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DYNAMICS OF PADDY CULTIVATION IN KERALA (2005–2020): AN ANALYSIS OF DECLINING AREA, RISING PRODUCTIVITY, AND FUTURE OF FOOD SECURITY

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ABSTRACT

This study provides a comprehensive analysis of the paddy cultivation sector in the state of Kerala, India, from 2005 to 2020, a period characterized by significant structural transformations. The research addresses the central paradox of a sharp and continuous decline in the area under paddy cultivation occurring concurrently with a steady increase in land productivity. The primary objectives of this paper are to empirically analyse the trends in land utilization, including both cultivated and fallow lands; to examine the divergent trajectories of total production and per-hectare productivity; and to evaluate the profound implications of these trends for the state's food security. The methodology is based on a descriptive and comparative analysis of time-series data compiled from official government sources, including the Kerala Directorate of Economics and Statistics and National Sample Survey reports. The findings reveal a substantial contraction of approximately 25.6% in the cultivated paddy area over the 15-year period. In stark contrast, productivity demonstrated a robust increase of 35.3%, rising from approximately 2,285 kg/ha to over 3,090 kg/ha. Despite these efficiency gains, the state's domestic production has stagnated, consistently meeting only about 10% of its total rice consumption, thereby creating a significant food security deficit. Scenario-based analysis indicates that even under optimistic assumptions of full land utilization and achieving national productivity benchmarks, Kerala cannot attain self-sufficiency. The study concludes that productivity enhancements alone are insufficient to address the state's food security challenges. It underscores the critical need for an integrated policy framework that not only promotes technological adoption and climate resilience but also addresses the underlying socio-economic drivers of land conversion, thereby ensuring the economic viability and ecological sustainability of paddy farming in Kerala.

KEYWORDS: *Paddy Cultivation, Land Use Change, Food Security, Agricultural Productivity, Kerala, Agricultural Policy*

1. INTRODUCTION

1.1 The Agrarian and Ecological Context of Kerala

Paddy (rice) cultivation is deeply interwoven with the history, culture, and economy of the Indian state of Kerala. As the staple food for the majority, rice has traditionally been the keystone of the state's agrarian economy, with the lush expanse of paddy fields defining its iconic landscape [1]. Kerala's unique geography, characterized by high rainfall during the monsoons and an intricate network of rivers, backwaters, and wetlands, provides a naturally conducive environment for rice farming. This has historically supported up to three distinct cultivation seasons: *Virippu* (April-July), *Mundakan* (September-December), and in certain regions, *Punja* (January-April), ensuring a consistent agricultural cycle.

Beyond their role in food production, paddy fields perform critical ecological functions that are integral to the state's environmental stability. These agroecosystems act as natural sponges, facilitating groundwater recharge, which is vital in a densely populated state [2]. They also serve as essential drainage basins that mitigate the impact of flooding during periods of intense rainfall, a function of increasing importance in an era of climate volatility [1]. The conversion of these lands, therefore, represents not just a loss of agricultural capacity but also a degradation of natural infrastructure that protects against environmental hazards. The devastating floods of 2018, which caused widespread damage to the state's agricultural sector, underscored the vulnerabilities associated with the loss of these natural water management systems. The decline in paddy cultivation is thus a multifaceted issue, posing a dual threat to Kerala's food security and its ecological resilience.

1.2 The Long-Term Trajectory of Decline: A Historical Perspective
The period under examination in this study, 2005 to 2020, does not represent the beginning of the decline in paddy cultivation but rather a continuation of a profound structural shift in Kerala's agrarian economy that began in the late 1970s. Following the formation of the state, the area under paddy cultivation initially expanded, reaching a peak of approximately 880,000 hectares in the mid-1970s. At that time, rice was the state's dominant crop, accounting for nearly a third of the gross cropped area.

However, from the 1980s onward, a steady and precipitous decline began. The area under cultivation fell from 850,000 hectares in 1980–81 to 560,000 hectares in 1990–91, and further to just 230,000 hectares by 2007–08. This long-term trend has been driven by a fundamental change in cropping patterns, with farmers shifting from subsistence food crops to more remunerative perennial cash crops, most notably rubber and coconut. By the start of the 21st century, rice had been relegated to the third position among Kerala's crops in terms of cultivated area, far behind these commercial alternatives. The data from 2005–2020 thus captures a mature phase of this transformation, where the forces driving land conversion have become deeply entrenched. Understanding this historical context is crucial for interpreting the contemporary data and for formulating policies that address the root causes of the sector's decline rather than merely its symptoms.

