



Cow Manure Management Policy Innovation Based on Co-Creation and Mass Collaboration for Sustainable Environmental Governance: A Case Study of Kuningan Regency, Indonesia

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ABSTRACT

The rising population of beef and dairy cattle in Kuningan Regency, Indonesia, has generated a large volume of manure that threatens environmental quality when it is not managed properly. Although national and regional regulations already govern livestock waste, implementation at the village level remains weak, producing a persistent gap between policy on paper and practice on the ground. This study aims to describe and assess a participatory model of cow manure management policy built on co-creation and mass collaboration, and to examine how such a model can support a friendly and sustainable environment. A descriptive qualitative approach was used, and data were collected through in-depth interviews with multiple actors, field observations, and documentation studies of local regulations in Cipari Village, Cigugur District. The findings indicate that the co-creation phase established a space for equal dialogue among stakeholders, reduced sociological resistance, and produced jointly agreed standard operating procedures (SOPs) for waste management and communal pen zoning. The subsequent data-based mass collaboration strategy mobilised cross-sector support from non-governmental organisations, student volunteers, and the private sector through a blended finance scheme, enabling the construction of a village composting house and a communal biogas reactor. This synergy helped establish a circular economy ecosystem that converts waste into an economic asset, reduces air and river pollution, and supports regional food security consistent with Kuningan Regency Regulation No. 5 of 2022. Remaining obstacles include inconsistent participation among some senior farmers and the absence of a real-time digital monitoring platform. The study suggests that policy innovation grounded in co-creation and mass collaboration can shift the role of local government from a single provider (rowing) toward a network coordinator (steering), and offers a transferable, though context-dependent, reference for ecological governance in comparable regions.

Keywords: policy innovation; co-creation; mass collaboration; circular economy; environmental sustainability

INTRODUCTION

Livestock waste has become a significant public concern because of its wide-ranging effects on the environment and on human health, and its management requires coordinated attention to policy, infrastructure, and public education (Wicaksono et al., 2024). Among the various instruments available to public authorities, policy innovation has emerged as a strategic response to problems that can no longer be resolved through conventional, top-down administrative approaches (Sururi, 2016). In the classic formulation attributed to Walker, a policy may be considered innovative when it is perceived as new by the adopting jurisdiction, regardless of how long the program has existed elsewhere or how widely it has been adopted in other places (Tyran & Sausgruber, 2003).

In public administration, innovation is generally understood as the process of generating new policies, procedures, and services to address emerging public problems (Wahab, 2012). Prabowo et al. (2022) describe public sector innovation as the effort of public organisations to design new policies and to update



standard operating procedures so that they can respond more effectively to public needs. Innovation in this sense is therefore not only a technical fix but an effective, creative, and often distinctive solution to new problems, or a fresh approach to long-standing ones (Sururi, 2017). Increasingly, scholars argue that such innovation is best achieved through interactive and collaborative value creation among government, citizens, and the private sector rather than through the actions of the state alone (Ansell & Torfing, 2021; Emerson et al., 2012). Understood in this way, policy innovation functions as a strategic instrument for building sustainable governance, not merely as a one-off intervention (Muliawaty et al., 2024).

The livestock sector in Indonesia, and dairy cattle farming in particular, makes an important contribution to local and national economies, yet it also produces large volumes of manure (Handayani, 2024). When this waste is left unmanaged, it becomes a major source of water pollution, odour, and greenhouse gas emissions, and it may place farmers in breach of Law No. 32 of 2009 on Environmental Protection and Management. Conversely, manure holds considerable economic and environmental potential as a feedstock for organic fertiliser, biogas, and renewable energy (Lestari et al., 2024; Oyedun et al., 2025). This dual character, at once a pollutant and a resource, is precisely what makes manure a suitable object for policy innovation aimed at transforming waste into value.

