Evaluating Equity and Governance Gaps in Distribution of Micro-Irrigation Technology Subsidy: Evidence from Palnadu District, Andhra Pradesh

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ABSTRACT

Context: Demand for micro-irrigation (MI) technologies has increased in semi-arid agricultural areas due to water scarcity, but the spread of such technologies promoted through government subsidy schemes has often been compromised by poor governance and elite capture, with the most vulnerable farmers failing to benefit.

Objectives: This paper examines awareness levels, identification of beneficiaries, impact on use and the estimation of leakages among state government-subsidized Micro-Irrigation System (MIS) schemes in Palnadu District of Andhra Pradesh, India.

Methods: The primary data were collected from 145 farmers belonging to 4 villages in Macherla mandal through a structured schedule and the data was analysed with the help of $\chi 2$ tests.

Key Results: However, 60.42% of applications were approved, and implementation was highly unequal. Delays in subsidies were reported in 46.55% of the cases, field verification was insufficient in 66.21%, and elite capture was noted in 50.34% of the recipients. Tenant farmers were excluded at a rate of 54.48%, and collusion between contractors, government officials and beneficiaries was found in 64.14% of cases. Education was a significant predictor of scheme awareness (χ^2 (df) =11.24, p=0.024), and self-exclusion — rather than formal discrimination on the basis of land size — was one of the major barriers to access. Among the respondents who actually benefited (n = 26), a total of 89.66% reported water savings of 30–50%.

Implications: To promote more equitable irrigation development there is a need for direct and transparent beneficiary selection, strong field monitoring, affirmative action for small and marginal farmers and protection of scheme administration from political interference.

Keywords: Micro-irrigation subsidies, elite capture, governance failures, beneficiary identification, political economy, water-saving technologies, agricultural equity, Andhra Pradesh

INTRODUCTION

Water is one of the most limiting resources for agricultural sustainability in the semi-arid regions of India, and the livelihoods of millions of smallholder farmers are at risk as groundwater levels are depleting, rainfall patterns being erratic due to climate change, and irrigation practices are inefficient (Mohan et al., 2024; Singh, 2024). Micro-Irrigation System (MIS) options including drip and sprinkler irrigation systems have also increased adoption as technically feasible interventions to minimize water use by 30-50% without compromising or increasing yield through accurate application of water in the root zone of plants (Kiruthika & Suresh Kumar, 2020; Archana & Suthacini, 2024). In view of this, the Government of India has also made substantial investments towards the promotion of MIS adoption through subsidy schemes under the Pradhan Mantri Krishi Sinchai Yojana (PMKSY) as well as at state level, with clear policy focus to give priority to small and marginal farmers who are the most water stressed and have the least means to access to technology.

However, increasing evidence indicates marked divergences in policy intentions and implementation outcomes at the ground level. Research reveals that there has been pervasive elite capture in which subsidies meant for marginal and resource-poor farmers have been largely cornered by the richer farmers, those who have greater access to documentation, political clout and knowledge of the workings of bureaucracy (Rao & Prasad, 2019; Ponugoti, 2025). Srinivas and Reddy (2018) noted that political patronage influences the selection of beneficiaries, and Deveshwar (2024) pointed out that subsidies can be captured without use due to a lack of sufficient monitoring. The patterns here raise fundamental concerns about fairness, governance and value for money in spending on public agricultural welfare schemes.

Micro-Irrigation in Andhra Pradesh and Macherla Context

Andhra Pradesh has been considered a water scarce state, with its semi-arid climate, reducing per capita availability of water (declining @1.5% annually as per Central Water Commission, 2022), and smallholder-dominated agriculture makes it a critical setting to analyse constraints in MIS adoption. The state has been actively promoting micro-irrigation with subsidies towards 60-90% of installation costs for different categories of farmers but the uptake is significantly below potential — a mere 15% of the estimated 72-78 million hectares of technically feasible land in India is presently under micro-irrigation (Kishore et al., 2023).