1.3 Research Problem and Objectives
This paper examines a central paradox in Kerala's rice farming: a continuous and significant decline in the total land area used for cultivation is occurring at the same time as a consistent and impressive rise in land productivity, meaning more rice is grown per hectare. While this loss of farmland is a direct threat to the state's food supply and ecological balance, the simultaneous increase in farming efficiency points to the successful adoption of modern technology and improved agricultural methods. This conflicting situation raises critical questions about the long-term sustainability of the sector, the net impact on food security, and the effectiveness of government agricultural policy.
To investigate this complex dynamic, this study pursues the following primary objectives:

1. To analyse the trends in land utilization for paddy cultivation in Kerala from 2005 to 2020, including a detailed examination of the dynamics between actively cultivated areas and various categories of fallow land.
2. To examine the divergent trends of total paddy production and per-hectare productivity over the same period, identifying key variations and their potential causes.
3. To investigate the gap between domestic paddy production and estimated consumption, thereby quantifying the state's food security deficit and its dependence on external food sources.
4. To evaluate the impact of utilizing the existing fallow land and raising Kerala's agricultural productivity to meet the national average

By addressing these objectives, this paper aims to provide a robust, evidence-based analysis of the challenges and opportunities facing Kerala's paddy sector and to contribute to the formulation of more effective and holistic agricultural policies.

2. DATA AND ANALYTICAL FRAMEWORK
2.1 Data Sources and Period
This study is based on the analysis of secondary time-series data covering the 16-year period from 2005 to 2020. The data on agricultural land use, production, and productivity were primarily compiled from official publications and digital repositories managed by the Government of Kerala. Key sources include the annual reports of the Directorate of Economics and Statistics and the Kerala Open Government Data portal, which provide reliable and consistent state-level statistics.

Data for estimating state-wide rice consumption were derived from two sources. The per capita consumption rate was based on the 66th round report of the National Sample Survey (NSS), a comprehensive nationwide household survey. This per capita figure was then multiplied by annual population estimates for Kerala, which were obtained from reputable demographic data aggregators. It is noted that the dataset for production and productivity in the source material omits the year 2016; this is treated as a missing data point in the trend analysis, though qualitative observations from the source indicate that production was exceptionally low in that year due to a severe drought.

2.2 Key Variable Definitions and Measurement
To ensure clarity and analytical rigor, the key variables used in this study are defined as follows, consistent with official government classifications:

- **Cultivated Area:** The total land area, measured in hectares (ha), utilized for the cultivation of paddy within a given agricultural year.
- **Uncultivated/Fallow Land:** This category is disaggregated into three distinct classifications based on the duration of non-use:
    - *Current Fallow:* Land which is left without cultivation for one agricultural year or less.
    - *Other Fallow:* Land that has been taken up for cultivation previously but is temporarily out of cultivation for a period of not less than one year and not more than five years.
    - *Cultivable Waste:* Land available for cultivation but not cultivated during the last five or more consecutive years.
- **Production:** The total annual output of paddy, measured in metric tons (MT).
- **Productivity:** A measure of land efficiency, calculated as the total production in kilograms (kg) divided by the total cultivated area in hectares (ha), expressed as kilogram per hectare (kg/ha).
- **Consumption:** An estimate of the total annual rice requirement for the state's population. It is calculated by multiplying the annual population by the per capita annual rice consumption figure of 177.62 kg, as reported by the NSS.

2.3 Analytical Approach

The study employs a multi-stage analytical approach to interpret the collected data.
First, descriptive statistics are used to summarize the fundamental trends and central tendencies of the key variables over the 2005–2020 period. This includes calculating means, ranges, and percentage changes to provide a foundational understanding of the sector's dynamics.

Second, trend analysis is conducted to visualize and interpret the temporal patterns in land use, production, and productivity. This involves plotting the time-series data and analysing year-over-year percentage changes to identify periods of acceleration, deceleration, or reversal in trends.

