wayanad (WYD)	20908(3.56)	39786(3.75)	1.90	15982(4.57)	37751(5.04)	2.36	11015(5.05)	28198(5.01)	2.56	7970(4.04)	22565(3.78)	2.83
Kannur (KNR)	21430(3.65)	33073(3.12)	1.54	12460(3.57)	21008(2.81)	1.69	6403(2.94)	13107(2.33)	2.05	5411(2.74)	11639(1.95)	2.15
Kasaragod (KSR)	16218(2.76)	27956(2.64)	1.72	8517(2.44)	16504(2.21)	1.94	4135(1.90)	9216(1.64)	2.23	2814(1.43)	6057(1.02)	2.15
KERALA TOTAL	588344(100)	1062130(100)	1.81	349953(100)	749588(100)	2.14	218454(100)	563355(100)	2.58	197489(100)	597226(100)	3.02

(Figures in parentheses indicate per cent of the state total, TE -Triennium)

period I and Idukki during period V. It is evident that majority of the districts have shown positive growth rates in any one of the periods under consideration. The highest growth rate was observed in Alappuzha (5.84%) during the period I. It can also be seen that Malappuram (3.88%), Pathanamthitta (3.62%), Kottayam (2.51%), Thrissur (1.65%) and Alappuzha (1.06%) had positive growth rates in the paddy production during period V (2008-09 to 2022-23). Not a single district showed a positive growth rate during period II. A positive annual growth rate in paddy production in the last period can be attributed to various factors and practices like improved seed varieties, better agricultural practices, irrigation management, soil health management, access to technology, market access and government policies and support.

According to the agricultural census, Kerala is dominated by small and marginal farms, with an average holding size of 0.18 ha. The smallness of farms and scattered landholdings obstruct farmers from reaping the benefits of economies of scale and embracing contemporary technologies, particularly machines. Variability in rainfall patterns, increased temperatures and extreme weather events have adversely affected paddy cultivation, impacting production and sowing seasons. Hopefully, consistency in paddy production was observed during period V, where there was a slight increase from 590241 t in 2008-09 to 595860 t in 2022-23. This seems to be a positive sign in reviving paddy production in the state.

Trend in paddy productivity

The paddy productivity level improved from 1.77 t/ha in period I (1985-86 to 1989-90) to 2.77 t/ha in period V (2008-09 to 2022-23), as depicted in Table 6. Kerala's paddy productivity had a positive compound annual growth rate of 1.57 per cent during the overall period. The highest growth rate in productivity of 3.74 per cent in the state was observed during period IV. While productivity increases continuously in the state and districts, significant variations occur across districts. Pathanamthitta (2.62 t/ha) recorded the highest overall productivity and followed by Alappuzha

Table 5: Trend in paddy production across districts in Kerala (t)

District/State	Period I 1985-86 to 1989-90	Period II 1990-91 to 1996-97	Period III 1997-98 to 2002-03	Period IV 2003-04 to 2007-08	Period V 2008-09 to 2022-23	Overall period 1985-86 to 2022-23
Thiruvananthapuram	40449	32225	16354	10385	5343	17316
	-5.54	-5.37***	-6.61***	-10.47*	-3.24**	-7.13***
Kollam	54838	49107	30732	15939	4688	25062
	-2.31	-4.04**	-8.19***	-22.58***	-2.99	-9.10***
Pathanamthitta	29535	29044	16696	8535	8848	16488
	5.02	-5.38**	-7.96**	-21.54***	3.62***	-4.28***
Alappuzha	124350	112468	91133	73135	106587	103166
	5.84**	-5.01*	-2.16	1.16	1.06	-0.30
Kottayam	64845	56283	35785	30845	50203	48426
	3.03	-4.01*	0.75	2.47	2.51**	-0.44
Idukki	13048	11460	8952	7255	2615	7228
	-9.89*	-0.11	1.30	-4.90	-11.15***	-6.64***
Ernakulam	126459	103404	71168	44998	13334	58109
	-4.36**	-1.94	-6.27*	-16.50*	-4.36**	-8.23***
Thrissur	134742	115671	83841	72935	70108	89546
	-5.34**	-3.03***	1.49	-8.50**	1.65**	-2.02***
Palakkad	293315	315782	254432	246108	224851	258078
	0.77	-2.75**	0.14	5.61	-0.05	-1.10***
Malappuram	85875	71998	43269	31906	23704	44949
	-3.77	-6.25***	-2.58	-10.84*	3.88***	-4.21***
Kozhikode	18178	12268	8456	6362	3656	8267
	-7.74*	-6.20***	-3.58	-8.54***	-5.02***	-5.53***
Wayanad	46375	45205	36065	29763	25275	34017
	-8.16	-0.56	-4.75	2.97*	-3.04***	-2.40***
Kannur	36201	28587	21457	16497	12065	20350
	-6.39*	-3.66***	-3.95*	-2.94	-1.67**	-3.73***
Kasaragod	30436	22956	15950	12777	7335	15328
	-5.89*	-3.87*	0.73	-5.64*	-5.07***	-5.07***
KERALA	1098660	1005043	733783	607433	558608	745989
	-1.67	-3.45***	-1.88*	-1.88	0.27	-2.29***

