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Varietal Replacement and Rice Productivity in Palakkad Plain Agroecological Zone of Kerala

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Abstract

The gains from green revolution era have helped the nation to become the second largest global producer of rice. Currently, the rice yield plateauing trend is causing concern to the nation in achieving the future food grain demand projections. The replacement of improved varieties with newer ones, termed as varietal replacement, is critical in increasing the productivity. This study is an attempt to estimate the varietal replacement rate together with its effect on productivity and to examine the trend in rice production and productivity. The study was based both primary and secondary data. The information collected from 411 farm households in Palakkad plain agroecological zone is utilized for estimating the varietal replacement rate inversely in terms of weighted average age (WAA) and its effect on yield. The trend analysis was based on the secondary data on rice production and productivity data for a period of 60 years. The rice production and productivity trends in Kerala state as well as Palakkad district indicate stagnation tendency. The estimated WAA of 26.41 years confirms the existence of very low varietal replacement rate. The effect of WAA on yield was found to be negative at the rate of 23.85 Kg/Ha. The proper policies for refurbishment of public seed systems together with involvement of farmers and private firms in seed multiplication and distribution is critical to transfer the varietal gains to farmers and thereby ensuring better rice productivity.

Keywords: Varietal replacement, Weighted average age (WAA), Log-linear regression, Rice productivity

JEL Classification: Q10, Q12, Q13, Q57

Introduction

Rice is the staple food for more than half of the global population and major calorie provider for the marginalised people of Asia and Africa (FAO, 2023). Globally India secured second position in rice production after a successful era of green revolution. Despite of global rice yield plateauing trend, sustaining the gains from green revolution and extending them to new heights is the current challenge before the country. India has produced rice of 130.3 million tonnes from 46.4 Million hectares with an average yield of 2809 Kg/Ha as per the latest estimates (GOI, 2023). But the productivity level in India is far below the global average productivity. Minimal progress in improved agricultural technology adoption, unfavourable environment factors and inadequate effective policies are the general reasons for low productivity (De Groot, 2023). Literature review suggests that among the agricultural technology adoption, slow adoption of latest improved varieties or low varietal turnover is critically limiting the yield increase of major food grains. (Ray et.al, 2012; FAO, 2014; Atlin et. al, 2016; Checco, 2023).

The situation in Kerala state was not different from the national scenario. The state has produced 5.59 Lakh ton rice from an area of 1.93 lakh hectares and recorded productivity of 2884 kg/ha (GOK, 2023). The productivity remains higher than the productivity average of the country but fall far behind the global average. The public investments in research have encouraged to release around 70 improved rice varieties in Kerala. But most of the rice area in the state is dominated by old improved rice varieties which was released twenty or more years ago. The frequent replacement of improved varieties with new ones are critical in increasing productivity and to augment climate change adaptation (Krishna, et.al, 2014). The varietal depreciation can affect farmers especially small hold farmers by making them more vulnerable to climate and income risks. Often, enhanced yields are associated with improved variety replacements and farmers are mislaying this genetic gain from new varieties when they continue with old improved rice varieties. The low varietal turnover rate may

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possibly be contributing to yield stagnation. The present study is a humble attempt to estimate the varietal turnover and to analyse its effect on yield. The trends in rice productivity over decades were also explored. Further, factors that affect varietal turnover is examined. The identification of factors that influence the varietal replacement rate will enable us to make policy decisions to enhance the popularisation and adoption of new improved varieties and necessary agronomic practices to attain better productivity as well as sustained climate change adaptation

Data Sources and Methodology

The Palakkad plain agroecological zone is one among the five agroecological zones in the state, contributing maximum to the rice production was selected as the study area. The Palakkad plain accounts for 40 per cent of rice cultivation area and 43 per cent of the rice production in the state (GOK, 2023). The study used primary data obtained through the survey together with secondary data. The secondary data on area, production, productivity statistics of rice from 1963 to 2022 pertaining to state as well as Palakkad district was collected from the official site of Kerala state economics & statistics department. The sample size of 411 was fixed using Taro Yamane formula (i) as the population size was known from various secondary data sources.

$$n = N/(1+Ne^2) \quad \text{(i)}$$

Where, *n* - sample size, *N* -population size and *e* = error (0.05), level of precision.