Third, a comparative analysis is performed to compare domestic production against estimated consumption. This allows for the quantification of the food security gap, which is expressed both in absolute terms (metric tons) and as a self-sufficiency rate (production as a percentage of consumption).

Finally, the study critically reviews a scenario-based analysis to evaluate the potential impact of two hypothetical policy interventions: (1) bringing all categories of fallow land under cultivation at current productivity levels, and (2) achieving national-level productivity benchmarks on all potentially cultivable land. This forward-looking analysis helps to assess the probable limits of policy interventions aimed at enhancing the state's self-sufficiency in rice.

3. RESULTS: EMPIRICAL TRENDS IN KERALA'S PADDY SECTOR (2005-2020)

3.1 The Reduction of Cultivated Area and the Dynamics of Fallow Land

The empirical data from 2005 to 2020 confirm a continued and significant contraction in the area dedicated to paddy cultivation in Kerala. As detailed in Table 1, the cultivated area decreased from 275,742 hectares in 2005 to 205,040 hectares in 2020, representing a net decline of 70,702 hectares, or approximately 25.6%, over the period. This downward trend was not monotonic; it reached its lowest point in 2016 at 171,398 hectares, a year marked by a severe drought that likely discouraged cultivation on marginal lands. Following this trough, a modest recovery was observed, with the cultivated area increasing in subsequent years, though it remained well below the levels seen at the beginning of the period.

This decline in active cultivation occurred within the context of a shrinking overall land base potentially available for paddy. The total potential area (cultivated plus all fallow categories) decreased by 13.4%, from 457,212 hectares in 2005 to 396,021 hectares in 2020, suggesting a permanent conversion of some agricultural land to non-agricultural uses. Within this shrinking base, the proportion of land left fallow increased. The ratio of fallow land to cultivated land rose from 0.66 in 2005 to a peak of 1.34 in the drought year of 2016, indicating that for a time, more land suitable for paddy was left idle than was being actively farmed. An analysis of the fallow land composition (Table 1) shows that while all categories fluctuated, "cultivable waste", land left uncultivated for over five years, remained a substantial component, representing a long-term withdrawal of land from production that would be difficult and costly to reverse.

Table 1: Trends in Cultivated and Fallow Land Categories in Kerala (2005-2020)

Year	Cultivated Area (ha)	Current Fallow (ha)	Other Fallow (ha)	Cultivable Waste (ha)	Total Fallow Land (ha)	Total Potential Area (ha)
2005	275,742	66,133	45,171	70,166	181,470	457,212
2006	263,529	90,288	47,144	81,651	219,083	482,612
2007	228,938	92,764	45,214	82,953	220,931	449,869
2008	234,265	67,759	45,955	96,193	209,907	444,172
2009	234,013	76,945	45,374	98,014	220,333	454,346
2010	213,187	91,665	51,943	76,028	219,636	432,823
2011	208,160	95,437	57,670	77,056	230,163	438,323
2012	197,277	96,596	55,835	76,744	229,175	426,452
2013	199,611	70,976	57,346	97,069	225,391	425,002
2014	198,159	65,329	54,741	100,676	220,746	418,905
2015	196,870	99,499	55,258	70,003	224,760	421,630
2016	171,398	101,379	55,530	72,008	228,917	400,315
2017	194,235	96,491	49,461	57,522	203,474	397,709
2018	202,907	96,497	45,541	57,464	199,502	402,409
2019	198,180	99,810	46,931	57,387	204,128	402,308
2020	205,040	93,974	42,752	54,255	190,981	396,021

