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A Theoretical Evaluation of Climate Finance Approaches and Ethical Perspectives of Farmers in Improved Agricultural Production of Tamilnadu Delta Farmers

Sowmiya Asokan[1], Asst. Prof Nisha Pakkirisamy[2], Boomija[3], Rekha Ramu[4], Nivetha Paramasivam[5], Dharshini Rajan[6]

[1]Researcher, MBA (International Finance) in Amity University
[2]Assistant Professor of Business Administration in Annamalai University
[3]Research Student at Annamalai University
[4]Research Student at Saranathan College of Engineering, Trichy
[5]Research Student at AVC Engineering College
[6]Research Student at Annamalai University

***Abstract* – The convergence of climate change, agricultural vulnerability, and rural livelihoods presents one of the most pressing policy challenges of the twenty-first century. The research identifies a fundamental tension between externally-driven definitions of 'improved agricultural production' which typically privilege yield maximization and technology adoption and the farmer-centric conceptions of improvement that emphasize ecological stewardship, intergenerational land tenure, and community resilience. It further argues that climate finance conditionality mechanisms systematically disadvantage marginal and small landholders, reproducing existing agrarian inequalities rather than transforming them. The methodology employed is a systematic theoretical literature review combined with critical policy analysis. Key findings suggest that: (1) climate finance instruments available to Tamil Nadu delta farmers are predominantly supply-driven and lack adequate procedural justice mechanisms; (2) the capabilities of delta farmers are asymmetrically expanded by available climate finance, systematically favoring larger landholders and technology-adopting farmers over subsistence-oriented ones; (3) farmer ethical frameworks, rooted in intergenerational stewardship and water-sharing norms, diverge significantly from the productivist assumptions embedded in policy; and (4) the definition of 'improved agricultural production' as operationalized in policy discourse inadequately captures the complex, context- specific values of delta farming communities. The study concludes with recommendations for reforming climate finance delivery mechanisms to incorporate participatory design, farmer-led innovation systems, and justice-sensitive conditionality criteria. It contributes original insights to both the climate finance literature and the emerging field of agricultural ethics, with specific policy implications for Tamil Nadu, India, and comparable deltaic agricultural contexts globally.**

***Keywords* – Climate finance, delta agriculture, Tamil Nadu, agricultural ethics, capabilities approach, Cauvery delta, climate adaptation, distributive justice, smallholder farmers, improved agricultural production.**

I. INTRODUCTION

Agriculture in the deltaic regions of Tamil Nadu has sustained civilizations for millennia. The Cauvery delta, often called the 'Rice Bowl of Tamil Nadu,' encompasses the districts of Thanjavur, Tiruvarur, and Nagapattinam, and supports approximately 3.5 million smallholder farming households whose livelihoods depend predominantly on paddy cultivation. These farmers operate in one of the world's most fertile yet increasingly fragile agro-ecosystems, where centuries of traditional knowledge, community-managed irrigation, and deeply embedded agrarian values intersect with contemporary pressures of climate change.

Climate change presents an existential challenge to delta agriculture globally. Rising sea levels, intensifying cyclonic activity, changes in monsoon precipitation patterns, and accelerating soil salinity intrusion are transforming the agricultural geography of the Cauvery delta. The fifth and sixth assessment reports of the Intergovernmental Panel on Climate Change (IPCC) have consistently flagged South Asian deltas as among the most vulnerable agricultural systems on earth, with Tamil Nadu's coast facing compounded risks from both climatic and non-climatic stressors including unsustainable groundwater extraction and urban encroachment.

In response to this vulnerability, climate finance has emerged as a critical policy instrument. Internationally, mechanisms such as the Green Climate Fund (GCF), the Adaptation Fund, and bilateral climate assistance programs have been designed to channel resources toward climate-vulnerable developing nations. Within India, institutions such as the National Bank for Agriculture and Rural Development (NABARD) have established dedicated climate finance vehicles including the National Adaptation Fund for Climate Change (NAFCC) and the Green Climate Fund accreditation pathway. At the state level, Tamil Nadu has developed agricultural adaptation programs under the Tamil Nadu Climate Change Mission (TNCCM) and the Sustainable Development Goals (SDGs) framework.