Palnadu District and in particular Macherla mandal within it is an illustration. Situated in the Krishna River basin, Macherla faces perpetual water shortage as a tail end in canal systems and over-exploited groundwater aquifers, with its agrarian economy reliant mainly on borewell irrigation (about 55 per cent of farmers are dependent on it) along with scanty canal supplies and depleting traditional tank systems. The region's cropping pattern—water-intensive paddy (29%) followed by groundnut (24%), cotton (21%) and budding horticulture (8%) – generates significant water demand-supply disparities. The district agricultural figures show medium and large farmers, who constitute only 22% of farmers, receive nearly 60% of the subsidies of the MIS subsidy, an indicator to the bias-prone administration (State Agricultural Department, 2021). The local governance apparatus in Macherla involves a range of actors—Mandal Agricultural Officers, elected Gram Panchayat members, private contractors who are supplying and sealing equipment, and state-level bureaucracy that manages the flow of subsidies—multiplying principal-agent dilemmas and scope for rent-seeking, asymmetric information, and discretionary decision-making. The socio-economic stratification in the region, with 57% of the farmers practising below 5 acres and 55% of the farmers earning less than ₹2,00,000 annually, and 15% of the population illiterate; along with patriarchal patterns of land ownership (91% male-headed farms), interact with implementation processes processes leading to exclusionary outcomes. Understanding these contextual elements have an impact on access to and use of the MIS scheme is essential for formulating just and successful agricultural water policies.

LITERATURE REVIEW AND THEORETICAL FRAMEWORK

Technical Efficacy and Adoption Determinants

Extensive research substantiates the capability of MIS technologies to enhance water-use efficiency dramatically. Kiruthika and Suresh Kumar (2020) reported 30-40% of water saving among the adopters of drip irrigation in Tamil Nadu, however, it was also found that technical inefficiencies resulted from inadequate post-installation support in realizing the full benefits. Yadav and Deshmukh (2025) reported similar results in Chhattisgarh with household-level energy efficiency gains but very high initial costs, delayed disbursal of subsidies, and limited technical guidance as significant barriers to adoption among resource-poor farmers. Abila Doss and Asokhan (2025) highlighted socio-psychological barriers such as perceived functional difficulties and complexity of operations and maintenance. Determinants of adoption are not based solely on the technology being appropriate but also on the education level of the farmer, contact with extension, income, size of farm and rural credit (Yadav et al., 2018; Singh & Gandhi, 2023). Archana and Suthacini (2024) revealed good awareness and subsidy as the major motivating factors in southern India; however Shanthasheela's (2025) findings also drew attention to several critical deficiencies in post-sale support and availability of spares that impede long run usage. Overall, the findings from these studies suggest that even potential technological potential is not

enough—institutional support, financial availability, and human capital capabilities play critical roles in realized adoption and use.

Governance Failures and Elite Capture

Political economy analyses on the delivery of welfare schemes show predictable patterns of access capture and elite capture. Land rights-based criteria for inclusion in land rights programmes or other benefits inherently discriminate against tenant farmers and landless labourers who are substantial majorities of real cultivators but do not have formal titles, Mohan et al. (2024). Political influences play a roll in the irrigation subsidy is illustrated by Ponugoti (2025) who demonstrates that political influence on administrative discretion helps the well-off farmers in farming irrigation subsidies into patronage resources. Deveshwar (2024) highlighted that subsidies can result in situations where farmers install systems only to obtain benefits rather than for actual agricultural use. Government of India (2014) surveys under PMKSY have indicated that complex documentation requirements and procedural opacity of procedures and absence of transparency would regularly discourage already marginalized farmers to apply, in thus creating a de facto barrier that prevents from entry into formal selection processes. Reddy et al. (2023) contended that a long-term institutionalized monitoring and accountability mechanisms are necessary conditions for just implementation in drought-prone areas. Singh (2024) raised concerns about "rebound" implications on efficiency gains, whereby, paradoxically, improved irrigation efficiency leads to an increase in aggregate water use, in the absence of institutional mechanisms to regulate water distribution – demonstrating that solutions require governance approaches-alongside technological ones.

