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Transforming Fallow Lands

An Impact Evaluation of the Comprehensive Rice Fallow Management (CRFM) Program in Odisha

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Introduction

The Comprehensive Rice Fallow Management (CRFM) program, initiated by the Department of Agriculture & Farmers' Empowerment (DAFE), Government of Odisha, is a program to address the underutilization of rice fallow lands in Odisha, particularly during the Rabi (post-monsoon) season which occurs following the Kharif (monsoon) paddy harvest. CRFM was implemented to encourage cultivation of pulses and oilseeds that thrive on residual soil moisture. The CRFM program was implemented in 20 districts of Odisha, in collaboration with the Consultative Group on International Agricultural Research (CGIAR) and the Indian Council of Agricultural Research (ICAR), Government of India empaneled agencies that have a presence in the state and prior experience in similar programs. In the remaining 10 districts of the state, the CRFM program was implemented by the state government's Chief District Agriculture Officers (CDAOs). The impacts of CRFM interventions evaluated in this study comprise crop demonstrations organized in clusters of at least 20 hectares, with crops like black gram, green gram, chickpeas, lentils, grass peas, sesamum, and mustard.

Odisha's strides in transforming fallow rice lands into productive agricultural areas stand out as a significant achievement. CRFM programs have also been carried out in Chhattisgarh, Jharkhand, West Bengal, and Madhya Pradesh, focusing on fallow land utilization through improved seeds, irrigation infrastructure, mechanization, and market linkages. This evaluation of CRFM looks at outcomes in terms of convergence of fallows, acreage and yields of cultivated crops that have followed from conversion of fallow lands, comprising the following research questions:

- What is the effect of CRFM on the utilization of fallow lands considering soil moisture and rainfall in the region?
- Upon utilization of fallow lands, what are the effects on acreage and yields of pulses and oilseeds grown on the converted fallow lands?

Data and Methodology

The evaluation used remote sensing data employing a supervised machine learning classification algorithm to estimate areas under rice fallow and rice cropping. Data sources included Sentinel-2 satellite imagery, SMAP soil moisture data, and CHIRPS rainfall datasets (2018-2023). A rice crop mask identified Kharif season crop areas and NDVI was used to distinguish crops from non-crop land. Cloud masking was performed to ensure accuracy. To further ensure robustness, cloud masking was performed to remove cloud-covered pixels, ensuring accurate NDVI calculations for the period November 1 to April 30 (covering the Rabi season) for each year of the 2018 to 2023 period. Using remote sensing, we identify the area under rice fallow and the area under rice cropping, and we identify areas where intervention seems most likely to be beneficial based on soil quality, climate, and agricultural potential.

We implemented a novel approach for matching observations from the CRFM database (20 districts of Odisha) with data from the Krushak Odisha Portal (KOP). To assess production and productivity impacts, CRFM beneficiary data was matched with KOP records using anonymized Aadhar numbers. Using these unique identifiers, CRFM beneficiaries were mapped to the corresponding farm records from the KOP. This mapping allowed for individualized data analysis by linking area and productivity information from the CRFM Portal with the demographic and farm-specific data from KOP. In the case of the 10 districts, data was sourced from the National Informatics Centre (NIC) and subsequently mapped to KOP. In this mapping process, the NIC team applied a similar approach, utilizing key beneficiary identifiers to ensure accurate linkage with the KOP.