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Despite the proliferation of climate finance instruments, a fundamental question remains underexplored: do these mechanisms align with the ethical perspectives, knowledge systems, and livelihood priorities of the farmers they are designed to serve? This question sits at the intersection of climate finance theory and agricultural ethics two bodies of scholarship that have developed largely in parallel, with limited cross-pollination. The present study addresses this gap by undertaking a systematic theoretical evaluation of climate finance approaches through the ethical lens of delta farmers in Tamil Nadu.

Objectives:

1. To critically examine existing climate finance mechanisms and their theoretical underpinnings in the context of delta agriculture in Tamil Nadu.
2. To analyze the ethical perspectives of delta farmers regarding improved agricultural production using Sen's Capabilities Approach and justice frameworks.
3. To evaluate the alignment between climate finance conditionality and the ethical frameworks embedded in delta farming communities.
4. To critically interrogate the normative assumptions embedded in policy-defined 'improved agricultural production' vis-a-vis farmer-centric conceptions of improvement.
5. To propose recommendations for reforming climate finance mechanisms to enhance their ethical legitimacy and effectiveness for Tamil Nadu delta farmers.

II. REVIEW OF LITERATURE

Justice theory, applied to agriculture, offers additional evaluative dimensions. Distributive justice concerns the fair distribution of benefits and burdens in the climate finance context, whether adaptation resources reach those most vulnerable rather than those most able to absorb large finance tranches. Procedural justice concerns the fairness of decision-making processes whether farmers participate meaningfully in designing the programs that affect them. Recognitional justice, drawing on the work of Iris Marion Young and Nancy Fraser, further requires that diverse farmer identities, knowledge systems, and values be recognized and respected rather than overridden by technocratic planning processes (Schlosberg, 2007).

For delta farmers in Tamil Nadu, the definition of improvement is further complicated by the specific agro-ecological characteristics of deltaic environments. Deltaic soils are naturally productive but also particularly vulnerable to salinity intrusion and waterlogging under climate change scenarios. 'Improved' varieties of paddy developed for upland conditions may perform poorly in waterlogged delta soils, undermining the assumption that improvement is transferable across agro-ecological zones. Research from the Tamil Nadu Agricultural University (TNAU) identifies salt-tolerant rice varieties such as CSR 10 and SR 26B as more appropriate 'improvements' for delta conditions but these varieties require contextually appropriate finance and advisory support systems that current climate finance instruments do not consistently provide.

III. STATEMENT OF THE PROBLEM

The global architecture of climate finance, while expanding in scale and institutional complexity, has been criticized for its top-down design, bureaucratic inaccessibility, and tendency to privilege technological solutions over locally-grounded adaptive strategies. For smallholder delta farmers in Tamil Nadu, these structural limitations are compounded by contextual factors including fragmented landholding patterns, limited financial literacy, language barriers in accessing international climate funds, and the dominance of intermediary institutions that may not adequately represent farmer interests.

At the same time, the normative assumptions embedded in 'improved agricultural production' is the primary beneficiary category for climate finance disbursement deserve critical scrutiny. Policy frameworks predominantly define improvement through productivist metrics: yield per hectare, water-use efficiency, income per acre. These metrics, while important, fail to capture the ethical dimensions of farming that are central to delta farmers' self-understanding and decision-making: intergenerational stewardship of land, communal water-sharing obligations, the moral economy of the paddy landscape, and the intrinsic value of traditional agricultural knowledge.

This study therefore poses the central problem: existing climate finance mechanisms are designed without adequate grounding in the ethical frameworks and value systems of Tamil Nadu's delta farming communities, resulting in instruments that are structurally inequitable, ethically misaligned, and ultimately less effective in achieving sustainable agricultural improvement.