*** denotes significant at 1% level ** denotes significant at 5% level * denotes significant at 10% level

(2.55 t/ha) Kottayam (2.55 t/ha) and Kozhikode (1.32 t/ha), the least. Malappuram (2.41%) showed the highest overall growth rate and Idukki (0.31%) the lowest.

Analysing the different break periods reveals that Thrissur (3.04 t/ha) had the highest productivity, followed by Pathanamthitta (2.97 t/ha) and Alappuzha (2.96 t/ha) coinciding during period V. The highest growth rate was observed in Palakkad (7.02%) during period IV, followed by Kottayam (5.98%) and Pathanamthitta (5.55%) during period I. The highest negative growth rate was noticed in Kozhikode (1.97%) during period IV. None of the districts exhibited a negative growth rate during the period I. Paddy output losses over the past few decades due to declining paddy acreage have been partially mitigated by positive productivity growth in most districts.

Even though paddy productivity has increased in the past decades, Kerala is still lagging compared to other states in India like Punjab, Andhra Pradesh and Tamil Nadu, having more than 4.2 t/ha productivity. Kerala faces low productivity levels because of unscientific and imbalanced farming practices. It is one of the lowest fertilizer-consuming states in India, where the NPK fertilizer consumption in 2020-21 was 39.62 kg/ha, the lowest among all Indian States compared to the national average of 137.15 kg/ha. Adequate policy intervention by the government for soil and plant

Table 6: Trend in paddy productivity across districts in Kerala (t/ha)

District/State	Period I 1985-86 to 1989-90	Period II 1990-91 to 1996-97	Period III 1997-98 to 2002-03	Period IV 2003-04 to 2007-08	Period V 2008-09 to 2022-23	Overall period 1985-86 to 2022-23
Thiruvananthapuram	1.72	1.79	2.03	2.39	2.51	2.18
	0.64	0.39	4.74**	4.63*	0.18	1.37***
Kollam	1.75	1.87	2.01	2.26	2.2	2.06
	1.54	0.94	3.58***	0.45	-0.05	0.74***
Pathanamthitta	2.13	2.38	2.55	2.44	2.97	2.62
	5.55	-0.77	0.99	0.08	1.23	1.08***
Alappuzha	1.99	2.19	2.54	2.33	2.96	2.55
	3.50	0.54	3.59	0.79	0.39	1.30***
Kottayam	2.11	2.31	2.43	2.48	2.88	2.55
	5.98**	-1.47**	1.75	2.91**	0.16	1.02***
Idukki	2.13	2.16	2.32	2.54	2.5	2.37
	3.11	-0.08	1.35	3.76***	-1.16**	0.50
Ernakulam	1.64	1.7	1.78	1.94	2.2	1.93
	0.72	1.05*	2.71*	1.95*	1.30***	1.14***
Thrissur	1.6	1.82	2.13	2.38	3.04	2.4
	0.73	2.38**	3.61**	0.63	2.04***	2.29***
Palakkad	1.96	2.25	2.22	2.28	2.78	2.42
	3.46	-0.68	-0.15	7.02*	1.76***	1.17***
Malappuram	1.47	1.61	1.84	2.16	2.76	2.15
	1.46	2.97*	3.43***	1.54*	3.50***	2.41***
Kozhikode	1.14	1.23	1.3	1.4	1.41	1.32
	0.69	0.35	3.29*	-1.97	-0.17	0.65***
Wayanad	1.88	2.22	2.36	2.51	2.7	2.42
	3.03	0.78	1.81	2.48	0.66***	1.09***
Kannur	1.52	1.6	1.72	1.89	2.13	1.85
	1.87	0.42	2.62***	2.67**	0.86**	1.25***
Kasaragod	1.66	1.77	1.99	2.24	2.23	2.03
	2.89*	0.30	2.62*	-1.35	-0.20	0.98***
KERALA	1.77	1.98	2.13	2.26	2.77	2.33
	2.77	0.51	2.09**	3.74	1.42***	1.57***