Two-stage proportionate random sampling was adopted to select the respondents. The primary data on socio-economic characteristics of farmer, rice variety in use, source of seed, yield, details of cultivation practices etc were collected from selected farmers through personal interview method using pre-tested interview schedule. The survey was conducted during the second season rice cultivation period starting from November 2022.

Varietal turnover was estimated using an index of variety change termed as Weighted Average Age of varieties (WAA) proposed by Brennan and Byrelee in 1991.

$$WAA_j = \Sigma P_{ij} A_{ij} \quad (4)$$

WAA - Weighted Average Age of variety

P – Share of area in which the variety cultivated (Area weighted)

A – Number of years since the ith variety was officially released

i - Variety , j – farmer household

A log-linear regression model was used to examine the effect of varietal turnover on rice productivity.

$$Ln(Y_i) = A + B X_i + e \quad (6)$$

Y – Yield (Kg/Ha)

A – Intercept

B- Regression coefficient

X - Weighted Average Age of varieties (WAA) in years

e – Error term

Descriptive statistical methods used as per the requirement to arrive valid conclusions. Trend analysis was done by plotting graphs of time series data.

Results and Discussion

Socio-economic Characteristics of Sample

The socio-economic characteristics of sample households are presented in Table 1. All the farmers who participated in the survey were literate. The average age points out that the older generation is more involved in agriculture than the younger generation. Seventy percent of farmer participated in the survey belong to marginal category (< 1 ha). All the farm household utilized more than seventy five percent of the land holding for rice cultivation. On an average farmer were having experience of 25 years in rice cultivation.

Table 1 Socio-economic characteristics of the respondents

Characteristics	Sample Average (N = 411)
Age (Years)	56
Education (Years)	10
Experience (Years)	25
Average Annual income (Rs.)	1,87,689
Family size (Number of family members)	5
Land holding size (Hectares)	0.944

Trends in Rice Productivity

The rice production and productivity trends of Kerala state were presented graphically in figure 1. The production initially shown an increase but declined after that and presently tends to stagnate around 6 Lakh tonnes. The rice cultivation area is showing a declining trend throughout the period. The rice productivity levels were slowly increasing but have a propensity to stagnate towards the recent periods.

The Palakkad district rice statistics trend analysis is presented in figure 2. On examining the production trend, the rice production is showing a decreasing trend and tends to settle around 2 lakh tonnes. The negative trend is due to the strong negative tendency exhibited by rice cultivation area. The productivity is moving upward slowly and incline to stagnate around 3000 kg/ha. The generalised trend of plateauing rice production and productivity at state and district level was observed.