Research Gap

Firstly, a majority of studies investigate technical efficiency or socio-economic factors alone, with rather marginal consideration for the aspects of governance and the political economy. Secondly, the processes of beneficiary identification – the ways in which farmers are selected and approved, rather than post-adoption outcomes, have received less attention. Thirdly, the perception-based indicators reflecting farmers' day-to-day experiences of fairness of implementation, political interference, and witnessed misuse are under-utilised, despite being crucial to scheme legitimacy and reform prioritisation. There has been no research that has specifically focused on the processes of selecting beneficiaries in the Palnadu district with an emphasis on governance failures, elite capture and exclusion mechanisms, thus leading to a localized gap in empirics on the implementation of micro-irrigation subsidies. This research fills these voids by coupling quantitative study of application success rates and approval routines with a systematic account of perceived exclusion, élite capture and governance breakdown in Palnadu District.

Objective and Research Questions

Objective: To assesses the awareness levels, identification of beneficiaries, impact on use and the estimation of leakages among state government-subsidized Micro-Irrigation System (MIS) schemes in Palnadu District of Andhra Pradesh, India.

This paper deals with three related questions:

1. What are the socio-economic and institutional determinants of a farmer's awareness, adoption behavior and success of adoption of a MIS/subsidy scheme?
2. Are there traces of elite capture, political capture, and systematic exclusion of marginal and landless farmers in the beneficiary identification processes?
3. What bureaucratic distortions, such as delays in disbursement, inadequate inspections, contractor-official collusion, and post-installation misuse of the product, contribute to the poor performance of the scheme?
4. By analyzing these questions with primary field data and farmers' perceptions of the fairness in implementation, this study aims to produce evidence-based policy implications for enhancing equity and accountability in delivery of agricultural welfare.

DATA AND METHODS

Study Area and Sampling

The study area was purposively selected from four villages in Macherla mandal, Palnadu District, Andhra Pradesh, to capture differences in irrigation access (borewell-dominated versus canal-dependent regions), crop diversity and levels of penetration of MIS schemes. Out of 160 farmers approached, 145 participated in the survey, making for a response rate of 90.6%. A sample size of 145 for chi-square analysis will yield roughly 80% power to detect medium effect sizes (w=0.30) at α=0.05, thus the statistical precision for the tested associations can be considered adequate. A total of 145 farmers were selected by stratified random sampling to represent different categories of landholding, which was expected to provide sufficient reliability and confidence for statistical analysis and extrapolation within the study area.

Data Collection and Variables

Data were collected through as structured Schedule through face to face survey. The instrument had five parts: (A) socio-economic and farm profile (age, gender, education, size of landholdings, category of farmer, principal crop, income, pre-MIS source of irrigation); (B) awareness, application status, approval results, subsidy timeliness, and approval determinants as perceived by respondents; (C) beneficiary identification procedures, documentation, and perceptions of disenfranchisement and capture by elites; (D) implementation problems such as under-utilization, equipment diversion, collusion between beneficiaries and others, and quality of inspection; (E) impact evaluation on water savings. The explanatory variables were landholding size, income, education, sex and source of irrigation and the outcome variables were awareness about MIS, application behavior, approval status and perception of quality of governance.

Analytical Techniques

Frequencies and percentages were used to describe the demographics of the sample and distribution of responses. Cross-tabulations and Chi-square tests were used to test the following associations between socio-economic variables and key outcomes: landholding category × application approval, income × perception of elite capture, farmer category × perceived differential difficulty, education × awareness, irrigation source × application behavior. Statistical significance was assessed at the 5% level. Perception-based questions were studied to highlight majority views and trends indicating system realisation biases.