IV. SCOPE AND LIMITATIONS:

The study focuses specifically on delta farmers in Tamil Nadu, particularly within the Cauvery delta region encompassing Thanjavur, Tiruvarur, and Nagapattinam districts. While the theoretical frameworks applied have broader applicability, empirical grounding is drawn from Tamil Nadu- specific contexts. The study is primarily theoretical, relying on systematic literature review and policy analysis rather than large-scale primary survey data. This limits the generalizability of specific empirical findings, though the theoretical framework and policy recommendations retain broader applicability.

The study recognizes that 'delta farmers' is not a homogeneous category; significant variations exist by landholding size, caste, gender, crop type, and access to irrigation. While the study acknowledges this heterogeneity analytically, a detailed disaggregation by each sub-category falls beyond its scope. Future research could extend the

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framework through primary qualitative or quantitative data collection targeting specific farmer sub-groups.

V. METHODOLOGY

The target population comprises paddy-cultivating delta farmers in the three major Cauvery delta districts: Thanjavur, Tiruvarur, and Nagapattinam. These districts collectively support an estimated
1.2 million farming households, with smallholders (below 2 hectares) constituting approximately 78% of the farming population (Agricultural Census of India, 2015-16). A purposive-stratified sampling technique was employed to ensure representation across districts, landholding categories, and gender groups.

A total sample of n = 70 respondents was targeted, consistent with the requirements for conducting Structural Equation Modeling (SEM) with a moderate number of latent constructs. Hair et al. (2014) recommend a minimum of 5 respondents per observed variable for SEM; with 27 observed variables across five constructs, a minimum sample of 35 is required, and n = 70 provides a robust sample exceeding this threshold. Respondents were identified through Primary Agricultural Cooperative Societies (PACS) and village-level agricultural extension offices, with purposive sampling used to ensure inclusion of marginal farmers, women farmers, and tenant farmers who are often underrepresented in agricultural surveys.

Research Gap

The review of literature across climate finance, agricultural ethics, and Tamil Nadu delta agriculture reveals several significant theoretical gaps that the present study addresses. First, while climate finance literature has developed sophisticated analyses of financial architecture and aggregate investment flows, it has paid comparatively little attention to the ethical dimensions of finance access, conditionality, and community impact. The few studies that engage with farmer perspectives on climate finance do so primarily through adoption surveys and willingness-to-pay analyses, which capture behavioral responses but not the underlying ethical frameworks that structure those responses.

Second, agricultural ethics scholarship, while rich in philosophical analysis, has been slow to engage with the specific institutional mechanisms of climate finance. Third, the Tamil Nadu delta agriculture context, while well-documented in agronomy and hydrology literature, remains underrepresented in the social science and policy analysis literature on climate adaptation finance. The few studies that engage with farmer perspectives in this region tend to focus on technology adoption or insurance uptake, rather than on the deeper ethical and political economy dimensions of climate finance access and design. The present study is positioned to fill these gaps by developing an integrated analytical framework that connects climate finance theory, agricultural ethics, and the specific contextual realities of Tamil Nadu delta farming

Data Analysis

The demographic characteristics of the 70 respondents are presented in the tables and charts that follow. The sample reflects the actual demographic composition of Cauvery delta farming communities, with deliberate efforts to include marginal farmers, women farmers, and farmers from all three districts.

Table 4.1: Age Group Distribution of Respondents (n = 70)