Kuningan Regency, and specifically Cipari Village in Cigugur District, is a centre of dairy farming, with a combined beef and dairy cattle population of about 7,054 head (Badan Pusat Statistik Kabupaten Kuningan, 2025). This concentration of livestock generates an estimated 248 tonnes of cow manure per day (Kuningan Mass, 2024). When this volume is poorly managed, it pollutes air, soil, and water in downstream areas and produces health and environmental problems, including the pungent odour frequently reported by residents, microbial contamination, and river pollution (Detik Jabar, 2025). Poorly managed manure has, in fact, polluted local river sources and generated the kind of odour nuisance that has escalated into social conflict and repeated complaints from surrounding communities (Ruyani et al., 2025). These conditions point to a shortfall in environmental regulation and, more precisely, in its implementation at the grassroots level.

Normatively, the legal framework is already in place. Livestock waste management is governed nationally by Law No. 32 of 2009, while at the regional level the Kuningan Regency Government has issued Regional Regulation No. 7 of 2014 on the control of environmental impacts from livestock activities (Dinas Lingkungan Hidup Kabupaten Kuningan, 2014). This is reinforced by Regional Regulation No. 5 of 2022 on Regional Food Development, which links sustainable livestock production and environmentally sound resource management to regional food quality and security (Badan Perencanaan Pembangunan Daerah Kabupaten Kuningan, 2022). In principle, manure processed into organic fertiliser or renewable energy could strengthen a circular economy approach to the regional food system.

In practice, however, implementation has fallen short. Barriers such as insufficient infrastructure, limited local budgets, low farmer awareness, scarce land for pens, weak cross-agency coordination, and minimal technical assistance have allowed livestock waste to be discharged largely untreated (Ruyani et al., 2025). Comparable difficulties have been documented in other developing contexts, where the adoption of circular manure management is constrained by cost, limited technical expertise, and inadequate infrastructure (Oyedun et al., 2025). The result in Kuningan is a policy gap between regulation and field practice that continues to aggravate environmental pollution, and preliminary research points to a marked weakness in institutional synergy among the responsible agencies (Ruyani et al., 2025).

Contemporary public administration scholarship suggests that effective responses to problems of this complexity are built through co-creation and mass collaboration rather than through hierarchical command (Ansell & Torfing, 2021; Ansell et al., 2023; Torfing et al., 2019). Co-creation invites government, farmers, academics, non-governmental organisations, and local communities to design solutions together on the basis of real needs, while mass collaboration broadens participation into a more systemic effort through mechanisms such as data sharing, village-scale composting, cross-university technical assistance, and government-community partnerships (Bason, 2015; Tapscott & Williams, 2010).

Despite growing interest in collaborative governance, relatively little empirical work has examined how co-creation and mass collaboration operate together in a single livestock-waste setting in a developing country,



or how they interact across the formulation and implementation stages of a local policy. This study addresses that gap by analysing the dynamics of the collaboration process in Cipari Village, focusing on how the principles of co-creation and mass collaboration are applied by multiple actors, namely the local government, the dairy farmers' cooperative Karya Nugraha Jaya (KSU), farmers, and academics, to produce workable solutions for manure management and, ultimately, environmentally friendly and sustainable governance. The cooperative, which is based in Cipari and organises dairy farmer groups across Cigugur District, was established in 1998 as Koperasi Serba Usaha Karya Nugraha and has since developed into a producer cooperative, Koperasi Produsen Karya Nugraha Jaya Kuningan; for consistency with local usage, it is referred to in this paper simply as the cooperative (KSU).

Research Objectives and Questions

Building on the problem outlined above, this study pursues three objectives: (1) to describe how the principle of co-creation shapes the formulation of the cow manure management policy in Cipari Village; (2) to examine how a mass collaboration strategy expands the implementation of that policy and mobilises non-governmental resources; and (3) to assess the environmental, economic, and social outcomes of the model, together with the obstacles that constrain its sustainability. Accordingly, the study is guided by two questions. First, how do co-creation and mass collaboration function across the formulation and implementation of manure management policy at the village level? Second, to what extent does this collaborative model contribute to a circular economy ecosystem and to sustainable environmental governance?

