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Comparative socio-economic profile and cultivation practices of indigenous aromatic rice cultivars in Cooch Behar and North Dinajpur districts of North Bengal

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Abstract
Indigenous aromatic rice cultivars such as *Kalonunia* and *Tulaipanji* hold high cultural, economic, and nutritional significance in North Bengal. This study documents and compares the socio-economic conditions of farmers, landholding patterns, varietal preferences, cultivation experiences, and the effects of climate variability on rice production in Cooch Behar and North Dinajpur districts. Data was collected from 100 farmers (50 in each district) through structured interviews. Results reveal that farmers in both regions are predominantly middle-aged with long cultivation experience (>20 years). In Cooch Behar, *Kalonunia* dominates (92%), while North Dinajpur exclusively cultivates *Tulaipanji*. Landholding is small (average <1 bigha under aromatic rice), highlighting its role as a niche crop. Climate stress—particularly reduced rainfall and increased temperatures—has led to significant changes in aroma, grain size, and yield. Market prices ranged between ₹3,500-₹4,500 per quintal across sites, with farmers of North Dinajpur district receiving slightly higher prices due to stronger market linkages. The findings suggest that while traditional knowledge sustains aromatic rice cultivation, adaptation strategies are urgently required to mitigate climate stress and safeguard this heritage crop.

Keywords: Aromatic rice, kalonunia, tulaipanji, socio-economic profile, climate change, North Bengal

Introduction
Indigenous aromatic rice varieties of North Bengal, particularly *Kalonunia* and *Tulaipanji*, are known for their unique fragrance, taste, and market demand. They are integral to regional food culture and possess high export potential. *Tulaipanji* and *Kalonunia* recently received GI recognition, reinforcing their regional exclusivity and market potential (GI Registry, 2023-24). However, small-scale cultivation, socio-economic constraints, and climate variability pose significant threats to their sustainability. While *Kalonunia* dominates in Cooch Behar, *Tulaipanji* is the exclusive variety in North Dinajpur. This study aims to provide a comparative analysis of farmer profiles, cultivation patterns, and challenges faced in these two areas.

Materials and Methods
The present study was conducted in Cooch Behar and North Dinajpur districts of West Bengal. The districts were selected purposefully as the cultivars are the indigenous to those districts. Respondents were selected from each district randomly. In this way, total one hundred (100) farmers (Respondents); fifty (50) from each district were selected for this study. The pre-tested interview schedule was used to get information on Socio-economic profile, landholding, varietal distribution, irrigation, experience, market price, and perceived climate impacts. Descriptive statistics (frequency, percentage, mean, mod) and comparative analysis were done in this study.

Results and Discussion

1. Socio-economic Profile of Respondents in Cooch Behar and North Dinajpur districts

Parameter	Category	Cooch Behar		North Dinajpur	
		Frequency	Percentage	Frequency	Percentage
Age Group (Years)	20 - 30	0	0.00	1	2.00
	31 - 40	16	32.00	12	24.00
	41 - 50	21	42.00	21	42.00
	51 - 60	13	26.00	16	32.00
Religion	Hindu	34	68.00	26	52
	Muslim	16	32.00	24	48
Education Level	Class-IV	1	2.00	3	6
	Class-VIII	9	18.00	12	24
	Class-X	11	22.00	14	28
	Class-XII	18	36.00	15	30
	Graduation and above	11	22.00	6	12
Caste	Gen	18	36.00	13	26
	OBC	17	34.00	26	52
	SC	15	30.00	8	16
	ST	0	0.00	3	6
Economic Class	APL	25	50.00	23	46
	BPL	18	36.00	22	44
	PPH	7	14.00	5	10
Occupation	Agriculture	35	70	44	88
	Agri. + Labour	8	16	3	6
	Agri. + Business	6	12	1	2
	Agri. + Govt. Sector	0	0	1	2
	Agri. + Masson	1	2	1	2

Comparative Socio-economic Profile of Respondents in Cooch Behar and North Dinajpur

Age Distribution

The age structure shows that the majority of respondents belong to the 41-50 years group in both Cooch Behar (42%) and North Dinajpur (42%). A substantial proportion also fall in the 31-40 years category (32% and 24% respectively) and 51-60 years category (26% and 32% respectively). Younger farmers (20-30 years) are negligible, with only one respondent (2%) in North Dinajpur and none in Cooch Behar. This pattern highlights a predominance of middle-aged farmers, reflecting the national trend of declining youth participation in agriculture (Chand *et al*., 2015; Birthal *et al*., 2020) [9, 7]. The aging farming population poses challenges for technology adoption and long-term sustainability of indigenous crop cultivation.