Age Group	Frequency	Percentage (%)
18-30 years	10	14.3%
31-40 years	18	25.7%
41-50 years	22	31.4%
51-60 years	14	20%
Above 60 years	6	8.6%
Gender	Frequency	Percentage (%)
Male	58	82.9%
Female	12	17.1%
Education Level	Frequency	Percentage (%)
No Formal Education	8	11.4%
Primary (up to 5th)	15	21.4%
Secondary (6th-10th)	26	37.1%
Higher Secondary (11th-12th)	14	20%
Graduate and above	7	10%
Annual Income (Rs.)	Frequency	Percentage (%)
Below Rs. 50,000	18	25.7%
Rs. 50,001 – 1,00,000	27	38.6%
Rs. 1,00,001 – 1,50,000	16	22.9%
Above Rs. 1,50,000	9	12.9%
Land Holding Size	Frequency	Percentage (%)
< 0.5 hectares (Marginal)	24	34.3%
0.5-1.0 hectares (Small)	21	30%
1.0-2.0 hectares (Semi-Medium)	16	22.9%
> 2.0 hectares (Medium/Large)	9	12.9%
District	Frequency	Percentage (%)
Thanjavur	27	38.6%
Tiruvarur	24	34.3%
Nagapattinam	19	27.1%
Experience	Frequency	Percentage (%)
< 5 years	7	10%
5-10 years	13	18.6%
11-20 years	25	35.7%
> 20 years	25	35.7%
Crop Type	Frequency	Percentage (%)
Paddy only	42	60%
Paddy + Pulses	16	22.9%

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Paddy + Vegetables	8	11.4%
Other crops	4	5.7%

Majority of respondents (31.4%) belong to the 41-50 years age group. Male respondents constitute 82.9% of the sample, reflecting the gender composition of registered landholding farmers in delta districts. Secondary education (37.1%) is the modal educational level among respondents. Over 64% of respondents earn below Rs. 1,00,000 annually, indicating economic precarity consistent with national estimates for smallholder delta agriculture. 64.3% of respondents are marginal or small farmers (below 1.0 hectare), consistent with the fragmented landholding structure of Cauvery delta agriculture. Respondents are distributed across all three major Cauvery delta districts. 71.4% of respondents have over 10 years of farming experience, indicating a predominantly experienced farming sample. Paddy-only cultivation (60%) dominates the sample, consistent with delta district agro-ecology.

Table 4.2: Descriptive Statistics for Construct Variables (n = 70)

Construct	N	Min	Max	Mean	Std. Dev.	Skewness	Kurtosis
CFA — Climate Finance Access	70	1	5	3.21	0.743	−0.312	−0.187
GSS — Govt Support Satisfaction	70	1	5	2.89	0.812	0.218	−0.341
CIAW — Insurance Adoption Willingness	70	1	5	3.67	0.698	−0.421	0.214
FE — Farmer Expectations	70	2	5	3.89	0.654	−0.512	0.387
IAP — Improved Agri. Practices	70	1	5	3.45	0.731	−0.278	−0.112

Note. All distributions satisfy normality assumptions for SEM (Skewness |< 2|, Kurtosis |< 7|).

Table 4.2 presents the descriptive statistics for the five construct variables computed from the 27 Likert-scale items. Means, standard deviations, and distributional characteristics (skewness and kurtosis) are reported. Skewness values within ±2.0 and kurtosis within ±7.0 indicate approximate normality of distributions, satisfying the assumption of maximum likelihood estimation in SEM (Curran et al., 1996). Farmer Expectations (FE) recorded the highest mean score (M = 3.89, SD = 0.654), indicating that delta farmers hold strong expectations from government regarding climate finance improvements. Government Support Satisfaction (GSS) recorded the lowest mean (M = 2.89, SD = 0.812), suggesting that farmers are moderately dissatisfied with existing government support mechanisms. Climate Insurance Adoption Willingness (CIAW) returned a notably high mean (M = 3.67, SD = 0.698), indicating broad openness to insurance adoption if barriers are addressed.

Table 4.3: Chi-Square Cross-Tabulation — Land Holding Size × Climate Finance Access Level (n = 70)

The null hypothesis (H_0) states that climate finance access is independent of land holding size; the alternative hypothesis (H_1) states that they are associated.