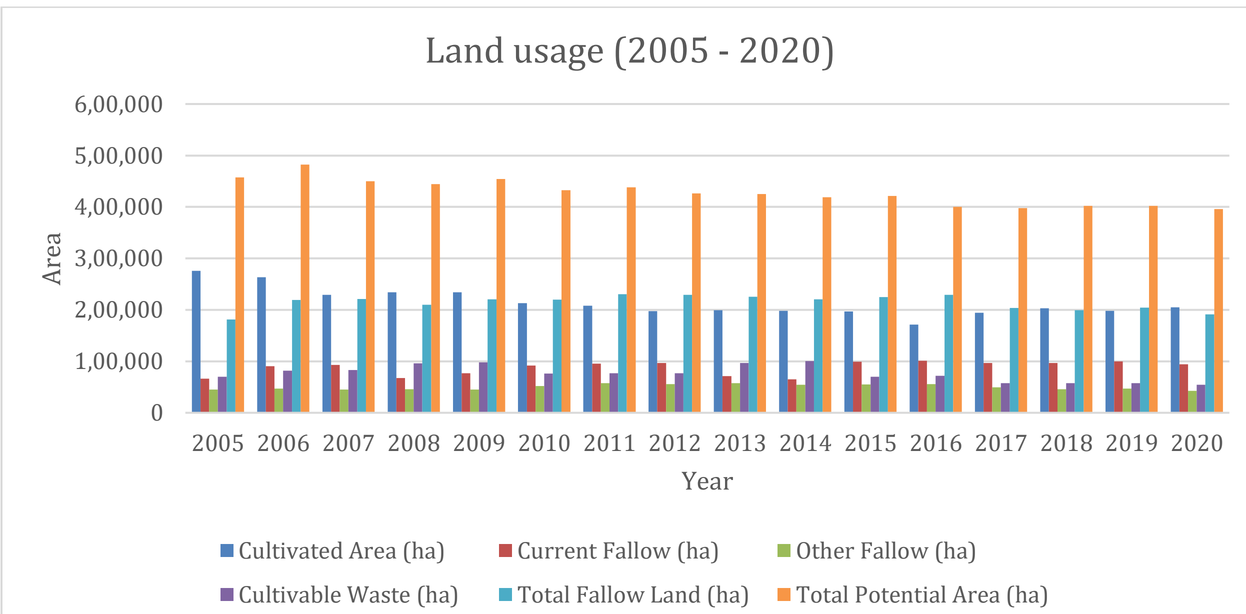

Figure 1: Bar chart of the land used and unused for paddy cultivation (2005-2020)

3.2 Production and Productivity: A Story of Divergence

In stark contrast to the declining trend in cultivated area, the productivity of paddy land in Kerala demonstrated a clear, consistent, and substantial improvement over the study period. As shown in Table 2, the average yield increased from 2,284.74 kg/ha in 2005 to a high of 3,090.81 kg/ha in 2020. This represents a total increase of 35.3%, signalling significant gains in efficiency through the adoption of better technologies, high-yielding seed varieties, and improved agronomic practices.

This rising productivity, however, was not sufficient to drive a corresponding increase in total production due to the prevailing consequence of having less farmland. Total annual production fluctuated significantly, starting at 630,000 MT in 2005 and ending at a nearly identical 633,739 MT in 2020. The period was marked by considerable volatility, with production dipping below 530,000 MT in 2007 and 2010. The data reveals a fragile "decoupling" of production from land area; while farmers were producing more per unit of land, the reduction in the total number of units under cultivation largely neutralized these gains.

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The period after 2017 is particularly enlightening. In 2018, for instance, a 4% increase in area was accompanied by an 11% increase in production, and in 2020, a 3% increase in area yielded an 8% increase in production. This indicates that the recovery in cultivation area post-2016 was combined with continued intensification, leading to disproportionately positive production outcomes. However, the system's vulnerability to climatic shocks remains a critical concern. The sharp drop in cultivated area during the 2016 drought suggests that these productivity gains are depending on favourable weather conditions, and the agricultural system lacks the resilience to maintain output during periods of environmental stress.

Table 2: Area, Production, and Productivity of Paddy in Kerala (2005-2020)

Year	Area (Hectare)	Production (MT)	Productivity (kg/Hectare)
2005	275,742	630,000	2,284.74
2006	263,529	641,575	2,434.55
2007	228,938	528,488	2,308.43
2008	234,265	590,241	2,519.54
2009	234,013	598,339	2,556.86
2010	213,187	522,738	2,452.02
2011	208,160	568,993	2,733.44
2012	197,277	580,829	2,944.23
2013	199,611	564,325	2,827.12
2014	198,159	562,092	2,836.57
2015	196,870	549,275	2,790.04
2017	194,235	521,310	2,683.91
2018	202,907	578,256	2,849.86
2019	198,180	587,078	2,962.35
2020	205,040	633,739	3,090.81