Religion

Religion-wise distribution demonstrates notable variation: 68% Hindus and 32% Muslims in Cooch Behar, whereas North Dinajpur shows a balanced composition with 52% Hindus and 48% Muslims. The relatively higher Muslim representation in North Dinajpur mirrors the demographic structure of Uttar Dinajpur district (Census of India, 2011). Such religious diversity has implications for community dynamics, local institutions, and collective agricultural decisions (Basu & Roy, 2019) [5].

Education Level

Educational attainment indicates moderate literacy across both sites, though concentrated at secondary levels. In Cooch Behar, 36% had studied up to Class XII and 22% up to graduation or above, while North Dinajpur reported 30% up to Class XII and only 12% with graduation or higher education. A larger proportion of respondents in North Dinajpur fall under lower education categories (24% up to Class VIII, 28% up to Class X). This indicates comparatively higher educational attainment in Cooch Behar, which may contribute to better access to information, training, and improved decision-making in farming (Adhikary & Ghosh, 2022) [1].

Caste

Caste distribution reflects socio-cultural heterogeneity. In Cooch Behar, General (36%), OBC (34%), and SC (30%) categories are almost evenly represented, whereas in North Dinajpur, OBC farmers dominate (52%), followed by General (26%), SC (16%), and ST (6%). The presence of Scheduled Tribes in North Dinajpur but absence in Cooch Behar is a distinguishing feature. Since caste often influences landholding, institutional participation, and access to schemes, these differences are critical for understanding disparities in agricultural opportunities (Deshpande, 2011) [12].

Economic Class

Analysis of economic class reveals that in Cooch Behar, 50% of respondents belonged to APL (Above Poverty Line), while 36% were BPL (Below Poverty Line) and 14% under PPH (Poorest of Poor Households). In North Dinajpur, the distribution is 46% APL, 44% BPL, and 10% PPH. Thus, both regions have a significant proportion of economically vulnerable households, though poverty is slightly more concentrated in North Dinajpur. This economic status directly shapes access to credit, inputs, and adoption of improved crop management practices (Jha *et al*., 2019) [18].

Occupation

The occupational profile shows a strong predominance of agriculture. In North Dinajpur, 88% of respondents are solely engaged in agriculture, compared to 70% in Cooch Behar. However, diversification of income sources is more evident in Cooch Behar, with 16% combining agriculture with labor, 12% with business, and small fractions with masonry or other sectors. In North Dinajpur, non-agricultural engagement is marginal (only 10% combined agriculture with labor, business, or government service). This indicates greater occupational diversification in Cooch Behar, which may provide resilience against agricultural uncertainties (Singh & Bhogal, 2014) [26].

2. Landholding and Resource Use Pattern of Respondents

Parameter	Cooch Behar	North Dinajpur
Avg. landholding	6.94 bigha	6.87 bigha
Owned land	85%	93.4%
Leased Land	15%	6.60%
Irrigated land	90%	100%

Landholding and irrigation status

Average Landholding

The average size of operational landholding among respondents was 6.94 bigha in Cooch Behar and 6.87 bigha in North Dinajpur. This near parity reflects the small and medium-scale farming structure prevalent in West Bengal, where landholdings are generally fragmented due to demographic pressure and inheritance laws (Chand *et al*., 2015; Government of West Bengal, 2020) [9, 16]. The similarity in farm size also indicates that resource constraints in terms of land are uniform across both

regions.

Land Tenure (Owned vs. Leased Land)

In terms of tenure security, 85% of land in Cooch Behar was owned and 15% leased-in, whereas in North Dinajpur, 93.4% was owned and only 6.6% leased-in. This suggests that land leasing is more prevalent in Cooch Behar. Tenancy farming has long been recognized as a means for landless or smallholders to gain access to cultivable land, but it often comes with reduced tenure security, limiting the incentive to invest in long-term improvements (Bardhan & Mookherjee, 2011; Rawal, 2001) [4, 21]. The higher proportion of owned land in North Dinajpur indicates greater tenure stability, which may foster greater willingness among farmers to invest in crop management and sustainable practices.

Irrigation Availability

Irrigation coverage was reported to be 100% in North Dinajpur, while 90% of land in Cooch Behar was irrigated. This demonstrates that North Dinajpur enjoys a comparatively more favorable production environment, reducing dependence on monsoonal rainfall and enabling more consistent crop planning. Irrigation has been widely documented as a critical factor in enhancing cropping intensity, productivity, and reducing production risks (Fan, Hazell, & Thorat, 2000; Singh & Pal, 2012) [13, 25]. The slightly lower irrigation coverage in Cooch Behar, though still substantial, suggests a marginal disadvantage that may constrain water-demanding crops during periods of stress.