THEORETICAL FRAMEWORK

This study draws on three interrelated bodies of literature: policy innovation, co-creation and collaborative governance, and the circular economy. Together they provide the conceptual lens through which the Cipari case is interpreted.

Policy Innovation in the Public Sector

Policy innovation refers to the introduction of policies, procedures, or arrangements that are new to the adopting jurisdiction and that depart from established administrative routines (Sururi, 2016, 2017; Tyran & Sausgruber, 2003). In the public sector, innovation is valuable not for novelty in itself but for its capacity to resolve problems that conventional instruments have failed to address (Wahab, 2012; Prabowo et al., 2022). In the environmental domain, this often means moving from a purely regulatory, sanction-based logic toward instruments that align ecological goals with the economic interests of those being regulated.

Co-Creation and Collaborative Governance

Co-creation describes a process in which public and private actors, including citizens, jointly define problems and design solutions, thereby pooling knowledge and resources and enhancing the legitimacy of the resulting policy (Ansell & Torfing, 2021; Ansell et al., 2023). It is closely related to the broader framework of collaborative governance, which Emerson et al. (2012) define as the processes and structures through which public policy decisions are made and managed by engaging actors across the boundaries of public agencies, levels of government, and the public, private, and civic spheres. Collaborative governance is particularly relevant in socio-ecological settings where authority and responsibility are dispersed and where no single actor can resolve the problem alone. Studies of collaborative governance in Indonesia have similarly stressed the importance of inclusive structures, shared learning, and resource sharing for effective environmental management (Torfing et al., 2019).

Mass Collaboration and the Circular Economy

Mass collaboration extends participation beyond a small group of negotiating actors to a wider network of contributors, drawing on data transparency, distributed effort, and voluntary engagement (Tapscott & Williams, 2010; Bason, 2015). When applied to waste, this networked logic connects naturally to the circular economy, which is organised around reducing, reusing, and recycling material flows so that waste



from one process becomes an input for another (Oyedun et al., 2025). In livestock systems, circular manure management converts manure into biogas, digestate, and organic fertiliser, reducing pollution while generating renewable energy and soil nutrients (Oyedun et al., 2025). Framing the Cipari initiative through these three lenses allows the analysis to connect the micro-level dynamics of local collaboration to broader debates on sustainable governance.

METHOD

This study employed a qualitative approach with a descriptive analytical design, which is well suited to portraying a situation as it unfolds during the period of research (Sugiyono, 2001). A qualitative design was chosen because the study seeks to understand the meaning, dynamics, and interactions of a collaborative process rather than to measure variables statistically. The research was conducted in Cipari Village, Cigugur District, Kuningan Regency, which was selected purposively as an information-rich site given its high livestock density and its documented history of manure-related pollution and social conflict.

Data were collected through three complementary techniques. First, in-depth interviews were conducted with key informants representing the main stakeholder groups, namely officials from the relevant local agencies, administrators of the Karya Nugraha Jaya dairy cooperative (KSU), participating academics, and dairy farmers and community members. Informants were selected purposively on the basis of their direct involvement in, or knowledge of, the manure management process. Second, field observations were carried out to examine waste handling practices, the composting house, and the communal biogas installation. Third, a documentation study reviewed the relevant local regulations, official reports, and secondary data related to the manure management program. Triangulation across these sources was used to strengthen the credibility of the findings.

Data analysis followed the interactive model of Miles and Huberman (2002), in which analysis proceeds alongside data collection rather than only after it. The process moved through four stages: data collection, data reduction, data display, and the drawing and verification of conclusions. In practical terms, interview notes, field notes, and documents were organised and condensed, arranged into themes that reflected the co-creation and mass collaboration phases, and then interpreted to identify patterns, outcomes, and remaining obstacles.