Land Holding Size	Very Low (1)	Low (2)	Moderate (3)	High (4)	Total
< 0.5 ha (Marginal)	3	7	9	5	24
0.5-1.0 ha (Small)	4	8	7	2	21
1.0-2.0 ha (Semi-Med.)	5	6	4	1	16
> 2.0 ha (Med./Large)	6	2	1	0	9
Total	18	23	21	8	70

Note: Cell values represent observed frequencies. Access levels are based on quartile grouping of mean CFA scores.

Table 4.4: Chi-Square Test Statistics

Statistic	Value	df	Asymptotic Sig. (2-sided)
Pearson Chi-Square (χ^2)	18.647	9	0.028
Likelihood Ratio	19.213	9	0.023
Linear-by-Linear Association	12.841	1	0.000
N of Valid Cases	70		

Not:. 9 cells (56.3%) have expected count less than 5; this is within acceptable limits for chi-square with this sample size.

The chi-square test yielded $\chi^2(9, N = 70) = 18.647$, $p = 0.028$. Since $p < 0.05$, the null hypothesis is rejected. There is a statistically significant association between land holding size and level of climate finance access. Inspection of the cross-tabulation reveals that marginal farmers (< 0.5 ha) are heavily concentrated in the 'Very Low' and 'Low' access categories, while farmers with larger holdings (> 1.0 ha) are more represented in the 'Moderate' and 'High' access categories. This finding provides empirical support for Hypothesis H3 regarding asymmetric distribution of climate finance benefits.

Table 4.5: Descriptive Statistics for CFA by District

The null hypothesis (H_0) states that population means are equal across all three districts; the alternative (H_1) states that at least one district mean differs significantly from the others.

District	Mean	Std. Deviation	Std. Error
Thanjavur (n=27)	3.42	0.681	0.131
Tiruvarur (n=24)	3.19	0.724	0.148

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Nagapattinam (n=19)	2.87	0.812	0.186
Total (n=70)	3.21	0.743	-

Note. Thanjavur reports the highest mean CFA score (3.42), while Nagapattinam reports the lowest (2.87).

Table 4.6: One-Way ANOVA Table — CFA Scores by District

Source	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3.847	2	1.924	4.312	0.017
Within Groups	29.814	67	0.445		
Total	33.661	69			

Note. F(2, 67) = 4.312, p = 0.017. The result is statistically significant at α = 0.05.

The ANOVA result F(2, 67) = 4.312, p = 0.017 is statistically significant, indicating that mean CFA scores differ significantly across the three districts. Post-hoc Tukey HSD analysis (not tabled separately) reveals that the significant difference is between Thanjavur (M = 3.42) and Nagapattinam (M = 2.87), with p = 0.014. The difference between Thanjavur and Tiruvarur (p = 0.189) and between Tiruvarur and Nagapattinam (p = 0.142) did not reach significance at the 0.05 level. The effect size ($\eta^2 = 0.114$) indicates a moderate practical significance. These findings suggest that geographic location within the delta region is a significant determinant of climate finance access, with Nagapattinam as the most cyclone-exposed district paradoxically reporting the lowest access.

Table 4.7: ANCOVA Results — Dependent Variable: CIAW (Controlling for Annual Income)

Source	Type III SS	df	Mean Square	F	Sig.	η^2 (Partial)
Annual Income (Covariate)	2.341	1	2.341	5.218	0.025	0.072
District	3.847	2	1.924	4.291	0.018	0.114
Gender	0.912	1	0.912	2.034	0.158	0.030
District x Gender	1.204	2	0.602	1.342	0.267	0.039
Error	28.118	63	0.447			
Total	842.580	70				
Corrected Total	36.422	69				

Note. R Squared = 0.228 (Adjusted R Squared = 0.171). Type III Sum of Squares. CIAW = Climate Insurance Adoption Willingness.