Varietal Replacement Rate

The area-weighted average year (WAA) was estimated

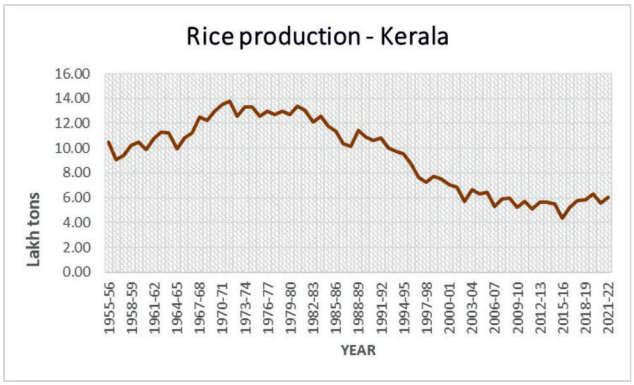

Figure 2: Rice production and productivity trends in Palakkad district

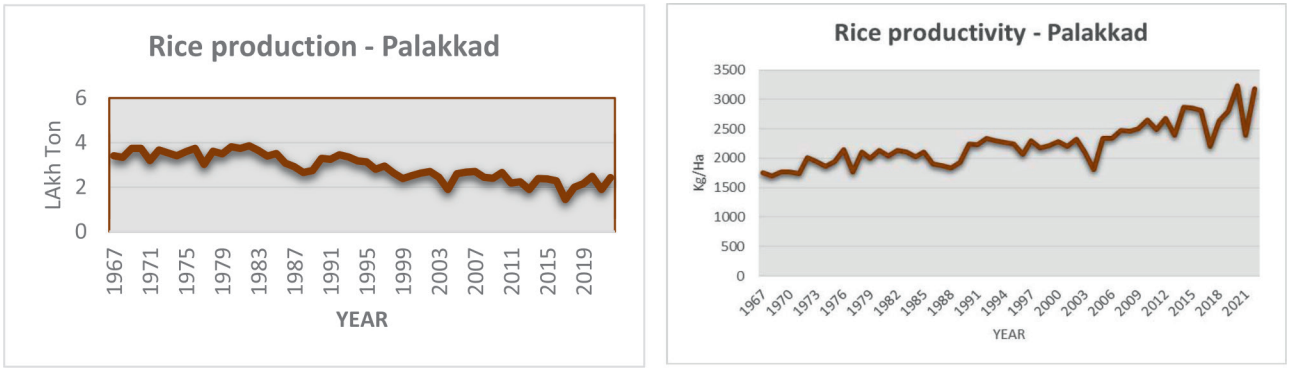

Figure 1: Rice production and productivity trends in Kerala state

for knowing the inverse speed of varietal replacement at present. The WAA was estimated for the whole sample as well as for farmer categories such as marginal and small farmer category (< 2ha) and medium& large farmer category (> 2ha). The WAA is 26.41 years (Table 2) implies that the low speed of variety replacement. The estimates reveal that marginal and small farmers are slower than medium and large farmers in replacing the variety. Thismay be due to continued popularity of old improved rice varieties along with lack of information about new varieties. There is an urgent need for popularisation of new varieties in campaign mode before the new variety mises the chances of increasing productivity at farm level in this changing climate scenario.

Table 2 Varietal replacement rate in terms of WAA,2022

Particulars	Weighted Average Age (WAA)
Marginal and Small farmers (n_1 = 377)	26.42
Medium and Large farmers (n_2 = 34)	23.26
Overall (N = 411)	26.41

Effect of WAA on yield

The correlation between the grain yield (kg/ha) and WAA was found to be -0.156, implying that WAA is reducing the yield. The relationship was confirmed by regression analysis using log-linear model. The results (Table 3) reveal that varietal replacement rate in terms of WAA is reducing the grain yield significantly. The antilog of regression coefficient of WAA states that with every one-year increase in WAA, the grain yield reduces by 23.85 kg/ha. In other words, the one-year reduction in WAA will increase the average rice productivity of the state by 0.83 percent.

Table 3 Estimates of log-linear model

Variable	Coefficient	Std. Error	P value
WAA	-3.170**	1.025	0.024
Constant	8.674***	0.020	0.000
N		411	
Adj. R^2		0.235	

*Note: *** denotes significance at 1%, ** denotes significance at 5%,*

Conclusion and Policy Implications

Then trend analysis of state wise as well as district wise rice productivity points to the tendency of yield stagnation.

The results on farm household survey data analysis shows that WAA is currently 26.41 and is higher for small and marginal farmers compared to medium and large farmers. The varietal replacement rate is inversely related to WAA. Therefore, there exist very low varietal replacement rate. The effect of WAA on grain yield was significantly negative. The one-year reduction in WAA will increase the grain yield by 23.85 kg/ha. The change in attitude of farmer for adopting new improved varieties may be made possible by proper field demonstration efforts, trainings, new variety popularisation campaigns etc. Expanding seed production and distribution programs among innovative farmers in the locality will improve the new variety adoption rates.The proper policies for refurbishment of public seed development and distribution systems together with involvement of farmers and private firms in seed multiplication and distribution especially in remote areas is critical to transfer the varietal gains to farmers and thereby ensuring better productivity.

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