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Research Article

Rethinking Fertilizer Subsidies for Small-Scale Aquaculture: A Governance and Impact Perspective

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Abstract: *Fertilizer subsidies are widely used by governments as a policy tool to boost aquaculture productivity and support rural livelihoods. Yet, in many developing countries, including Indonesia, their effectiveness in reaching small-scale fish farmers remains uncertain. This paper examines two interconnected dimensions of the issue: (1) the governance effectiveness of subsidy distribution systems, and (2) the socio-economic impacts experienced by smallholder fish farmers. Through a conceptual review of academic literature and official policy documents, the study identifies critical shortcomings in current fertilizer subsidy programs, particularly in terms of inclusion, transparency, and geographically targeted delivery. While policies often prioritize input distribution and national production targets, they frequently overlook equity, environmental sustainability, and adaptive governance. The analysis reveals that most subsidy schemes fail to reach their intended beneficiaries. This is largely due to rigid, top-down planning and insufficient involvement of local stakeholders. Furthermore, non-localized supply chains and the absence of real-time data systems, which together undermine efficiency and increase the vulnerability of small-scale farmers. The paper proposes a new conceptual governance model that integrates spatial equity, digital traceability, and multi-stakeholder participation. By highlighting these insights, the study contributes to ongoing debates on sustainable aquaculture governance and offers actionable, policy-relevant recommendations for redesigning input subsidy programs to be more inclusive, transparent, and results-driven. This review also lays the groundwork for future empirical research aimed at evaluating governance performance and measuring the actual impacts of subsidies across diverse aquaculture settings.*
Keywords*: Fertilizer subsidy, small-scale aquaculture, governance effectiveness, socio-economic impact, inclusive policy, sustainable development*

1. Introduction

Aquaculture has emerged as one of the fastest-growing food sectors globally, playing a critical role in food security, poverty reduction, and rural employment, particularly in developing countries (FAO, 2021). Small-scale aquaculture (SSA) represents the backbone of fish farming in many parts of Asia and Sub-Saharan Africa, where it supports millions of households (Beveridge et al., 2013; Nune, 2008; Subasinghe & Phillips, 2010). However, SSA is often constrained by limited access to affordable inputs such as feed, seed, and fertilizers (Hasan, 2020).

Fertilizer subsidies have been widely adopted as a policy instrument to enhance aquaculture productivity and improve the livelihood of smallholder farmers. These fertilizer aim to stimulate plankton growth in pond ecosystems, thereby reducing the reliance on expensive external feeds (Ahmed & Lorica, 2002; Fatimah & Muhafidin, 2024). While the rationale for fertilizer subsidies is well-founded, evidence suggests that their implementation is often plagued by inefficiencies, lack of transparency, and privilege Sezure (Peñalosa-Martinell et al., 2025; Ruffino, 2017). Moreover, subsidy schemes frequently adopt a top-down, bureaucratic approach, disconnecting policy design from on-the-ground realities (Firdausi et al., 2025; Suryana et al., 2016).

The consequences have multi-fold, especially in SSA. Subsidies may fail to reach their intended beneficiaries such as SSA, due to weak institutional coordination, poor data systems, and exclusionary governance (Huang et al., 2011; Mitra et al., 2024). Additionally, many subsidy programs lack environmental safeguards and do not align with broader sustainability goals, contributing to long-term

ecological risks (Holden, 2018). Despite their potential, fertilizer subsidies often end up reinforcing inequality and inefficiency unless guided by inclusive and accountable governance structures.

This paper critically reviews existing literature to analyze the main question addressed is how fertilizer subsidy governance affects the socio-economic outcomes of small-scale aquaculture. We explore three core dimensions: policy effectiveness, distributional equity, and governance frameworks. The paper argues for a paradigm shift toward transformational governance, an approach that incorporates participatory, adaptive, and evidence-based mechanisms to restructure input subsidy programs. This study aims to offer conceptual clarity and actionable recommendations for policymakers and researchers seeking to reform subsidy governance in the aquaculture sector.

2. Literature Review and Hypothesis Development

Weak Governance Undermines Subsidy Effectiveness

Multiple studies consistently highlight that weak institutional governance is a key bottleneck in subsidy distribution (Holden, 2018; Nhlengethwa et al., 2023). In Indonesia, the e-RDKK digital subsidy system was introduced to reduce leakages, but field-level implementation remains inconsistent due to poor digital literacy and bureaucratic complexity and also limited capacity of local institutions hinders transparency (Firdausi et al., 2025; Putri et al., 2023; Suryana et al., 2016). The absence of reliable beneficiary databases, lack of real-time tracking systems, and minimal accountability frameworks create an environment conducive to elite capture and diversion of subsidized inputs (Rahmat et al., 2024).