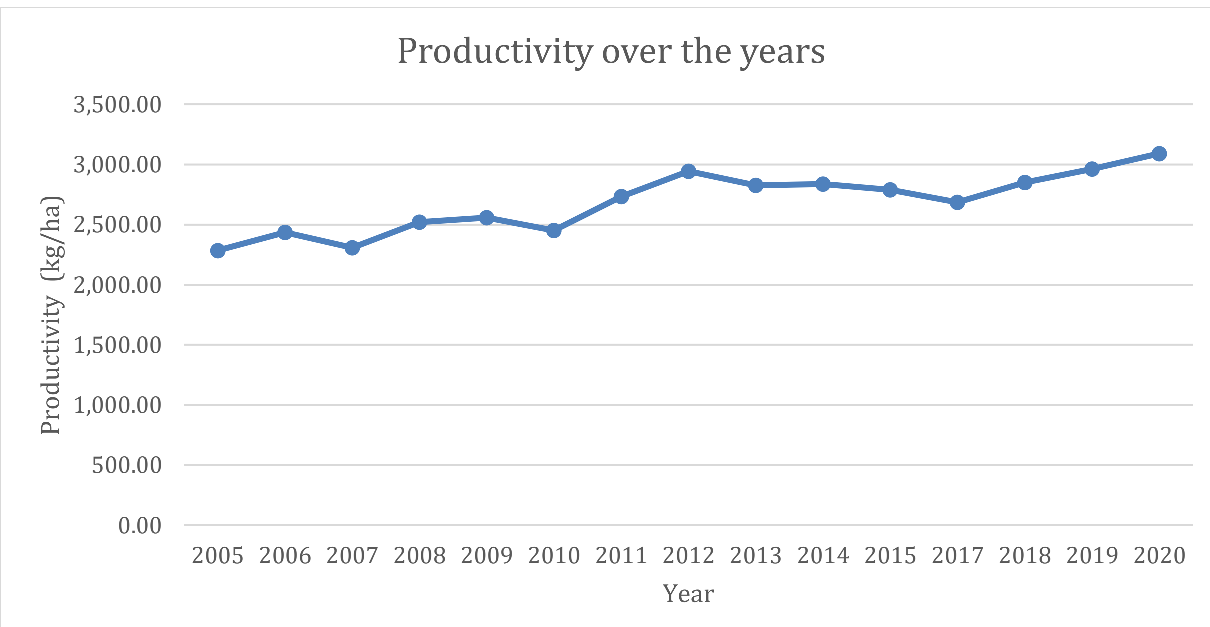

Figure 2: Trends in productivity of paddy in Kerala (2005-2020)

4. DISCUSSION: DRIVERS, CHALLENGES, AND IMPLICATIONS

4.1 The Widening Gap: Production, Consumption, and Food Security

The analysis of production and consumption data reveals a vast and persistent gap between Kerala's domestic rice supply and its demand, a defining feature of the state's food security landscape. As shown in Table 3, while annual paddy production fluctuated in a range of approximately 520,000 to 640,000 metric tons, the estimated consumption of rice grew steadily with the population, increasing from 5.54 million MT in 2005 to 6.27 million MT in 2020.

This has resulted in a structural food deficit of staggering proportions. The self-sufficiency rate, the percentage of consumption met by in-state production remained consistently low throughout the period, hovering between 9% and 11%. This means that for its staple food, Kerala is dependent on external sources for approximately 90% of its needs. This confirms Kerala's status as one of India's most food-deficit states, a situation that has worsened from a 50% deficit in the 1960s to over 85% in the contemporary era [2]. This heavy reliance on interstate trade and the central government's Public Distribution System (PDS) creates a significant vulnerability. While the PDS has historically served as a critical buffer, ensuring food availability and accessibility for a large portion of the population, its effectiveness is subject to national policy shifts, such as the move from a universal to a targeted system, and logistical challenges [3]. Any disruption in national supply chains, whether due to climatic events, policy changes, or economic shocks in producer states, could have severe consequences for food security in Kerala.