RESULTS

Socio-Economic Characteristics of Respondents

Table 1: Socio-Economic Profile of Sample Farmers (N=145)

Variable	Category	Frequency	Percentage
Age Group	20-40 years	50	34.48
	41-60 years	81	55.86
	Above 60 years	14	9.66
Gender	Male	132	91.03
	Female	13	8.97
Education	Illiterate	22	15.17
	Primary	30	20.69
	Secondary & above	93	64.14
Farmer Category	Marginal (<2.5 acres)	44	30.34
	Small (2.5-5 acres)	39	26.90
	Semi-medium+ (>5 acres)	62	42.76
Annual Income	<₹2,00,000	80	55.17

	₹2,00,000-4,00,000	43	29.66
	>₹4,00,000	22	15.17
Primary Irrigation	Borewell	80	55.17
	Surface (Canal/Tank)	39	26.90
	Rainfed	22	15.17
Main Crop	Paddy	42	28.97
	Groundnut/Cotton	66	45.52
	Horticulture/Chilli	30	20.69

The sample is characterized by majority subject farmers who are middle-aged (mean 45.3 years), predominantly male (91.03%), slightly literate (84.83%), with a significantly stratified agrarian structure (57.24% operating below 5 acres). The income distribution indicates a high level of inequality, as 55.17 % make less than ₹200,000 per year, which is financially vulnerable. Borewell reliance (55.17%) indicates excessive dependence on groundwater, in contrast to mixed cropping (water guzzling paddy at 28.97% with commercial crops) promote diversified irrigation needs.

Awareness, Application, and Approval Patterns

Table 2: MIS Scheme Awareness, Application Status, and Outcomes (N=145)

Parameter	Response	Frequency	Percentage
Awareness of MIS Subsidies	Yes	118	81.38
	No	27	18.62
Applied for MIS	Yes	96	66.21
	No	49	33.79
Application Outcome (n=96)	Approved	58	60.42
	Rejected	26	27.08
	Pending	12	12.50
Subsidy Received on Time (n=58)	Yes	31	53.45
	No	27	46.55
Selection Criteria Explained	Yes	47	32.41
	No	98	67.59
Landholding Influenced Approval (n=96)	Yes	64	66.67
	No/Unsure	32	33.33

High awareness (81.38 %) suggests that the information dissemination is reasonably good, however, the application of the information (66.21 %) indicates a decay of 15 percentage points which implies that there are other constraints besides the lack of information. A selective screening: among the applicants, 60.42 % were approved and 27.08 % were rejected.

Crucial 67.59 % said the criteria were vague for selection – which is a basic transparency malfunction that allows for discretionary enforcement. Although the chi-square test revealed no significant association (Table 5) within the applicant pool, the fact that 66.67% considered that having land is necessary for approval could mean that self-exclusion happens before formal application. Late payment of the subsidies (46.55 %) adds up to liquidity constraints, especially impacting the poor farmers, who must obtain the money upfront, in the expectation of a prompt reimbursement.

Beneficiary Identification and Exclusion Evidence

Table 3: Perceptions of Exclusion, Elite Capture, and Political Influence (N=145)

Perception Indicator	Yes	No/Unsure	Total
Small/marginal farmers face more difficulty	101 (69.66%)	44 (30.34%)	145
Well-off farmers received subsidies despite capacity	73 (50.34%)	72 (49.66%)	145
Large/influential farmers have better access	97 (66.90%)	48 (33.10%)	145

Same family received benefits multiple times	56 (38.62%)	89 (61.38%)	145
Political connections influence selection	88 (60.69%)	57 (39.31%)	145
Tenant farmers/sharecroppers excluded	79 (54.48%)	66 (45.52%)	145
Medium/large farmers receive benefits more frequently	71 (48.97%)	74 (51.03%)	145

The dominant narratives reflect systemic failures in governance, the 69.66% acknowledged that small farmers face more challenges, 66.90% believe that access is reserved for big and influential farmers, 60.69% stated that the system is politically influenced—these three could be summarised as saying that it is social, economic and political capital, rather than technical eligibility that determines one's access. Evidence of elite capture (50.34% reporting wealthy beneficiaries) and exclusion of tenants (54.48%) point to limited in design and execution. The 48.97% who consider medium/large farmers as the biggest beneficiaries is in fact in contrast to the policy goals that favored smallholder. Although opinions may be subjective in nature, their agreement across different groups of respondents (Table 6) implies that they represent realities in the field rather than being unique personal perceptions.