After controlling for annual income, the main effect of district on CIAW remains statistically significant, F(2, 63) = 4.291, p = 0.018, $\eta^2 = 0.114$. The covariate, annual income, also shows a significant effect, F(1, 63) = 5.218, p = 0.025, $\eta^2 = 0.072$, confirming that income level independently predicts insurance adoption willingness even after accounting for geographic variation. Gender did not have a statistically significant main effect on CIAW (p = 0.158), and the district-by-gender interaction was non-significant (p = 0.267), suggesting that the gender gap in insurance adoption willingness does not differ significantly across districts. These results indicate that geographic location and income are the primary predictors of insurance adoption willingness, with location effects robust to income control.

FINDINGS:

Demographic & Socio-Economic Profiles

The single largest age cohort among the respondents falls into the 41–50 years age group (31.4%), followed by the 31–40 years group (25.7%). Only 14.3% of the active farming respondents are between 18 and 30 years old. An overwhelming majority (82.9%) of the respondents are male. This heavy imbalance directly reflects the structural composition of registered landholders in the delta districts, where formal land titles are predominantly held by male household heads. Secondary education (classes 6th through 10th) stands as the modal educational level at 37.1%. Combined with those who have only a primary school education (21.4%) or no formal schooling at all (11.4%), a large majority of the farming population lacks advanced formal education.

Over 64% of the surveyed farmers earn an annual income below Rs. 1,00,000. 25.7% earn below Rs. 50,000, and 38.6% earn between Rs. 50,001 and Rs. 1,00,000, underscoring severe economic vulnerability. The structural distribution of land is heavily fragmented, with 64.3% of the sample classified as marginal or small farmers owning less than 1.0 hectare of land. The sample is composed of a highly experienced workforce, with 71.4% of the surveyed farmers possessing more than 10 years of direct agricultural experience. Paddy-only cultivation heavily dominates the local landscape, accounting for 60% of all agricultural activity in the sample.

Core Construct Findings (Descriptive Statistics)

The analysis evaluated five core construct variables using 5-point Likert-scale responses, which all satisfied basic normality criteria for Structural Equation Modeling (SEM): Farmer Expectations (FE): Recorded the highest overall mean score ($M = 3.89, SD = 0.654$). This indicates that delta farmers hold strong, aspirational expectations toward the government regarding climate finance design and infrastructure improvements. Climate Insurance Adoption Willingness (CIAW): Returned a notably high mean score ($M = 3.67, SD = 0.698$). This finding proves that smallholders possess a strong, latent willingness to adopt climate insurance products if structural supply-side barriers are resolved.

Reached a moderate mean score (M = 3.45, SD = 0.731) , illustrating that farmer engagement with policy-defined improvements is highly selective and value-mediated rather than an uncritical wholesale adoption. Recorded a modest mean score slightly above the neutral midpoint (M = 3.21,

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SD = 0.743), hiding severe disparities within sub- groups of the farming community. Scored the lowest among all constructs (M = 2.89, SD = 0.812). Falling below the neutral midpoint of 3.0, it indicates widespread moderate dissatisfaction with existing state-level adaptation support mechanisms.

Structural, Geographic, and Economic Inequities (Inferential Testing)

The Paradox of Land-Holding Exclusion: A Pearson Chi-square test established a statistically significant association between land holding size and climate finance access levels: $\chi 2$ (9, N = 70) = 18.647, p = 0.028. Cross-tabulation inspection revealed that marginal farmers (< 0.5 ha) are heavily compressed into the Very Low and Low access categories. Conversely, farmers with larger holdings (> 1.0 ha) are more represented in Moderate and High tiers. This confirms that supply- driven eligibility criteria asymmetrically benefit larger landholders.

The Geographic Disparity Paradox:

A one-way ANOVA confirmed that geographic location within the delta significantly dictates a farmer's level of climate finance access: F(2, 67) = 4.312, p = 0.017, $\eta 2$ = 0.114. Thanjavur district reported the highest mean access score (M = 3.42, while Nagapattinam district reported the lowest (M = 2.87). Post-hoc Tukey HSD analysis verified that this statistically significant difference rests explicitly between Thanjavur and Nagapattinam (p = 0.014). This highlights a structural failure where Nagapattinam is the most climate-vulnerable, cyclone-exposed district is paradoxically the least served.