Exclusion of Smallholders from Subsidy Access

Though fertilizer subsidies are meant to target smallholder farmers, evidence shows that medium to large-scale aquaculture enterprises often dominate access. Structural biases,such as land ownership requirements or complex application procedures, marginalize poor and landless farmers (Mitra et al., 2024). In Kenya, for example, only 38% of intended small-scale aquaculturists reported receiving input subsidies, despite being registered beneficiaries (Muthoka et al., 2024). Digital platforms like e-vouchers can improve targeting, but their success depends heavily on mobile access and literacy, which are unevenly distributed across rural communities (Ba, 2019; He et al., 2025).

Socio-Economic Impacts: Mixed and Uneven

Subsidies can reduce production costs and increase fish yields—leading to higher incomes and food security—but these benefits are unevenly distributed. Studies from Vietnam and India show that beneficiaries with access to extension services and cooperative networks are more likely to convert input support into productivity gains (Ansari & Sheereen, 2022; Fatimah & Muhafidin, 2024).

Conversely, poorly timed or misallocated subsidies can cause financial strain, forcing smallholders to seek private inputs at inflated prices during peak seasons (Jolly et al., 2023). This results in increased cost of production and reduced profit margins, undermining the original goals of the subsidy programs.

Moreover, environmental concerns emerge when subsidized chemical fertilizers are over-applied, leading to water pollution and degradation of pond ecosystems (Partelow et al., 2023). This has long-term implications for ecosystem sustainability and farmer resilience.

Positive Deviance: Lessons from Adaptive Governance

Countries such as Nepal and Vietnam offer cases where participatory governance and decentralized distribution models have enhanced subsidy effectiveness. For instance, Nepal's area-based subsidy targeting and cooperative-managed input distribution has improved transparency and inclusivity

(Gautam et al., 2022). Similarly, in Vietnam, integration of subsidy programs with farmer field schools has empowered communities to monitor allocation and outcomes (Lai et al., 2009; Nguyen et al., 2023).

These cases demonstrate that effective governance, not subsidy volume, drives outcomes, reinforcing the need for context- specific, adaptive policy design (Aziz et al., 2025; Bush et al., 2019)

Conceptual Framework: Governance, Subsidies, and Socio-Economic Outcomes

Input Subsidies in Agricultural and Aquaculture Development

Input subsidies have long been a central policy tool in the Global South for stimulating agricultural and aquaculture growth (Jayne et al., 2017; Pingali, 2012; Sumaila, 2024). In theory, these subsidies address market failures, improve input accessibility, and reduce production costs for smallholder farmers (Morris et al., 2007). In aquaculture, subsidized fertilizers are particularly vital for enhancing natural pond productivity and reducing feed dependence (FAO, 2021). However, the actual efficacy of input subsidies is highly context-dependent and influenced by governance quality ((Nhlengethwa et al., 2023).

Good Governance and Transformational Governance in Input Distribution

The concept of good governance in subsidy distribution encompasses transparency, accountability, stakeholder participation, and institutional coordination (Wellard et al., 2016). Yet, in fragmented bureaucratic systems, subsidy programs often lack these attributes (Booth, 2011). Recent literature advocates for transformational governance, which emphasizes adaptive policymaking, cross-sector collaboration, and digital innovations in monitoring (Rahmat et al., 2024). This model is increasingly relevant for sectors like aquaculture, where socio-ecological complexity demands dynamic and localized solutions (Aziz et al., 2025).

Socio-Economic Impact Indicators for Small-Scale Aquaculture

To evaluate subsidy outcomes, scholars highlight several socio-economic indicators: household income, production efficiency, market access, flexible, and inclusion in decision-making processes (Bush et al., 2019; Muthoka et al., 2024). A well-governed subsidy system can enhance these indicators by ensuring equitable input access and reducing vulnerability. Conversely, poorly managed subsidies may deepen rural inequality, distort market behavior, and foster rent-seeking (Dorward & Chirwa, 2011).

Theoretical Integration

This paper integrates three thematic domains, policy design, distributional mechanisms, and livelihood outcomes, through the lens of governance. Figure 1 visualizes this interrelation. The literature suggests that improving governance structures, rather than merely expanding subsidy budgets, is key to maximizing the socio-economic return of fertilizer support in aquaculture (Holden, 2018; Jolly et al., 2023).

Figure 1. Interrelation between policy design, distributional mechanism and livelihood outcomes through lens of governance.

3. RESEARCH METHOD

This article adopts a qualitative, desk-based review approach, synthesizing existing literature on fertilizer subsidies in the context of small-scale aquaculture (SSA). The methodology integrates elements from systematic literature review (SLR) and narrative synthesis, enabling the collection and interpretation of diverse perspectives on subsidy governance and its socio-economic implications. While not a meta-analysis, this review adheres to structured inclusion criteria and thematic coding to ensure academic rigor.