Implementation Challenges and Misuse

Table 4: Implementation Problems and Governance Quality (N=145)

Implementation Problem	Yes	No/Unsure	Percentage Reporting Problem
MIS installed but not used regularly	67	78	46.21%
Equipment diverted/resold/unused	41	104	28.28%
Contractor-official-beneficiary collusion	93	52	64.14%
Field inspections inadequate	96	49	66.21%

A large shares report that they had installed but do not used (46.21%) and the diversion of the equipment (28.28%), which indicates capture of subsidies without achieving developmental goals. A full 64.14% think there is contractor-official-beneficiary collusion, which reveals an understanding of tripartite rent-extraction nexuses wherein equipment suppliers, implementing bureaucrats, and some beneficiaries collude to inflate costs, approve poor-quality installations, or share surplus subsidies. Inadequate field inspections (66.21%) is a critical monitoring failure—as long as there are not stringent checks on eligibility prior to installation and monitoring of usage after installation, unethical claims and non-operational systems will go undetected and the leakage will persist.

Statistical Associations: Chi-Square Analysis

Table 5: Landholding Category and Application Approval Outcome

Farmer Category	Approved	Rejected	Pending	Total	χ^2	p-value
Marginal	18 (62.1%)	10 (34.5%)	1 (3.4%)	29	8.42	0.394
Small	16 (59.3%)	8 (29.6%)	3 (11.1%)	27		
Semi-medium	13 (59.1%)	6 (27.3%)	3 (13.6%)	22		
Medium	7 (63.6%)	2 (18.2%)	2 (18.2%)	11		
Large	4 (57.1%)	0 (0.0%)	3 (42.9%)	7		

Within the applicant pool there is no significant relationship (χ^2 (df) =8.42, p=0.394) between the category of landholding and the outcome of approval. The approval rates are tightly clustered between 57.1% (large) and 63.6% (medium), which would suggest that there is no overt bias against landholding in the formal selection procedure once an application is received.

Nonetheless, the fact that none of the applications of the large farmers was rejected (0% versus 34.5% for marginal) is worth noting despite the small sample size. Most importantly, it does not account for those barred from applying—should marginal farmers be discouraged to apply (self-exclusion), it is the pool of applicants that is skewed, hiding discrimination prior to formal assessment.

Table 6: Education Level and MIS Scheme Awareness

Education	Aware	Not Aware	Total	χ^2	p-value
Illiterate	14 (63.6%)	8 (36.4%)	22		
Primary	23 (76.7%)	7 (23.3%)	30		
Secondary	32 (84.2%)	6 (15.8%)	38	11.24	0.024*
Intermediate	28 (87.5%)	4 (12.5%)	32		
Graduate+	21 (91.3%)	2 (8.7%)	23		

*Significant at $p<0.05$

The significant association (χ^2 (df) =11.24, p=0.024) indicates the presence of an educational gradient in awareness: more than one-third of illiterate farmers are still not aware as compared to only 8.7% of graduates. Such information asymmetry results in de facto discrimination — the uninformed can't apply. The pattern probably results from the fact that well-educated farmers are more likely to have access to written materials and to be contacted by the media, by government officials, and have confidence in dealing with bureaucracies. Since illiteracy is associated with poverty, those who would benefit most from subsidies are the least likely to be informed about them--confirming the necessity for focused audio-visual messages, door-to-door outreach as well as for distillation of complexities of information.