Table 3: A Comparative Analysis of Paddy Production and Estimated Consumption in Kerala (2005-2020)

Year	Population	Estimated Consumption (MT)	Domestic Production (MT)	Deficit (MT)	Self-Sufficiency Rate (%)
2005	31,196,176	5,541,190	629,987	4,911,203	11.4%
2006	31,469,764	5,589,785	641,575	4,948,210	11.5%
2007	31,743,352	5,638,381	528,488	5,109,893	9.4%
2008	32,016,940	5,686,977	590,241	5,096,736	10.4%
2009	32,290,527	5,735,573	598,339	5,137,234	10.4%
2010	32,564,115	5,784,168	522,738	5,261,430	9.0%
2011	32,837,703	5,832,764	568,993	5,263,771	9.8%
2012	33,111,291	5,881,360	580,829	5,300,531	9.9%
2013	33,384,879	5,929,956	564,325	5,365,631	9.5%
2014	33,658,466	5,978,551	562,092	5,416,459	9.4%
2015	33,932,054	6,027,147	549,275	5,477,872	9.1%
2017	34,479,230	6,124,339	521,310	5,603,029	8.5%
2018	34,752,818	6,172,935	578,256	5,594,679	9.4%
2019	35,026,405	6,221,530	587,078	5,634,452	9.4%
2020	35,299,993	6,270,126	633,739	5,636,387	10.1%

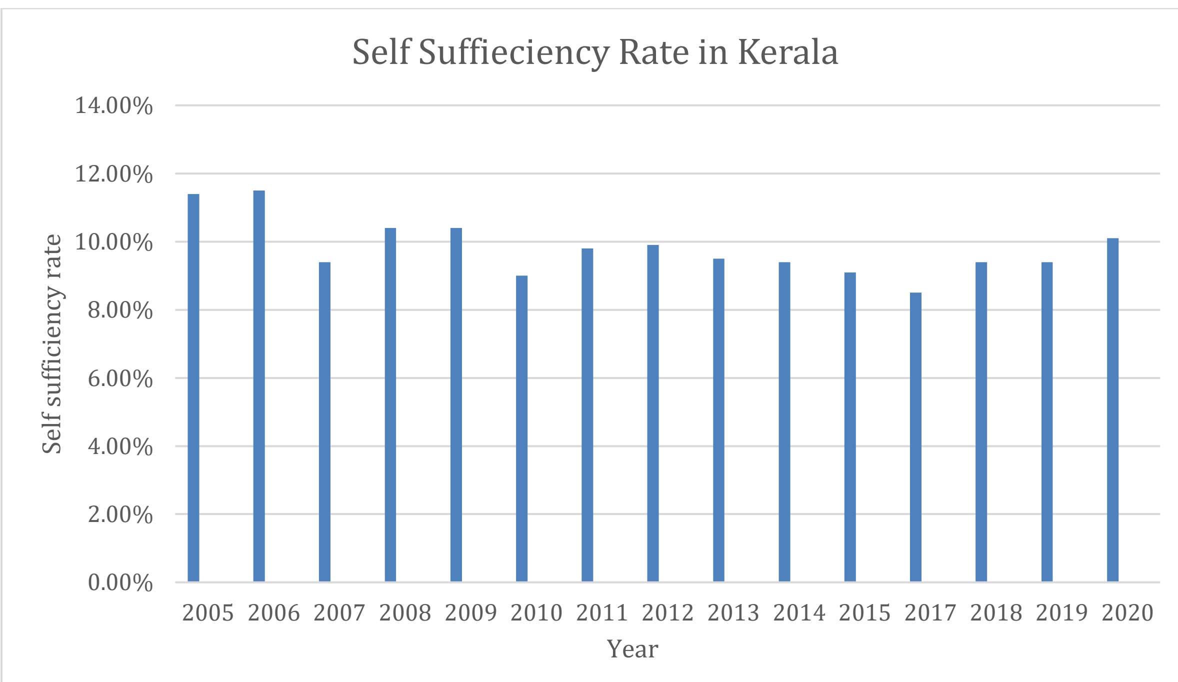

Figure 3: Self-sufficiency rate of paddy production in Kerala (2005-2020)

4.2 Unpacking the Decline: Socio-Economic and Structural Drivers

The contraction of paddy cultivation in Kerala is not the result of a single factor but rather a consequence of a complex interplay of deep-seated socio-economic and structural forces that have systematically reduced the viability and attractiveness of paddy farming. Decades of research have identified a consistent set of drivers that explain this long-term trend.

