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RESEARCH ARTICLE

Prioritizing strategies for sustainable urban dairy management: Evidence using the analytical hierarchy process

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Abstract: Urban and peri-urban dairies are vital for milk supply in rapidly growing cities but pose significant challenges through waste mismanagement, methane emissions, water contamination, and zoonotic risks. Hyderabad, with one of the highest concentrations of urban dairies in India, presents a critical case where relocation to city outskirts, attempted in other metropolitan areas, may be unsustainable amid rapid urban expansion. This study employed the Analytical Hierarchy Process (AHP) to prioritize strategies for managing dairy externalities, utilizing pairwise comparisons from 70 experts representing scientists, researchers, and policymakers. Five themes, Capacity Building, Emission Control, Waste Recycling, Governance & Monitoring, and Environmental Buffering, were evaluated. Results show Capacity Building (29.1%) and Emission Control (24.8%) as the most important themes, followed by Waste Recycling (19.9%), Governance (16.2%), and Buffering (10.0%). Among strategies, *training on waste handling (S1.1)*, *scientific feeding (S2.1)*, *zoonotic awareness (S1.2)*, and *breed improvement (S2.2)* were top-ranked, while relocation of dairies and buffer enforcement received the least weight. Integrating costs revealed that training, awareness, and feeding practices represent low-cost, high-priority quick wins, while biogas plants and breed improvement are strategic, resource-intensive investments. The study offers a phased roadmap that aligns urban dairy management with sustainable urbanization and climate mitigation goals.

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Introduction

More than 56% of the global population currently lives in urban areas (Ritchie & Roser, 2024; United Nations, 2018), and this figure is projected to increase to 68% by 2050 (United Nations, 2018). This demographic shift drives rapid growth of urban and peri-urban agriculture, especially dairy farming, which is vital to urban food security and fresh milk supply (Kumar et al. 2021; Khan et al. 2020). In developing regions, particularly in South Asia—urban and peri-urban dairies remain a cornerstone of food systems and rural livelihoods, supporting thousands of smallholders and landless households (Khan et al. 2020; Kumar et al. 2021). In India, the world's largest milk producer, annual output reached 239.3 million metric tonnes in 2023–2024, accounting for about 25% of global production (Government of India, 2024; National Dairy Development Board [NDDB], 2024). Peri-urban dairying forms the backbone of metropolitan supply chains, bridging the rural–urban divide and supporting millions of producers (Khan et al. 2020; Kumar et al. 2021).

Despite their socio-economic contributions, urban and peri-urban dairies impose substantial negative externalities on urban environments and populations. These externalities are multidimensional. Environmentally, dairy waste is often mismanaged, leading to the accumulation of dung heaps, open discharge of effluents, and leakage of nutrients into water bodies, contributing to eutrophication and groundwater pollution. Moreover, livestock are a recognized source of methane and nitrous oxide emissions, both potent greenhouse gases (Hristov et al. 2011). From a public health perspective, poor waste handling and close human–animal interactions in dense settlements increase the risk of zoonotic disease outbreaks, including brucellosis and bovine tuberculosis. Socially, urban residents are affected by odour nuisance, fly infestations, and reduced quality of living conditions. Institutionally, the largely informal nature of these dairies, combined with weak regulatory

enforcement, has hindered systematic monitoring and effective waste management (Teenstra et al. 2014).

These externalities represent a classic market failure. While producers internalize the benefits of dairy production, the costs of waste disposal, pollution, and public health impacts are borne by society at large (Stiglitz, 2019). The absence of effective regulatory and incentive mechanisms creates little motivation for dairy owners to adopt environmentally sustainable practices. In the Indian context, where urban growth is fast-paced and municipal governance often overstretched, this problem is particularly acute.

Addressing such externalities is not merely a local necessity but a national and global priority. At the national level, India's commitments to reducing GHG emissions under the Paris Agreement and its pursuit of sustainable urban development hinge critically on addressing livestock-related emissions and waste management. Dairy systems in urban areas directly intersect with policy agendas on climate resilience, sustainable agriculture, and public health. At the international level, livestock contributes nearly 14.5% of total global anthropogenic GHG emissions (FAO, 2013). Interventions to mitigate emissions from dairying directly contribute to achieving the Sustainable Development Goals (SDGs), especially SDG 2 (Zero Hunger), SDG 11 (Sustainable Cities and Communities), and SDG 13 (Climate Action). Thus, the prioritization of interventions for urban and peri-urban dairies holds dual importance—enhancing India's urban sustainability while contributing to global climate and environmental goals.