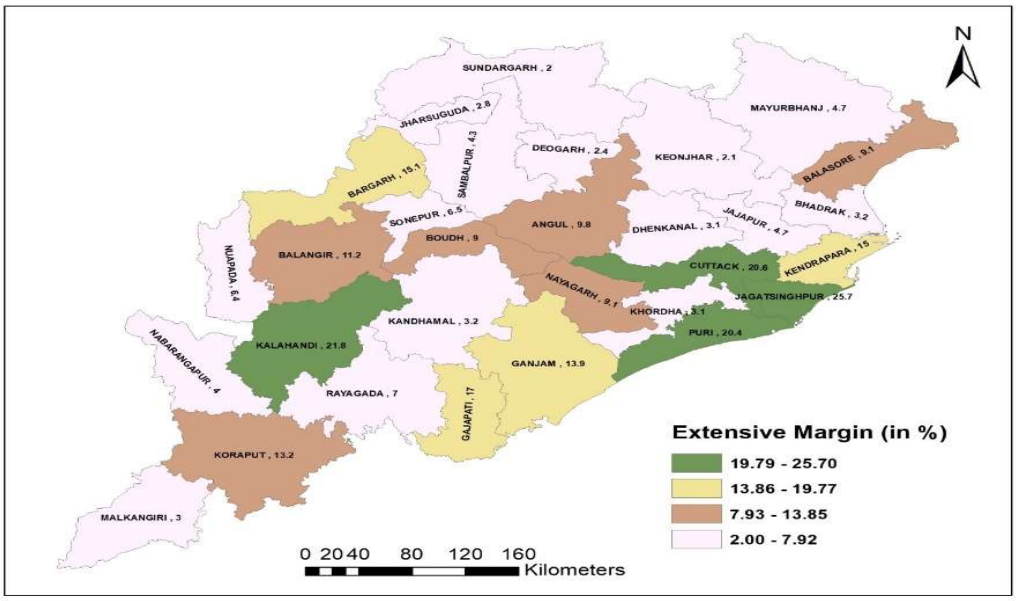
In principle, evaluation of CRFM has several options for exploiting treatment variations. If CRFM interventions were implemented over time, then the same location could constitute both the treated and the untreated (control) group, based on when data was gathered at that location. Unfortunately, that information is unavailable. As all 30 districts of Odisha are sites for CRFM, and without data on variations in timing of interventions or the incidence of treatment and control contexts across locations (districts), we rely on differences in treatment intensity in CRFM to evaluate the impact. The evaluation categorized areas into high-intensity and low-intensity CRFM based on median land proportion under CRFM, implementing Duflo and Saez (2002) approach. Impacts were evaluated using Propensity Score Matching (PSM), Coarsened Exact Matching (CEM), and Inverse Probability Weighted Regression Adjustment (IPWRA) methods.

Results and Findings

Utilization of Rice Fallows

Using the remote sensing data, we used the extensive and intensive margin approach to understand the change in fallow land in different scenarios. In the extensive margin, we looked at the percentage change in the areas of land that were consistently left fallow prior to CRFM and have been converted to crop land post CRFM. The extensive margin approach showed Jagatsinghpur at 25.7 percent, Kalahandi at 21.8 percent, and Cuttack at 20.6 percent new fallow land utilization. Odisha achieved an overall extensive margin of 9.1 percent or 257.3 thousand hectares of newly cultivated land under the CRFM program (Figure 1).

Figure 1: Distribution of extensive margin (new land) using remote sensing data



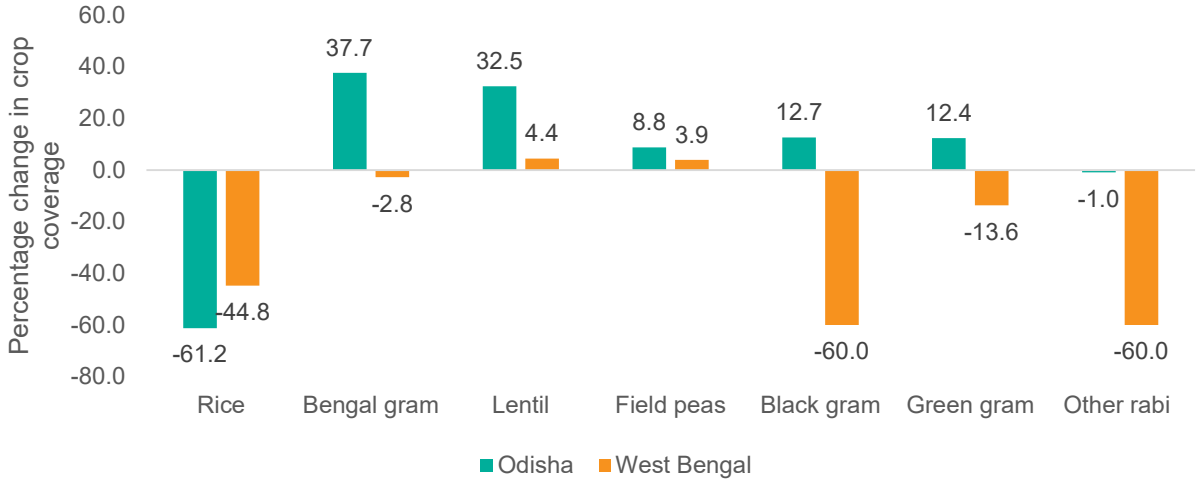
Source: Remote sensing and authors' analysis.