Impact Assessment

Among the 58 accredited recipients of MIS installation, 89.66% experienced a decrease in water consumption as opposed to conventional irrigation, with a major portion having 30-50% savings. This substantiates the technological efficiency when adequately applied. On the other hand, high technical efficiency is contrasted with considerable signs of underuse (46.21%), elite capture (50.34%), and exclusion (69.66% sensing differential difficulty for the small farmer), to reveal a basic misfit: the technology is sound, but governance failures preclude its fair provision to those who would gain the most and make most productive use of it.

DISCUSSION

Governance Deficits and Institutional Failures

The results reveal an erosion of governance in various aspects that led to unfair enforcement. Communalities reported were that there were non-transparent criteria of selection (67.59%) and an information opacity that allowed for discretionary decision-making and rent-seeking. Poor field inspections (66.21%) allow fraud and low-quality equipment to go unnoticed. Beneficiaries suffer (46.55%) from delayed subsidies, and possibly distress borrowing. These failures are not isolated execution errors; they are systemic patterns consistent with weak accountability, understaffing, and collusive relations between implementing agencies and contractors.

The contractor-official-beneficiary triad perception (64.14%) is consistent with principal-agent theory analyses of welfare schemes assuming minimal monitoring combined with discretion vested in officials: rent extraction equilibria develop wherein contractors overcharging, shares proceeds with approving official, and delivers substandard equipment to adversely impacted beneficiaries who acquiesce to lower quality solutions in exchange for smaller up-front contributions (Bardhan & Mookherjee, 2000). To break such equilibria one must introduce structural reforms—competitive e-procurement, randomized beneficiary-contractor assignment, third-party quality audits, and protected whistleblower mechanisms.

Elite Capture and Political Economy

Rich farmers receiving subsidies (50.34%), large farmers have better access (66.90%), political influence (60.69%), and that medium/large farms are the greatest recipients (48.97%)—corroborates political economy criticisms of agricultural welfare programs. As noted by Mohan et al. (2024) and Ponugoti (2025) found comparable patterns across the country. Elite capture takes place via multiple channels: better documentation and credit that helps in subsidy navigation, political connections that help in gaining approval, bureaucratic

knowledge that results in lower transaction costs, and officials' interests that align with processing larger installations as they yield higher absolute subsidies and potential kickbacks.

It is important that the statistical insignificance of the landholding × approval relationship (Table 5) does not undermine the evidence for elite capture (Table 6). Self-exclusion prior to formal application–marginal farmers conclude it is ineffective or they cannot come up with what is required up front–skews the applicant pool toward those who are most likely to be approved. So discrimination happens before selection by the state, making the official approval statistics appear more fair. That argues for the focus on the entire access funnel–from awareness to application to approval–rather than just the end position.

Exclusionary Design: The Tenant Farmer Problem

Exclusion of tenant (54.48 %) exposes core design flaw: land ownership-based eligibility neglects in situ situation where significant cultivation is by tenanting. As Mohan et al. (2024) highlighted, this prioritization of property rights at the expense of cultivation rights systematically displaces the poorest and most vulnerable landless cultivators who stand to gain the most from irrigation efficiency upgrades. it also distorts incentives by allowing landlords to pretend that they have ownership of the land and use that "credential" to claim subsidies but they install on non-tenanted plots or they don't install at all, thus, benefit leakage without any agricultural innovation. These reforms are subject to political economy limitations—landed elites will resist the inclusion of potential competitors—but they are vital for justice and effectiveness.

Education-Awareness Nexus and Capability Barriers

The prominent education-awareness correlation (Table 6) along with 15.17% of the respondents being illiterate and 35.86% having under 10 years of formal education signifies a potential barrier to access which the needs of the LDCs intimated in the preceding section could be matched with. Dissemination of information presupposing literacy and bureaucratic savvy invariably disadvantages farmers with low levels of education. As Sen (1999) framed it, real access means more than just the existence of schemes, it also depends on what capabilities one has to transform resources into functioning – these include literacy, possession of documents, knowledge about the system, and trust in bureaucratic process.