*** denotes significant at 1% level ** denotes significant at 5% level * denotes significant at 10% level

health management, financial support and subsidies, and encouraging research and development can aid in significantly enhancing productivity in the state.

Instability in area, production and productivity

The instability indices of paddy area, production and productivity across districts of Kerala are presented in Table 7. During the overall study period, the highest variation in paddy was reported in area (14.77%) compared to production (12.89%) and productivity (4.83%). Comparing the districts, the highest variability in paddy area was observed in Thiruvananthapuram (33.7%), placing it in the strong instability category, followed by Malappuram (29.15%) and Pathanamthitta (29.07%) in medium instability category. The highest variability in paddy production was noticed in Pathanamthitta (30.58%), placing it in the strong instability category, followed by Thiruvananthapuram (27.6%) and Malappuram (25.5%) in the medium instability category. Concerning productivity, none of the districts fall under medium or strong instability, but Alappuzha (11.43%) and Pathanamthitta (10.57%) showed the highest variability. Palakkad (5.86%, 11.57%) exhibited the lowest variability in area and production and Ernakulam in productivity (4.09%). Analysing the different periods, strong instability in the area and production were observed in Kollam (33.69%, 33.85%) and Idukki (30.59%, 31.23%) during period V. Alappuzha (17.98%) showed medium instability in productivity during period IV. Besides Kottayam (15.55%) exhibiting medium

Table 7: Instability (%) in paddy area, production and productivity across districts in Kerala