We also found a positive relationship existed between land suitability and transformation of fallow areas, particularly in Jagatsinghpur, Puri, and Kendrapara with high suitable land percentages. Intensive margin analysis indicated an overall decline of 64.5 thousand hectares in ephemeral fallows, with Khordha, Cuttack, and Puri showing the highest reductions.

Crop Diversification

Figure 2 highlights the percentage change in crop coverage area between the pre-CRFM period (2020/2021 and 2021/2022) and the post-CRFM period (2022/2023 and 2023/2024) for Odisha and West Bengal. The figure depicts Odisha's significant post-CRFM success in crop diversification from Rabi rice to pulses. Odisha recorded a 61.2 percent decline in Rabi rice and substantial increases in pulses: Bengal gram (37.7%), lentils (32.5%), black gram (12.7%), and green gram (12.4%).

Figure 2: Percentage change in crop area during Rabi season (CRFM states comparison)



Source: India, Department of Agriculture and Farmers' Welfare (2023).

Comparison between perennial and ephemeral fallows in relation to CRFM

Table 1 presents the matrix categorizing Odisha's districts based on CRFM area trends. The matrix categorizes districts based on whether their fallow area increased or decreased in the post-CRFM period. It also identifies districts with a consistent decline in perennial fallow land from 2018 to 2021, a consistent rise in perennial fallow land from 2018 to 2021, and a fluctuation or mix (increase or decrease) during the pre-CRFM period.

Table 1: Matrix of districts showing increased or decreased ephemeral and perennial fallows pre- and post-CRFM

Pre-CRFM (2018 to 2021)	Post-CRFM (2022 to 2023)	
	Increase in fallow area	Decrease in fallow area
Ephemeral fallow area	Kandhamal, Malkangiri, Nayagarh, Rayagada	Bhadrak, Boudh, Cuttack, Ganjam, Jagatsinghpur, Jharsuguda, Kendrapara, Koraput, Mayurbhanj, Nabarangapur, Nuapada, Puri, and Sonepur
Decrease in perennial fallows	Angul, Balasore, Bargarh, Gajapati	Dhenkanal, Jajapur, Keonjhar
Increase in perennial fallows	Balangir, Sundargarh	Deogarh, Kalahandi, Khordha, Sambalpur

Source: Remote sensing and authors' analysis.

Factors associated with utilization of fallow land: Soil moisture and rainfall

In remote sensing analysis, soil moisture and rainfall data play a critical role in evaluating the potential for utilization of fallow land in terms of land suitability, crop viability, and land use dynamics. In areas where there is a weak link between rainfall and soil moisture levels, interventions such as rainwater harvesting and improved irrigation systems may be required with the provision that the CRFM is predicated on utilizing residual soil moisture for transforming fallow lands. Excessive soil moisture is also unfavorable as it adversely affects pulses and oilseeds by causing root rot, reduced yields, and increased susceptibility to diseases. With excessive soil moisture, pulses also suffer from disrupted nitrogen fixation, while oilseeds face compromised soil quality. Proper drainage, balanced irrigation, and effective residual moisture management are critical for maintaining the health, productivity, and quality of these crops.