RESULTS AND DISCUSSION

The Problem Context and the Limits of Conventional Governance

Analysis of manure management in Cipari Village points to a fundamental shift in the local governance paradigm. Dairy farming has long made an important economic contribution to the community, yet the rapid growth of the livestock population has not been matched by adequate waste management infrastructure. As a result, the daily accumulation of manure has become a public problem that strains the environmental carrying capacity of the area and calls for a strategic response through updated policy instruments.

The scale of the problem is considerable. The village produces an estimated 248 tonnes of manure per day from a livestock population numbering in the thousands, a load that exceeds the natural assimilation capacity of the local environment when left untreated. Before the collaborative policy was introduced, most farmers discharged waste directly into water bodies or piled it in open spaces, seriously polluting downstream river ecosystems, degrading groundwater quality, and producing a pervasive odour across the settlement. These impacts are consistent with the wider literature, which documents how untreated manure raises the biological oxygen demand of water bodies and releases odour compounds and greenhouse gases that pose health and environmental risks (Oyedun et al., 2025).

These ecological pressures fed directly into social conflict. Non-farming residents, who felt that their right to a healthy environment had been violated, lodged repeated complaints with the local government, exposing a sharp tension between economic growth in the livestock sector and environmental sustainability. This



tension revealed the limits of a conventional, one-directional administrative approach that proved unable to cope with the complexity of the waste problem.

The shortfall was not one of regulation on paper. National Law No. 32 of 2009, Regional Regulation No. 7 of 2014, and Regional Regulation No. 5 of 2022 together provided a layered legal basis for controlling environmental impacts and promoting sustainability. The difficulty lay in a policy gap between these norms and the everyday realities of farmers. Structurally, the local government faced budget constraints that made large communal wastewater treatment plants difficult to finance, while coordination between the animal husbandry and environmental agencies remained weak. Spatially, the dense settlement pattern in Cigugur left farmers with very little land for independent treatment facilities and placed pens in close proximity to homes.

Compounding these structural and spatial barriers, the technical capacity and awareness of many farmers were limited. Most lacked detailed knowledge of how to convert manure into higher-value products, and technical assistance from agencies was sporadic rather than sustained, so it rarely produced lasting behavioural change. In this context the sanctions available under Regional Regulation No. 7 of 2014 lost much of their force. Recognising this systemic failure, the Kuningan Regency Government began to adopt a more interactive, collaboration-oriented approach to public administration.

Co-Creation in the Formulation of Policy

Policy innovation in Cipari was formulated by placing co-creation at the centre of the design process. In practice this meant establishing a forum for equal dialogue among four key actors: the government bureaucracy, the Karya Nugraha Jaya dairy cooperative (KSU) representing farmers, academics from nearby universities, and community representatives. Within this forum, policy formulation no longer proceeded top-down from officials' desks but was built from the bottom up around the identified needs of farmers, with the local government positioning itself as a facilitator and regulator rather than as a sole decision-maker. This mirrors the logic of co-creation described in the public administration literature, in which shared problem definition and joint design enhance both the quality and the legitimacy of the resulting policy (Ansell & Torfing, 2021; Ansell et al., 2023).

The co-creation process helped surface common ground among interests that had previously blocked implementation. Farmers who had resisted environmental regulation for fear of new restrictions became more willing to cooperate once they were directly involved in designing solutions. Academics contributed appropriate, low-cost technologies suited to limited land, while the KSU acted as an aggregator that consolidated farmers' economic interests so that waste processing would not simply add to production costs. The tangible output of this phase was a jointly agreed draft standard operating procedure (SOP) for waste management.