3. Aromatic Rice Variety and Cultivation Scale

Aspect	Cooch Behar	North Dinajpur
Dominant variety	Kalonunia (92%)	Tulaipanji (100%)
Avg. aromatic rice area	0.56 bigha	1.02 bigha
cultivating <1 bigha	86%	74%

Cultivation of Indigenous Aromatic Rice Varieties

Dominant Varieties

In Cooch Behar, the overwhelmingly dominant variety was Kalonunia, cultivated by 92% of respondents. In contrast, in North Dinajpur, Tulaipanji was the exclusive choice of all respondents (100% adoption). These patterns reflect the strong regional varietal identity associated with these districts: Cooch Behar has historically specialized in Kalonunia, while North Dinajpur (Uttar Dinajpur) is the traditional home of Tulaipanji (Bhattacharjee *et al*., 2002; Roy & Banerjee, 2015) [6, 22]. Such varietal dominance underscores the cultural and geographical linkage between rice varieties and their conventional production environments.

Area under Aromatic Rice

The average area devoted to aromatic rice cultivation differed across sites. In Cooch Behar, respondents allocated 0.56 bigha on average, whereas in North Dinajpur the area was 1.02 bigha. This indicates that North Dinajpur farmers, on average, devote nearly double the land area to aromatic rice compared to their counterparts in Cooch Behar. The relatively larger allocation in North Dinajpur may be attributed to stronger market linkages and consumer demand for Tulaipanji, which has been recognized with Geographical Indication (GI) status (Government of India, 2017) [15].

Scale of Cultivation

A majority of farmers across both sites cultivated aromatic rice on small plots (<1 bigha), though the extent varied: 86% of farmers in Cooch Behar and 74% in North Dinajpur. This suggests that while both groups treat aromatic rice as a subsidiary crop rather than a staple, North Dinajpur farmers are relatively more inclined to expand acreage beyond 1 bigha. Earlier studies have noted that farmers often limit the area under aromatic rice due to lower yield potential compared to HYVs, higher labor demand, and vulnerability to climatic risks (Sarkar *et al*., 2010; Das *et al*., 2018) [23, 11].

4. Farmers' Experience in Aromatic Rice Cultivation

- **Cooch Behar:** Avg. 23.2 yrs (72% >15 yrs).
- **North Dinajpur:** Avg. 24.2 yrs (84% >20 yrs).

The experience of farmers in cultivation plays a critical role in shaping their decision-making, varietal choice, and capacity to sustain indigenous aromatic rice varieties.

In Cooch Behar, the average farming experience among respondents was 23.2 years, with 72% of farmers having more than 15 years of cultivation experience. In North Dinajpur, the mean farming experience was slightly higher at 24.2 years, with 84% of respondents having more than 20 years of experience. This clearly indicates that farmers in both study areas possess extensive practical knowledge of farming, particularly in the management of indigenous aromatic rice.

The relatively higher proportion of highly experienced farmers in North Dinajpur suggests that cultivation of Tulaipanji rice is deeply embedded in the local farming tradition and has been passed down intergenerationally. In contrast, though Cooch Behar farmers also display considerable experience, their comparatively lower percentage of long-term cultivators may reflect greater diversification into other livelihood activities, as discussed earlier.

The significance of farmers' experience cannot be understated. Long-term engagement with a particular crop enhances experiential knowledge, improves skill in handling location-specific challenges, and strengthens the preservation of traditional seed systems (Stone, 2007; Altieri, 2018) [27, 3]. Moreover, experienced farmers often act as custodians of indigenous germplasm, transmitting both seed and cultural practices across generations (Sthapit & Ramanatha Rao, 2009) [28].

However, while high levels of experience contribute to the conservation and continuity of aromatic rice cultivation, it may also signal a potential challenge for the future, as younger generations show declining interest in agriculture (Birthal *et al*., 2020) [7]. This raises concerns regarding the sustainability of indigenous rice farming traditions in the absence of adequate incentives and institutional support.

5. Quality and Post-Harvest Practices

Parameter	Cooch Behar (%)	North Dinajpur (%)
Aroma rated high/very high	58	28
Post-harvest treatment practiced	12	4
Parboiling practiced	30	20

Kalonunia (Cooch Behar) perceived to have higher aroma quality compared to North Dinajpur's Tulaipanji, though post-harvest handling remains minimal.

6. Market Price Trends of Indigenous Aromatic Rice (₹/Quintal)

- **Cooch Behar**: ₹3600-₹4500
- **North Dinajpur**: ₹3500-₹4500
- **Mode price**: Cooch Behar - ₹4100; North Dinajpur - ₹4300

Price realization is one of the most critical determinants influencing the economic viability of indigenous aromatic rice cultivation. The market price trends observed across the two study areas indicate both similarities and subtle differences that reflect varietal reputation and market demand.