District/State		Period I 1985-86 to 1989-90	Period II 1990-91 to 1996-97	Period III 1997-98 to 2002-03	Period IV 2003-04 to 2007-08	Period V 2008-09 to 2022-23	Overall period 1985-86 to 2022-23
Thiruvananthapuram	Area	1.78	4.01	7.74	6.06	15.25*	33.7**
	Production	7.31	5.72	4.58	10.21	17.19*	27.6*
	Productivity	6.56	3.78	5.29	4.22	5.63	7.42
Kollam	Area	5.54	2.68	5.45	2.83	33.69**	27.01*
	Production	9.96	7.16	6.15	4.75	33.85**	24.79*
	Productivity	5.07	4.56	2.49	1.84	6.71	6.8
Pathanamthitta	Area	3.72	2.96	4.28	4.11	10.93	29.07*
	Production	9.43	6.64	8.1	7	13.64	30.58**
	Productivity	7.11	6.42	7.58	7.08	12.21	10.57
Alappuzha	Area	6.3	5.44	7.04	5.41	7.31	18.8*
	Production	4.18	9.26	10.42	15.75*	9.94	18.18*
	Productivity	7.45	12.93	11.2	17.98*	7.61	11.43
Kottayam	Area	4.5	6.13	10.61	9.4	12.43	25.83*
	Production	6.65	7.33	15.55*	11.27	13.44	25.32*
	Productivity	3.65	2.63	7.59	2.14	5.53	6.48
Idukki	Area	8.12	10.77	8.39	6.09	30.59**	18.93*
	Production	11.4	12.18	10.44	6.87	31.23**	18.53*
	Productivity	4.23	4.15	5.83	0.8	7.41	8.09
Ernakulam	Area	2.16	3.45	6.34	10.05	30.21**	20.33*
	Production	3.95	4.82	9.45	12.15	27.27*	18.6*
	Productivity	5.01	2.47	4.66	1.82	3.39	4.09
Thrissur	Area	0.43	2.26	4.11	6.02	8.19	21.09*
	Production	2.97	2.61	6.62	6.98	10.40	16.2*
	Productivity	2.82	3.21	4.03	1.26	6.24	5.9
Palakkad	Area	2.86	1.83	4.48	4.92	6.84	5.86
	Production	8.54	3.95	4.79	11.09	13.21	11.57
	Productivity	5.95	3.59	3.6	6.78	8.25	8.73
Malappuram	Area	3.64	4.87	5.71	9.51	13.18	29.15*
	Production	8.4	5.55	5.09	9.69	14.41	25.5*
	Productivity	5.29	5.07	1.21	1.75	5.77	8.37
Kozhikode	Area	4.83	3.97	6.34	3.42	13.15	26.75*
	Production	9.08	3.92	8.01	3.09	13.85	21.39*
	Productivity	6.28	1.62	4.3	2.95	8.88	7.53
Wayanad	Area	9.9	8.19	6.26	3.99	10.01	15.16*
	Production	14.52	10.37	11.2	2.65	10.61	13.48
	Productivity	5.65	4.1	5.86	3.4	2.75	4.67
Kannur	Area	4.92	2.81	6.71	5.52	14.35	18.43*
	Production	7.43	3.31	6.79	7.14	11.76	14.45
	Productivity	4.26	4.64	1.16	1.99	4.70	4.49
Kasaragod	Area	8.21	4.52	8.13	3.98	15.96*	23.72*
	Production	6.04	7.56	5.18	5.52	14.97	15.37*
	Productivity	3.17	4.15	3.62	2.59	3.64	6.3
KERALA	Area	2.65	2.2	2.33	3.74	5.96	14.77
	Production	5.92	2.55	3.08	8.9	8.35	12.89
	Productivity	4.02	1.53	2.17	5.02	4.54	4.83

** indicates strong instability * indicates medium instability

instability in paddy production during period III, no other districts have shown medium or strong instability in area, production or productivity during the first three periods. The least instability in area and production was shown by Thrissur (0.43%, 2.61%) during periods I and II, respectively and Idukki (0.8%) in productivity during period IV. In comparison, both area, production and productivity

exhibited increasing instability due to a decrease in paddy area and production and an increase in paddy productivity. Government initiatives to promote paddy, such as training programs on more efficient paddy cultivation, may have had a favourable impact on productivity, as seen by the low instability index.

CONCLUSION

This study analysed the trends and instability in the area, production and productivity of paddy across districts in Kerala from 1985-86 to 2022-23. Trend and instability index were found for the five periods and the overall time. Bai-Perron test identified a structural break in the paddy area and production in the state coincided with the agricultural year ending 2007-08 and productivity during 2008-09, showcasing the effect of The Kerala Conservation of Paddy Land and Wetland Act of 2008, which was put forward to check the indiscriminate and unlawful conversion of paddy lands and wetlands and also promoted paddy cultivation. The compound annual growth rate for area and production was negative, but the productivity was positive. During the overall study period, the highest instability index was reported in the paddy area compared to production and productivity.