Theoretically, this shift transformed compliance from something coerced into something closer to voluntary commitment. Because farmers helped design the SOPs, the agreed rules were realistic at the farm level, and the government's role moved from that of a rigid inspector toward that of a facilitator offering incentives and easier access to support. This equal footing among actors gradually eroded the historical distrust that many farmers had felt toward environmental agendas, which they had often perceived as threats to their livelihoods.

The co-creation phase also produced a micro-spatial planning innovation in the form of collective zoning, that is, a mutually agreed communal pen arrangement. The problem of limited individual land in a densely populated settlement was eased when farmers, facilitated by the KSU and the village government, agreed to consolidate parcels of land for shared processing infrastructure. Academics then contributed spatially and economically efficient designs for a communal biogas reactor. In this way, physical and geographical constraints were partly overcome because the planning process was grounded in a close understanding of local social conditions. Table 1 summarises how the roles of the main actors changed as the policy moved from a conventional to a co-creation-based model.



Table 1. Redefinition of Multi-Actor Roles in the Co-Creation Phase

Stakeholder	Conventional (old) role	Co-creation-based (new) role	Concrete contribution to policy
Local Government (Environmental and Animal Husbandry agencies)	Rigid supervisor and unilateral, top-down rule-maker enforcing sanctions	Facilitator of inclusive dialogue, provider of legal legitimacy, and source of incentives	Issued the joint-processing SOP and aligned it with Regional Regulation No. 5 of 2022
Karya Nugraha Jaya Dairy Cooperative (KSU)	Milk collection point that reported farmer problems to agencies	Economic aggregator, land consolidator, and downstream supply-chain manager	Provided communal pen land and mobilised self-help funds from members
Academics (universities)	Theoretical researcher offering recommendations on paper	Appropriate-technology provider, technical educator, and quality-control advisor	Designed the communal biogas reactor and standardised fertiliser formulas
Community and farmers	Objects of policy, rule-breakers under pressure, and complainants	Equal partners in design, independent implementers, and compost-unit managers	Offered voluntary compliance and labour for the village composting house

Source: Processed from field data, 2025.

Mass Collaboration in the Implementation of Policy

Once a technical solution had been agreed through co-creation, implementation was scaled up through a mass collaboration strategy designed to compensate for the limited fiscal and personnel capacity of the local government in handling 248 tonnes of waste per day. In line with the networked logic described by Tapscott and Williams (2010), the government moved beyond conventional public-private partnership by opening participation to community organisations, youth groups, environmental activists, and private actors.

A key enabler of this phase was the transparent disclosure of ecological data. By publishing accessible information on the distribution of manure production across the village, the local government encouraged external parties, including non-governmental organisations, community groups, and donors, to engage with the pollution problem. This openness supported a degree of self-organisation, as community-based groups began to establish composting activities in the most affected areas without waiting for detailed instructions from agencies.

The concrete result was a decentralised system of village-scale composting houses managed by community groups and environmental NGOs, rather than a single government-owned disposal point. Universities reinforced this effort by deploying students through thematic community service programs to provide technical assistance in producing solid and liquid organic fertiliser. This academic involvement helped offset the shortage of government extension workers and supported quality control in fertiliser production, so that technology transfer reached farmers who had previously been beyond the reach of official services.

Alongside composting, mass collaboration supported the development of a communal biogas installation connecting several farms. This area-based design responded directly to the shortage of individual land. Financing came through a blended scheme that combined village funds, corporate social responsibility (CSR) contributions from private companies, and self-help funds from KSU members. This mix demonstrates that constraints in the regional budget can be partly overcome by mobilising non-governmental



resources in an organised way, freeing policymakers from the fiscal bottleneck that has often stalled government programs.

Toward a Circular Economy and Improved Food Security

The mobilisation of these resources supported the emergence of a circular economy ecosystem at the local level. Manure that had once been treated as toxic waste and a source of conflict was redefined as an economic asset. Organic fertiliser from the community composting houses was absorbed by the horticultural sector around Kuningan, creating a mutually beneficial link between dairy farming in Cigugur and food-crop farming in the surrounding areas. This pattern reflects the core logic of circular manure management, in which manure is recovered as fertiliser and energy rather than discarded (Oyedun et al., 2025).