Effect on yield and acreage: Short-run outcome as a gateway to long-term effects

Given the short time that has elapsed for CRFM, short-term outcomes in terms of gains in productivity and acreage may serve as gateway to achieving long-term goals such as sustainable agricultural development, improved market integration, and higher or stable farmer incomes over time. For specific crops such as pulses or oilseeds, the extent of the average yield transformation effect depends both on pre-CRFM yield levels as well as on the productivity of incremental or transitioned land area. Odisha's post-CRFM changes in yield align closely with those of high-performing states where the structural shift in yield is driven by the transformation of low- or zero-yield land into cultivated and productive land; for crops where pre-CRFM yield trends were positive, the shift in yields could be comparatively small. Pre-CRFM relative yield trends also will help determine if yield will converge toward those of other states post-CRFM (for example, green gram).

Also, if CRFM-type interventions are taking place in other states, this effect will be embedded in the yields of the comparator states. Odisha stands out with pronounced post-CRFM increases in yields of black gram, green gram, lentils, sesamum, and mustard relative to other states and an overall convergence toward the all-India average. Field pea showed the most substantial increase (38%), followed by grass pea (10.7-13.4%), and lentils (10.2-11.3%). Sesamum and mustard yields improved by 5-6 percent. Input subsidies had significant positive effects on acreage expansion, particularly INM (2.3 ha) and IPM (1.3 ha). Subsidized micronutrients, need-based pesticides, and bio-input notably boosted area expansion.

Key Takeaways

- **Recalibrating CRFM interventions:** Targeted allocation to under-supported crops and areas.
- **Scoping land for diversification:** Identifying additional fallow lands suitable for pulses, oilseeds, and vegetables.
- **Focused crop assessment:** Investigating low-yield crops like green gram for targeted improvement.
- **Market engagement:** Exploring high-value markets and value-added opportunities.
- **Comprehensive outcome surveys:** Regularly assessing climate resilience, water usage, and economic impacts.
- **Integrated assessment:** Combining environmental, livelihood, and economic perspectives.
- **Ensuring data integrity:** Using georeferencing, remote sensing, and data triangulation for real-time, accurate program monitoring.

By implementing these strategic actions, the CRFM program can enhance its effectiveness, foster sustainable agricultural practices, and promote economic stability across the region. This approach will address current challenges and create a resilient agricultural framework that benefits farmers, supports inclusivity, and strengthens Odisha's agricultural productivity.

Conclusion and Policy Recommendations

CRFM has demonstrated promising outcomes in utilizing fallow lands, enhancing productivity, and supporting sustainable land use. By focusing on converting underutilized rice fallow lands during the Rabi season, the program has enabled increased cropping intensity, which contributes directly to both food security and sustainability for smallholder farmers; it also provides promising evidence on sustainability. To maximize CRFM's potential and address the gaps, a strategic focus on targeted resource allocation, enhanced market linkages, and inclusive measures is essential. Strengthening data systems and integrating technology such as remote sensing for real-time monitoring can further optimize resource distribution, ensuring that interventions are more precisely tailored to regional needs. Additionally, implementing outcome surveys that assess climate resilience, water usage, and economic impacts will provide valuable data to guide adaptive management and long-term planning.

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REFERENCES

Duflo, E., and E. Saez. 2002. “Participation and Investment Decisions in a Retirement Plan: The Influence of Colleagues' Choices.” Journal of Public Economics 85 (1): 121–148. https://doi.org/10.1016/S0047-2727(01)00098-6.

India, Department of Agriculture and Farmers’ Welfare. 2023. *Monthly Report*. New Delhi: Ministry of Agriculture and Farmers’ Welfare, Crops Division. Accessed January 19, 2025. https://agriwelfare.gov.in/Documents/CWWGDATA/crops_(36)_0.pdf

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