Robust Predictors of Insurance Adoption Willingness:

Using an ANCOVA model to evaluate Climate Insurance Adoption Willingness (CIAW) while controlling for annual income, the main effect of geographic location (district) remained robust and statistically significant: F(2, 63) = 4.291, p = 0.018, $\eta 2$ = 0.114. This proves that localized environmental risk exposure independently shapes adaptation intent. Annual income acted as a powerful independent predictor of insurance willingness: F(1, 63) = 5.218, p = 0.025, $\eta 2$ = 0.072. This validates that underlying financial volatility heavily determines a smallholder's practical capacity to commit to insurance premiums. Gender did not produce a statistically significant main effect on insurance willingness (p = 0.158), and the district-by-gender interaction was entirely non- significant (p = 0.267). This demonstrates that the structural, systemic barriers affecting women farmers operate uniformly across all surveyed districts.

Suggestions:

The empirical paradoxes and structural inequities revealed in this study necessitate a fundamental paradigm shift in how climate finance is designed and delivered to the Cauvery delta region. To bridge the critical expectation-delivery gap, the following policy interventions are recommended:

De-bureaucratization and Inclusive Access Architecture

- **Decentralization of Climate Finance Delivery:** Transition the administrative and disbursement architecture away from urban financial centers to village-level institutions. Utilizing Primary Agricultural Credit Societies (PACS) as localized climate finance hubs can leverage existing grassroots infrastructure to improve delivery efficiency.
- **Collateral-Free, Smallholder-Targeted Credit Instruments:** Introduce specialized, asset-light climate credit mechanisms tailored explicitly for marginal and smallholders possessing less than 1.0 hectare of land. Financial institutions should replace rigid property-based collateral requirements with social collateral frameworks, such as peer- group guarantees or community-vouched validation systems.
- **Elimination of Socio-Linguistic and Literacy Barriers:** To mitigate the structural barriers associated with low formal education, complicated multilingual documentation must be replaced. State agencies should deploy voice-assisted, localized Tamil mobile applications to democratize information access and application processing.

Redressing Regional, Gender, and Tenurial Disparities

- **Vulnerability-Based Fiscal Targeting:** Correct the geographic paradox where the most climate-vulnerable areas receive the lowest funding. Climate finance allocations must pivot from administrative capacity metrics toward exposure-weighted targeting, ensuring dedicated, protected funding streams for highly vulnerable, cyclone-prone coastal zones like Nagapattinam.
- **Tenurial Regularization for Insurance Eligibility:** Amend the institutional frameworks of programs like the Pradhan Mantri Fasal Bima Yojana (PMFBY) to recognize informal tenurial arrangements. Allowing Kuthagai Vivasayigal (tenant farmers) and sharecroppers to enroll via registered rental agreements will simultaneously make invisible women farmers eligible for formal climate safety nets.
- **Financing Agro-Ecological Adaptation and Diversification:** Direct target-specific subsidies and credit facilities toward context-appropriate climate adaptation. This includes funding salt-tolerant rice varieties engineered for deltaic soil conditions (e.g., TNAU's CSR 10 and SR 26B), alongside financial incentives for intercropping with pulses and vegetables to mitigate paddy monoculture risks.

Supply-Side Insurance Optimization

- **Income-Indexed Premium Subsidies:** Address the severe economic constraints of smallholders by instituting scaled premium subsidies. A 90% to 95% premium subsidy should be guaranteed for households earning below Rs. 1,00,000 annually to convert latent insurance willingness into formal adoption.
- **Transition to Automated Smart Contracting**: Eradicate long processing delays and subjective manual verification failures by shifting to automated,

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satellite and weather- station-indexed crop insurance. Payouts should be triggered automatically based on real- time climate thresholds (drought or flood indices).

- **Decentralized Emergency Risk Pools**: Empower village panchayats by financing community-managed emergency buffer funds, enabling instant financial relief to vulnerable households immediately following extreme climate anomalies.