Price Range

In Cooch Behar, Kalonunia rice fetched prices ranging from ₹3600 to ₹4500 per quintal, while in North Dinajpur, Tulaipanji was marketed between ₹3500 and ₹4500 per quintal. The overlapping price bands suggest that both varieties enjoy strong consumer preference in niche markets. However, the lower floor price in North Dinajpur (₹3500) points to greater variability, possibly due to differences in grain quality, local market linkages, or seasonal fluctuations. Studies on indigenous aromatic rice marketing in Bengal indicate that while demand remains steady, market imperfections and lack of standardized grading often create price variation (Das *et al*., 2018; Roy & Banerjee, 2015) [11, 22].

Mode Price

Despite similar ranges, the mode price—the most frequently realized price point—differed between the districts. In Cooch Behar, the mode price for Kalonunia was ₹4100 per quintal, whereas in North Dinajpur, Tulaipanji achieved a higher mode price of ₹4300 per quintal. This difference suggests that Tulaipanji commands a slightly stronger premium in the marketplace, reflecting its Geographical Indication (GI) status and long-established reputation (Government of India, 2017) [15]. Farmers in North Dinajpur, therefore, tend to benefit from comparatively better and more consistent price realization.

North Dinajpur farmers secured relatively higher and stable prices.

7. Perceived Impacts of Climate Change on Aromatic Rice Cultivation

Climate impact	Cooch Behar (%)	North Dinajpur (%)
Reduced rainfall	100	100
Increased temperature	100	100
Change in maturity period	60 (increased)	56 (increased)
Reduced aroma	62	58
Grain size change	62	66
Yield decline	44	46

Climate variability has emerged as a critical factor influencing the sustainability of indigenous aromatic rice cultivation. Farmers in both Cooch Behar and North Dinajpur reported a wide range of perceived impacts, highlighting the vulnerability of traditional varieties to changing climatic conditions.

Reduced Rainfall and Increased Temperature

All respondents (100% in both districts) identified reduced rainfall and increased temperature as major climatic changes affecting aromatic rice. These perceptions are consistent with meteorological studies that indicate a declining trend in monsoon precipitation and rising mean temperatures across Eastern India (Kumar *et al*., 2014; IMD, 2020) [19, 17]. Since aromatic rice varieties are highly sensitive to water availability and thermal regimes, these changes directly threaten yield stability and grain quality.

Change in Maturity Period

About 60% of farmers in Cooch Behar and 56% in North Dinajpur reported an increase in crop maturity period, suggesting that climate stress is prolonging the growth cycle. Similar findings have been reported by Chakraborty *et al*. (2018), who noted that altered temperature and rainfall patterns can delay flowering and grain filling in aromatic and fine rice cultivars, thereby affecting productivity.

Reduced Aroma and Grain Size Variation

A significant proportion of farmers observed decline in aroma (62% in Cooch Behar; 58% in North Dinajpur) and changes in grain size (62% and 66% respectively). The aromatic quality of rice, largely governed by the compound 2-acetyl-1-pyrroline (2-AP), is highly sensitive to temperature and soil moisture stress during grain filling (Mo *et al*., 2019) [20]. Farmers' perceptions thus align with experimental evidence that climate change threatens not only yield but also the organoleptic qualities that give these varieties their premium market value.

Yield Decline

Perceptions of yield decline were reported by 44% of farmers in Cooch Behar and 46% in North Dinajpur. Yield reduction in traditional aromatic rice is attributed to increased abiotic stress, pest incidence, and reduced water availability, which compromise productivity compared to high-yielding varieties (Singh *et al*., 2017) [24]. This has implications for farmers' willingness to continue cultivation of indigenous varieties unless adequate support and adaptation measures are introduced.

Both regions face severe climate stress, leading to yield and quality deterioration.

Conclusion and Recommendations

The present study highlights that indigenous aromatic rice cultivation in North Bengal is primarily undertaken on small, fragmented plots by middle-aged, highly experienced farmers. Varietal specialization is evident, with Kalonunia dominating in Cooch Behar and Tulaipanji being exclusively cultivated in North Dinajpur, reflecting deep-rooted regional traditions and agro-cultural preferences.

Economic analysis indicates that market prices for these varieties are attractive, with Tulaipanji commanding a slight premium. However, price variability and limited scale of cultivation restrict farmers' ability to fully capitalize on market opportunities. Additionally, climatic stress—manifested through reduced rainfall, higher temperatures, prolonged crop maturity, yield decline, and compromised grain aroma and size—poses a significant threat to the sustainability of indigenous aromatic rice cultivation.

By integrating climate-smart agriculture, improved post-harvest practices, market development, and knowledge conservation, the long-term sustainability of Kalonunia and Tulaipanji cultivation in North Bengal can be safeguarded, ensuring both livelihood security for farmers and preservation of cultural and genetic heritage

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