This integration is normatively aligned with Regional Regulation No. 5 of 2022 on Regional Food Development. As a local, affordable supply of organic fertiliser became available, farmers' dependence on synthetic chemical fertiliser could be gradually reduced, which in turn supported the recovery of agricultural soils that had shown signs of nutrient saturation and secured a more sustainable input base for regional food production. In this sense, improved waste management produced a positive spillover for food security at the regional scale.

Environmental improvements followed at the site level. As most manure was diverted to biogas plants and composting houses, the volume discharged directly into rivers fell substantially, and monitoring indicated a decline in biological pollutant levels downstream of Cipari. The chronic odour problem also began to ease, improving the living environment for residents. It should be noted, however, that these outcomes are drawn from qualitative observation and available monitoring reports rather than from a controlled quantitative measurement, so they are best read as indicative trends rather than precise effect sizes.

The reduction in pollution was accompanied by a marked easing of social tension. Complaints about the effects of dairy farming declined over the two years following implementation, and relations between farming and non-farming residents improved as both groups came to benefit from a cleaner environment. Notably, some non-farming residents who had previously felt disadvantaged became involved as workers or managers in the composting houses, allowing them to share in the economic value created. This suggests that the policy innovation helped rebuild social capital that environmental degradation had earlier eroded.

The Changing Role of Local Government

Taken together, these findings support the argument that policy innovation in complex settings can no longer rest on a single state authority. A problem on the scale of 248 tonnes of waste per day requires a fair and systemic sharing of burdens among actors. Co-creation gave the resulting policy strong sociological legitimacy because it was designed together with those it affected, while mass collaboration provided the logistical and social energy needed to sustain implementation. In the terms often used in the governance literature, the Kuningan Regency Government shifted from directly providing services (rowing) toward coordinating a network of actors (steering). Manure management was thereby reframed from a temporary, curative clean-up project into a longer-term instrument of sustainable regional governance, reflecting a degree of institutional maturity in the local bureaucracy.

Remaining Obstacles and Sustainability Challenges

Despite these achievements, the model faces several obstacles that bear on its long-term sustainability. The most persistent is the inconsistent participation of some older farmers, who tend to prefer familiar practices and are more reluctant to adopt new technologies. In addition, fluctuations in the market price of organic fertiliser occasionally weaken the motivation of community compost groups to maintain steady production.

A further limitation concerns the governance of the collaboration itself, which still depends heavily on a small number of local leaders and motivators at the village and cooperative levels. To reduce this dependence, the collaborative arrangement would benefit from stronger institutionalisation through binding local instruments, such as a Regent Regulation, so that its continuity is not disrupted by changes in political



leadership. As production volumes rise, local market saturation is also a realistic risk, which suggests a need to extend distribution networks beyond the regency and to consider measures that protect local organic fertiliser, for example by prioritising its use in regional greening projects.

Sustainability also depends on generational renewal. Many active participants belong to an older age group, while interest in the livestock sector among younger people appears to be declining. Integrating digital tools into farm management and product marketing, and introducing the idea of environmentally based smart farming, may help attract younger participants and sustain the ecosystem over time.

Finally, the collaboration currently relies on conventional, face-to-face coordination, which is vulnerable to information gaps. A digital platform that records and monitors manure volumes, biogas reactor capacity, and fertiliser stocks in real time would improve operational efficiency, reduce information distortion between actors, and simplify policy evaluation. Comparable experiences elsewhere indicate that digital tools and decision-support systems can meaningfully strengthen circular manure management, particularly where data on flows and quality are otherwise fragmented (Oyedun et al., 2025). Such transparency would also strengthen the confidence of partners who continue to invest resources in the ecosystem.