This needs to be tackled through multiple channels: using audio-visual mediums in local languages, officials from the agriculture department reaching out door-to-door, mandatory gram panchayat awareness meets (with attendance registers), dedicated facilitation centers for assisting in documentation, and streamlining of application processes (making them less bureaucratic for the marginal farmer).

From Technological Fix to Institutional Reform

The paradox of high technical effectiveness (89.66% are water saving users) coupled with widespread governance failures indicates that water scarcity solutions are dependent on institutional change rather than simply on the introduction of new technologies. "In view of the rebound effects, technological efficiency gains need to be complemented by governance ensuring that water savings lead to aggregate conservation rather than in an expansion of cultivated area or crop intensity" (Singh, 2024). In line with this expectation, the current study finds that a non-transparent selection procedure combined with weak monitoring and accountability allowed (MIS) subsidies to be misused and generated small developmental outcomes despite the promise of the technology.

Successful enforcement requires: 1) rule-based (publication of the algorithm and at least the socio-economic profile of approved beneficiaries), transparent beneficiary selection; 2) affirmative action-based quotas for the marginal farmers, women cultivators and tenant farmers; 3) performance based subsidies paid in installments linked to on the quality of installation and utilization; 4) independent third-party technical audits and unannounced inspections; 5) community monitoring in the forms of social audits and grievance redressal; and 6) protection from political interference by instituting merit based selection and charging the political class with favoritism.

CONCLUSIONS AND POLICY RECOMMENDATIONS

This study contributes to existing debates by presenting evidence of substantial governance failure and Elite capture in the application of MIS subsidies and hence raises question about the governance in context of Palnadu District, Andhra Pradesh. High levels of awareness and technological efficacy support continued investment in micro-irrigation dissemination, but structural barriers limit fair access and productive use. Principal findings include: known transparent selection criteria not divulged to 67.59%; political interference in selection was perceived by 60.69%; exploitation of the system by the rich was noted by 50.34%; exclusion of tenants was felt by 54.48%; installation without use was experienced by 46.21%; and insufficient inspections were reported by 66.21%. Statistical tests show educational gradients in awareness but no apparent discrimination on the basis of landholdings among the applicant pools, which could indicate that self-exclusion, comes before formal selection.

Policy Recommendations: (1) Transparency and Accountability: Make beneficiary selection algorithms public; require disclosure of profiles of selected beneficiaries; establish grievance redressal mechanisms with sanctions for baseless rejections. Affirmative Provisions: 60% quotas be reserved for marginal and small farmers proportional to their population; enhanced rates of subsidy be given to the economically weaker sections; specific provision for women and for tenant farmers in possession of cultivation certificates be introduced. Better Access: Set up facilitation centers to help with paperwork, mobilize agricultural extension workers to reach out to farmers directly, and accept simplified documentation from marginal farmers. (4) Enhanced Supervision: Require geo-tagged photographic documentation; perform third party technical audits; disburse subsidies in tranches tied to proofs of verification of quality and of utilization; hold surprise inspections with responsibility for approval of non functioning installations. (5) Anti-Collusion Measures: Introduce competitive e-procurement, which would limit contractor discretion; randomize beneficiary-contractor matching; shield whistleblowers who report corruption. (6) Political Insulation: Utilize a rule-based selection algorithm that minimizes discretion; create a political favoritism accountability mechanism. Further research is to be conducted on: the differential effects within caste and gender groups; challenges in the long-term use and maintenance; a comparative study of the selection of beneficiaries in states with different qualities of governance; and experimental interventions to test transparency and quota systems. In the end, unlocking the developmental potential of micro-irrigation for water-scarce areas requires not just the delivery of technology, but the transformation of governance to ensure equal access to technology, its productive use, and providers of public resources held accountable.

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