Search Strategy and Source Selection

To capture the most recent and relevant discourse, we searched across Scopus, ScienceDirect, SpringerLink, and FAO/World Bank repositories, using combinations of keywords: "fertilizer subsidy", "aquaculture", "small-scale fish farming", "governance", "policy", "socio-economic impact", "subsidy effectiveness", and "inclusive subsidy". In total, 412 papers were initially identified (2015–2025). After applying filters for open-access availability, relevance to smallholder aquaculture, and direct policy focus, 40 peer-reviewed journal articles and international policy reports were selected for final synthesis.

Inclusion Criteria

Articles were included based on the following:

a. Published in English between 2015–2025
b. Focused on subsidy policy, governance models, or aquaculture livelihood impacts
c. Emphasized small-scale or community-based aquaculture contexts
d. Open access or institutionally available full-text versions

Grey literature, such as FAO technical papers, WorldFish Tehcnical Paper and national evaluation reports, were also incorporated to enrich practical insights.

4. RESULTS AND DISCUSSION

Governance Gaps and Structural Inequity

The reviewed literature consistently indicates that governance shortcomings, rather than budget constraints, are the primary barriers to effective fertilizer subsidy implementation in small-scale aquaculture (Holden, 2018; Nhlengethwa et al., 2023). A centralized, top-down model prevails in most countries, where policy decisions are detached from local realities. For example, Indonesia's national e-RDKK system, while progressive on paper, suffers from outdated databases and limited field-level capacity (Firdausi et al., 2025; Suryana et al., 2016).

This disconnect between policy and practice creates structural exclusion. Land tenure is often a precondition for subsidy access, disadvantaging tenant farmers or women-led aquaculture enterprises (Liao et al., 2025; Mitra et al., 2024). Moreover, political patronage, local elite capture, and informal networks further skew distribution, contradicting the principle of equitable input allocation (Hasan, 2020).

Socio-Economic Implications: Beyond Input Support

Subsidies, when effectively governed, offer more than just input access, they catalyze rural transformation by improving productivity, reducing costs, and stabilizing incomes (Ansari & Sheereen, 2022; Fatimah & Muhafidin, 2024). However, poor timing, insufficient quantity, or lack of complementary services (e.g., technical training) can undermine these benefits. Several studies (Jolly et al., 2023; Muthoka et al., 2024) find that mismanaged subsidies increase smallholders' reliance on credit or lead to suboptimal production decisions.

Importantly, the social capital of fish farmers—such as membership in cooperatives or access to extension agents, amplifies the positive effects of subsidies (Bush et al., 2019; Lai et al., 2009; Thanh et al., 2022). This suggests that subsidies must be embedded within a broader ecosystem of support, rather than functioning as standalone interventions.

The Case for Transformational Governance

The current governance discourse around aquaculture subsidies is still largely compliance-oriented, focusing on fraud prevention and fiscal efficiency—rather than transformational, which emphasizes participation, learning, and systemic change (Giné et al., 2022; Rahmat et al., 2024). Drawing from best practices in Nepal, Vietnam, and Ghana (Gautam et al., 2022; Lai et al., 2009; Nguyen et al., 2023), a reoriented approach is needed, one that:

a. Prioritizes bottom-up input in policy design
b. Utilizes real-time digital monitoring systems
c. Encourages cooperative-led subsidy distribution
d. Embeds social inclusion metrics (e.g., gender, land access, geography)

This is especially relevant for aquaculture systems, where local ecological knowledge and management capacity are essential for sustainable production (Heymans et al., 2011; Partelow et al., 2023).

5. CONCLUSION

This review underscores the urgent need to reform fertilizer subsidy governance in small-scale aquaculture. While subsidies have potential to support fish farmers and improve rural livelihoods, governance failures, such as poor targeting, data inaccuracy, and exclusionary policies, often dilute their impact. The literature demonstrates that socio-economic outcomes depend less on the amount subsidized and more on how governance systems are structured and implemented.

Policy Recommendations

To move toward inclusive and effective subsidy governance, policymakers should:

a. Develop inclusive beneficiary identification systems, integrating gender, land status, and geographic vulnerability.
b. Strengthen local institutions, including cooperatives and extension services, to decentralize subsidy management.
c. Digitize distribution and monitoring processes, ensuring traceability and feedback loops.
d. Align subsidies with ecosystem-based aquaculture practices, minimizing environmental degradation.
e. Incentivize cross-sector collaboration, linking subsidies to training, insurance, and market access programs.

By embedding subsidies within a transformational governance model, countries can achieve not only increased productivity, but also more resilient and equitable aquaculture systems.

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