Theoretical Contribution

Beyond its practical results, the Cipari case offers a modest theoretical contribution to the study of collaborative governance in developing countries. It suggests that co-creation and mass collaboration are most effective not as separate techniques but as sequential and complementary phases, in which co-creation secures legitimacy and workable rules at the formulation stage, and mass collaboration supplies the resources and participation needed at the implementation stage. Read in this way, policy appears less as a static legal product than as a dynamic, evolving process of social learning. This interpretation is consistent with, and extends to a livestock-waste setting, the broader claim in the literature that public value is increasingly produced through collaboration across sectoral boundaries (Ansell & Torfing, 2021; Emerson et al., 2012). Because the analysis rests on a single case, however, these propositions are best treated as analytically transferable insights that invite testing in other settings rather than as statistically generalisable findings.

CONCLUSION, LIMITATIONS, AND FUTURE RESEARCH

This study examined how a cow manure management policy in Cipari Village, Kuningan Regency, was reshaped through co-creation and mass collaboration in response to an acute pollution problem of roughly 248 tonnes of manure per day. The findings suggest that co-creation helped break down conventional bureaucratic barriers, placed government, the cooperative, farmers, and academics on a more equal footing, and reduced social resistance through jointly designed SOPs and a participatory approach to communal pen zoning. A subsequent data-based mass collaboration strategy mobilised non-governmental resources at scale, decentralised waste processing into biogas and organic fertiliser through a blended finance scheme, and helped establish a circular economy ecosystem.

This ecosystem contributed to improvements in local air and river quality and, by supplying organic agricultural inputs, supported regional food security in line with Regional Regulation No. 5 of 2022. The evidence also indicates a shift in the role of local government from direct provision toward network coordination, in which the authority leads by weaving together dispersed community resources rather than by command alone. As set out in Section 4.6, the model still faces real obstacles, including inconsistent participation among some senior farmers, the risk of market saturation for fertiliser, dependence on a few local leaders, and the absence of a real-time digital monitoring system. On balance, the Cipari experience offers a promising but context-dependent reference for other regions in Indonesia that face a similar tension between livestock-based economic growth and ecological sustainability.

Several limitations should nonetheless be borne in mind when interpreting these conclusions. First, the study rests on a single case in Cipari Village, which was selected purposively for its information richness. This design is appropriate for understanding the dynamics of a collaborative process in depth, but it constrains



statistical generalisation; the results are therefore best read as analytically transferable insights rather than as findings that automatically apply to other regions. Second, the evidence is qualitative and draws on interviews, observations, and documentary sources. Reported improvements in air and river quality and in social tension are based on informant accounts and available monitoring reports rather than on controlled, longitudinal measurement, so they should be treated as indicative trends rather than precise effect sizes. Third, the study captures a particular period in the life of the program and cannot, on its own, confirm whether the collaborative model will remain stable after changes in local leadership, market conditions, or funding. Finally, the account relies to some extent on the perspectives of actors who were directly involved in the initiative, which may introduce a degree of positive framing that future work with a wider and more independent set of informants could help to balance.

These limitations point to several directions for future research. Comparative studies across multiple villages or regencies would help establish how far the co-creation and mass collaboration model travels to settings with different livestock densities, institutional capacities, and social structures. Longitudinal research that follows the program over a longer horizon would clarify its durability, particularly its resilience to political succession and to saturation in the local fertiliser market. Mixed-methods designs that combine qualitative analysis with quantitative measurement of water and air quality, greenhouse gas emissions, and household economic outcomes would allow the environmental and economic effects to be assessed more rigorously than is possible here. Further work could also examine the design and adoption of a real-time digital monitoring platform, testing whether such tools measurably improve coordination, reduce information distortion, and lower transaction costs within collaborative networks. Finally, research attentive to power dynamics and to the inclusion of younger and more marginal farmers would deepen understanding of the conditions under which collaborative governance remains equitable and sustainable over time.

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