First, the **economic viability** of paddy cultivation is fundamentally challenged by its low profitability relative to other land use options [4]. The returns from labour-intensive paddy are often dwarfed by those from less demanding and more lucrative cash crops like rubber, coconut, and banana. This economic disparity creates a powerful incentive for farmers to convert their land. The problem is compounded by high and rising input costs for fertilizers, pesticides, and machinery, which squeeze already narrow profit margins [5].

Second, **labour market dynamics** present a formidable structural constraint. Kerala has experienced a rapid structural transformation of its workforce, with labour moving out of agriculture and into higher-paying sectors like construction and services at a much faster rate than the rest of India. This has led to acute seasonal labour shortages, particularly for critical, time-sensitive operations like transplanting and harvesting [4]. The resulting high wage rates for agricultural labour constitute a major portion of the total cost of cultivation, further eroding profitability [5].

Third, intense **competition for land** from non-agricultural sectors is a major driver of conversion. High population density, coupled with rapid urbanization and a robust real estate market fuelled by remittance inflows, has transformed land into a highly valuable and speculative asset. For many farming families, the opportunity cost of continuing paddy cultivation is immense, and the pressure to sell land for residential or commercial development is often irresistible [6]. Finally, a host of **farm-level constraints** add to the burden on cultivators. These include persistent challenges with pest and weed management, crop damage from wild animals in areas bordering forests, and inadequate infrastructure for storage and processing [7]. Furthermore, inefficiencies in the government procurement system, particularly delays in receiving payment for produce, create severe cash flow problems for farmers, hindering their ability to invest in the next cropping season and adding a layer of financial uncertainty to an already risky enterprise [8].

4.3 Assessing Potential Futures: A Scenario-Based Analysis

To access the potential for enhancing Kerala's self-sufficiency in rice, a scenario-based analysis was conducted to model the impact of two major policy thrusts: expanding the area under cultivation by utilizing fallow lands, and increasing productivity to match national benchmarks. The results of this analysis, summarized in Table 4, provide a sobering perspective on the limits of what can be achieved.

Scenario 1: Full Utilization of Fallow Land. In this scenario, it is assumed that all land classified as "current fallow," "other fallow," and "cultivable waste" is brought back into paddy cultivation. If this entire potential area had been cultivated in 2020 at the state's achieved productivity level of 3,091 kg/ha, total production would have reached approximately 1.22 million MT. While this represents a near-doubling of the actual production, it would still only meet 19.5% of the state's estimated consumption for that year. This highlights that even a complete reversal of land fallowing would leave a food deficit of over 80%.

Scenario 2: Achieving National Productivity Benchmarks. This scenario models a more ambitious goal where Kerala not only cultivates all potential land but also achieves significantly higher yields. If the state were to match the maximum productivity achieved elsewhere in India (taken as 4,600 kg/ha), it could produce approximately 1.82 million MT, sufficient to meet 29.1% of its 2020 consumption.[1] Pushing this further to the targeted national productivity of 5,018 kg/ha would yield nearly 1.99 million MT, covering 31.7% of consumption.

The crucial conclusion drawn from these scenarios is that even under the most optimistic and likely unattainable conditions, cultivating every available hectare at productivity levels far exceeding the state's historical best, Kerala cannot achieve self-sufficiency in rice. The structural deficit is simply too large to be closed by supply-side interventions within the state's geographical and economic constraints. This finding has profound policy implications. It suggests that the overarching goal of agricultural policy should not be the futile pursuit of complete self-sufficiency, but rather the more practical objective of achieving a strategic level of production that enhances resilience. The focus must shift from maximizing output at all costs to optimizing the agricultural system for a combination of goals: supporting rural livelihoods, preserving ecological stability, and maintaining a strategic buffer against national food supply disruptions, while acknowledging the continued and necessary role of interstate trade and the PDS in ensuring food security.