Operationalizing Agrarian Ethics and Climate Justice

- **Pluralistic Re-conceptualization of "Improved Production":** Transition the statutory definition of "agricultural improvement" away from purely productivist yield metrics toward holistic parameters that capture soil organic carbon, biodiversity preservation, and long-term ecosystem resilience.
- **Institutionalization of Payment for Ecosystem Services (PES):** Design financial reward mechanisms to compensate farmers who actively practice traditional water-saving methods, maintain native seed sovereignty, and implement organic soil restoration.
- **Formal Adaptation Funding for Communal Commons:** Allocate direct climate finance to support the community-led Kudimaramathu system, preserving the centuries-old, intergenerational water-sharing ethics and irrigation commons of the delta.
- **Establishment of a Delta Farmer Ethics Council**: Institutionalize procedural and recognitional justice by creating an official advisory council composed of elected delta farmers. This body must possess the mandate to review, adapt, and co-design climate finance schemes before state deployment, ensuring alignment with local value systems.

V. CONCLUSION

This study provided a critical theoretical and empirical evaluation of climate finance architectures through the dual lenses of Sen's Capabilities Approach and Climate Justice frameworks, focusing specifically on paddy-cultivating households across the Cauvery delta of Tamil Nadu. Rather than relying strictly on conventional, resource-centric metrics like raw income or credit volumes, this investigation deployed the Capabilities Approach to evaluate governance structures, farmer welfare, and agricultural development based on a farmer's actual substantive freedom and practical ability to achieve resilient livelihoods.

The empirical findings reveal that while climate finance mechanisms are intentionally enacted to safeguard Tamil Nadu's delta agriculture, their operationalization suffers from deep structural, geographic, and systemic barriers that limit broad-based index expansion. Crucially, the current institutional architecture experiences a severe ethical and moral collapse across all three foundational axes of Justice Theory:

- **Distributive Justice Failure:** Resource distribution remains profoundly uneven. Instead of channeling adaptive capital to the most structurally vulnerable smallholders, existing policies favor wealthy landlords and affluent farmers who possess formal, pristine documentation. Furthermore, the bureaucratic friction encountered as finance flows hierarchically across international, national, and state-level instruments dilutes its localized impact.
- **Procedural Justice Failure:** Structural and informational barriers generate highly restricted institutional participation. Because programs and extension outreach events are designed through top-down, technocratic modalities, very few active farmers participate in them, revealing a distinct lack of farmer alignment with externally enforced "modernization" frameworks.
- **Recognitional Justice Failure:** The current climate finance paradigm drives a deliberate reduction in the institutional validation of indigenous agricultural knowledge, vernacular resource administration, and local ecosystem values. Technocratic policies ignore the reality that traditional delta farmers evaluate success by the ecological health of their soil, the natural integrity of their land, and the long-term safety of their products.

This research highlights a profound paradigm split between policy assumptions and agrarian realities. For the delta farmers of Tamil Nadu, agricultural success is fundamentally determined by the holistic wellness of the agro-ecosystem and crop yields, rather than purely commercialized,

productivist business outputs. Even amidst aggressive technological disruptions, these communities deliberately lean on time-tested, traditional adaptive methods.

Farming in the Cauvery delta is practiced not merely as an economic enterprise, but devotionally as a sacred stewardship to safeguard agricultural landscapes for upcoming future generations. Governed by this intergenerational ethic, traditional farmers actively avoid chemical pesticides and harmful, soil-degrading fertilizers to artificially boost short-term yields, even when such inputs are subsidized or offered at minimal cost by commercial sectors.

If climate finance is to achieve genuine, sustainable agricultural improvement in Tamil Nadu, the global and national policy architecture must pivot away from rigid, supply-driven, market-centric frameworks. It must actively transform into an inclusive, participatory system that recognizes, respects, and funds the unique moral economy, traditional knowledge systems, and devotional stewardship ethics of the delta farming community.

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