Analysis of the trends in growth rate helps us detect the varying patterns, land use dynamics under different crops and the rate of change in area, production and productivity, supplementing in designing appropriate agricultural policy for a district or state. Appropriate policies and programs that encourage farmers to adopt the recommended package of practices must be implemented to increase paddy production and productivity. Fallow lands must be brought under cultivation through the widespread promotion of rural development programs like MGNREGA. Developmental and construction activities should be diverted to barren and uncultivable lands. Extension services should be strengthened in the state to educate farmers on using better seeds, improved technologies and innovations and judicious use of inputs. Introducing appropriate coping strategies, adaptation and mitigating actions is necessary to prevent the detrimental effects of climate change. Even after implementing the conservation act, the paddy area in Kerala showed a declining trend, necessitating its effective implementation. Keeping this in mind, the government of Kerala should take necessary actions to effectively implement the act to maintain or enhance the status quo. Implementing these policies can help enhance paddy productivity in Kerala, ensuring food security and sustainable agricultural development.

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REFERENCES

Abraham, M. P. (2019). Paddy cultivation in Kerala: A trend analysis of area, production and productivity at district level. Department of Economics, Government College, Attingal, Thiruvananthapuram, 60 p.

Abu, O. and Adakole, O. (2017). Growth and instability in selected cereal crops in Benue State, Nigeria and its implications for food security. *Asian Research Journal of Agriculture*, 5(2): 1-8.

Bai, J. and Perron, P. (1998). Estimating and testing linear models with multiple structural changes. *Econometrica,* 66(1): 47-78.

Bai, J. and Perron, P. (2003). Computation and analysis of multiple structural change model. *Journal of Applied Econometrics*, 181-22.

Cuddy, J. D. and Valle, P. A. D. (1978). Measuring the instability of time series data. *Oxford Bulletin of Economics and Statistics*, 40(1): 79-85.

DES [Department of Economics and Statistics] (2024). Population Growth Trends in Kerala [on-line]. Available: https: // ecostat.kerala.gov.in/population-report01 [01 October 2024].

Dwivedi, R. K., Khavse, R. and Ahriwar, M. K.

(2024). Trend analysis of area, production and productivity of small millets in Madhya Pradesh, India. *Plant Archives*, 24(1): 543-548.

GOK [Government of Kerala] (2008). Economic Review 2007 Volume II. Kerala State Planning Board, Thiruvananthapuram, Kerala, India, 490 p.

GOK [Government of Kerala] (2024). Economic Review 2023 Volume I. Kerala State Planning Board, Thiruvananthapuram, Kerala, India, 654 p.

GOK [Government of Kerala] (2024). Economic Review 2023 Volume II. Kerala State Planning Board, Thiruvananthapuram, Kerala, India, 490 p.

Kumar, K. R. B., Reddy, M. A., Karunakaran, K. R. and Shafeer, K. B. (2021). Trend and instability index analysis in paddy crop area, productivity and production across district in Andhra Pradesh, India. *Asian Journal of Agricultural Extension, Economics & Sociology,* 39(11): 69-78.

Lekshmi, U. D. and Venkataramana, M. N. (2020). Growth and instability analysis of area, production and productivity of paddy in Kerala, with special reference to "The Kerala Conservation of Paddy Land and Wetland Act, 2008". *International Journal of Agriculture, Environment and Biotechnology*, 13(1): 93-98.

Maneesh, P. and Deepa, N. R. (2016). Trend analysis of area, production and productivity of rice in Kerala in the context of food security. *International Journal of Agricultural Research and Review*, 4(8): 538-546.

Mathew, S. and Prema, A. (2022). Land use changes in the Kerala state, India: A temporal analysis. *Asian Journal of Agricultural Extension, Economics & Sociology*, 40(11): 586-593.

Reddy, A. A. (2015). Regional disparities in profitability of rice production: Where small farmers stand? *Indian Journal of Agricultural Economics*, 70(3): 259-271.

Thomas, J. J. (2011). Paddy cultivation in Kerala. *Review of Agrarian Studies*, 1(2): 215-226.

Thomas, P. M. (2004). Agricultural performance in Kerala. In: B. A. Prakash (ed). Kerala's Economic Development Performance and Problems in the Post-Liberalisation Period. SAGE Publications, New Delhi, Pp 141-164.

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