Table 4: Scenario Analysis of Potential Paddy Production Under Enhanced Land Use and Productivity (Based on 2020 Data)

Scenario	Total Area Cultivated (ha)	Assumed Productivity (kg/ha)	Potential Production (MT)	Percentage of Consumption Met
Actual Performance (2020)	205,040	3,091	633,739	10.1%
Scenario 1: Full Land Utilization	396,021	3,091 (Actual 2020)	1,224,024	19.5%
Scenario 2a: High Productivity	396,021	4,600 (National Max)	1,821,697	29.1%
Scenario 2b: Target Productivity	396,021	5,018 (National Target)	1,987,233	31.7%

5. CONCLUSION AND POLICY RECOMMENDATIONS

5.1 Key Findings

This analysis of Kerala's paddy sector from 2005 to 2020 reveals a sector in the grip of a profound and challenging transition. The primary findings confirm that the period was characterized by a significant contraction of land under paddy cultivation, a continuation of a multi-decade trend driven by powerful socio-economic forces including low profitability, labour scarcity, and intense competition from non-agricultural land uses. Concurrently, the sector has demonstrated remarkable progress in land productivity, with yields per hectare increasing by over 35%.

However, these impressive efficiency gains have been largely insufficient to offset the impact of the shrinking land base. As a result, total paddy production has remained stagnant, while a growing population has led to a widening gap between supply and demand. The state's self-sufficiency in its staple food has languished at a critically low level of around 10%, cementing its dependence on external sources and highlighting its vulnerability to supply chain disruptions. The scenario-based analysis further underscores the scale of this challenge, demonstrating that even under the most optimistic assumptions of land and yield enhancement, complete food self-sufficiency remains an unattainable goal. The core conclusion of this study is that the future of paddy cultivation in Kerala cannot be secured through a narrow focus on technical solutions and production maximization alone. A sustainable path forward requires a holistic policy approach that addresses the fundamental economic and structural challenges facing farmers, while also recognizing the vital ecological role of paddy agroecosystems.

5.2 Policies for a Sustainable Paddy Sector

Based on the empirical findings and the analysis of structural drivers, a multi-pronged policy strategy is recommended to foster a more viable, resilient, and sustainable paddy sector in Kerala.

1. **Enhancing Economic Viability for Farmers:** The primary intervention must be to improve the profitability of paddy cultivation. This requires strengthening the state's procurement system to guarantee prompt and full payment to farmers, a critical issue that currently undermines financial stability[8] . The Minimum Support Price (MSP) mechanism should be made more dynamic, linking it directly to a realistic and annually updated cost of cultivation to ensure that it provides a genuine safety net against rising input and labour costs [5].
2. **Strategic Land Use Management and Conservation:** The continued conversion of paddy land must be curbed through stricter and more transparent enforcement of the Kerala Conservation of Paddy Land and Wetland Act (2008) [9]. Alongside regulation, positive incentives are needed to encourage landowners to keep their fields under cultivation. Schemes that provide a royalty or direct income support to the owners of paddy lands, contingent on their continued use for cultivation, can help offset the opportunity cost of not converting the land.
3. **Building Climate Resilience and Recognizing Ecological Services:** Future policy must proactively address the sector's vulnerability to climate change. It is imperative to scale up and mainstream initiatives like the World Bank-supported KERA project, which promotes climate-resilient practices such as the Alternate Wetting and Drying (AWD) technique for water conservation and methane emission reduction. A key innovation of this project is the introduction of a Payment for Ecosystem Services (PES) system, which would provide farmers

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with an additional income stream for the public goods they provide, such as groundwater recharge and flood mitigation. Institutionalizing PES would fundamentally alter the economic calculus of paddy farming, making conservation economically rewarding and aligning the interests of farmers with the broader environmental well-being of the state.

5.3 Limitations and Avenues for Future Research

This study, while comprehensive at the state level, has certain limitations. Its reliance on aggregated data may obscure significant regional and district-level variations in trends, challenges, and policy effectiveness. The analysis of fallow land dynamics, for example, would benefit from a more granular understanding of why specific parcels of land are left uncultivated.

Therefore, several avenues for future research are recommended. There is a pressing need for micro-level, farm-household surveys to conduct detailed economic analyses of the profitability of paddy cultivation across different agro-ecological zones, such as the unique wetland systems of Kuttanad and the canal-irrigated plains of Palakkad. Further research should also focus on impact evaluations of specific government interventions, such as the fallow land cultivation scheme or mechanization subsidies, to assess their cost-effectiveness and identify best practices. Finally, longitudinal studies on the socio-economic impacts of paddy land conversion on rural communities could provide valuable insights into the long-term consequences of this agrarian transformation for livelihoods, social equity, and community resilience.

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