Hyderabad represents a particularly relevant case for analyzing urban and peri-urban dairy externalities. The city and its peri-urban fringes host one of the highest concentrations of dairies among Indian metropolitan regions, owing to high milk demand, strong consumer preference for fresh milk, and established supply chains. These dairies are deeply embedded in the city's food system, supplying thousands of liters of milk daily. Recent inventories reinforce this scale: Telangana hosts 32,044 dairies with about 3.23 lakh bovines and 150 gaushalas with over 20,000 cattle, generating nearly 25,600 tonnes of dung per day in Hyderabad city alone (CPCB, 2020; *The New Indian Express*, 2020). This magnitude underscores why Hyderabad is a critical test case for sustainable management strategies. Unlike some metropolitan areas where dairies are being gradually relocated to the outskirts, Hyderabad continues to accommodate a dense belt of urban and peri-urban dairies within its metropolitan region.

Municipal authorities in several Indian cities — including Delhi, Bengaluru, and Mumbai — have experimented with relocating dairies to peripheral zones as a way to mitigate urban pollution and congestion. However, such relocation strategies often prove unsustainable in the long term, given the rapid pace of urban expansion and the constant redefinition of urban boundaries. As cities expand outward, peri-urban dairies that were once on the "outskirts" become absorbed into new residential and commercial zones, re-creating the very challenges relocation sought to resolve. Moreover, forced relocation risks undermining the livelihoods of smallholder dairy farmers and increasing costs of milk supply logistics.

In this context, Hyderabad provides a critical opportunity to study alternative approaches to managing dairy externalities without resorting to relocation. Its experience underscores the need for interventions that integrate capacity building, emission control, waste recycling, governance, and environmental buffering within the existing urban fabric. By prioritizing strategies that balance environmental sustainability, public health, and economic feasibility, the Hyderabad case offers insights that are relevant not only to Indian cities but also to rapidly urbanizing regions globally.

Although the technical, environmental, and institutional challenges of peri-urban dairying are well documented, there remains a critical research gap in systematically prioritizing strategies for sustainable management. Previous studies have focused on specific interventions such as composting (Madhavan, 2018), biogas plants, methane mitigation through improved feeding (Hristov et al. 2011), and manure-based value addition. While these provide valuable insights, they are largely technology-specific, context-fragmented, or descriptive in nature. Very few studies adopt a holistic, multi-criteria framework that integrates diverse technical, environmental, and governance perspectives to determine the relative importance of competing strategies. Furthermore, the literature on stakeholder-sensitive analysis—distinguishing how scientists, researchers, and policy makers evaluate strategies differently—is sparse. Finally, cost considerations are rarely integrated with priority-setting, despite being central to policy adoption in resource-constrained developing economies.

The novelty of this research lies in its comprehensive, multi-level prioritization framework that integrates scientific, technical, governance, and cost considerations. Beyond Hyderabad, the framework offers a replicable methodology for other Indian and global cities facing the dual challenge of meeting urban milk demand while minimizing environmental and health externalities.

Methodology

Study area

The research was carried out in the Hyderabad Metropolitan Region (HMR), one of India's fastest-growing cities with a population exceeding 10 million. Hyderabad is a major consumption hub for milk and milk products, supported by an extensive network of urban and peri-urban dairies. The region is estimated to host one of the highest densities of urban dairies in the country, making it a critical site for examining externalities associated with concentrated livestock systems. Unlike cities

such as Delhi, Mumbai, and Bengaluru, where municipal bodies have attempted to relocate dairies to peripheral zones, Hyderabad continues to maintain dairy clusters within its metropolitan and peri-urban boundaries. This makes it an ideal case for analyzing alternative approaches to externality management without resorting to relocation, which has proven unsustainable given the rapid pace of urban expansion.

Expert sampling and data collection

The study employed a purposive sampling approach to engage a diverse set of experts with direct knowledge of dairying, environmental management, and policy implementation. A total of 70 experts participated, consisting of scientists and researchers from the Indian Council of Agricultural Research (ICAR), agricultural universities, specialized livestock and environmental research institutes, and policy-level stakeholders.

This balanced mix ensured that both technical expertise and policy relevance were considered in the prioritization process. Experts were provided with structured questionnaires designed to elicit pairwise comparisons of themes and strategies using Saaty's 1–9 fundamental scale (Saaty, 1980). Responses were collected through in-person consultations, email surveys, and online meetings to maximize coverage and reliability.

Analytical Hierarchy Process (AHP) Framework

The study employed the AHP framework to structure the decision problem and derive relative priorities of strategies. The hierarchy was defined in three levels:

***Goa*l**: Sustainable management of urban and peri-urban dairy externalities.

Themes (5)*:* Capacity Building, Emission Control, Waste Recycling, Governance & Monitoring, and Environmental Buffering.

Strategies (25): Five under each theme, covering interventions such as training on waste handling, scientific feeding to reduce methane, composting, biogas plants, digital monitoring, and establishment of green buffers.

Pairwise comparisons

Experts compared the relative importance of elements at each level:

Themes were compared against each other to establish their relative importance in achieving the overall goal.

Strategies within each theme were compared pairwise to determine intra-theme priorities.

Construction of comparison matrices

Responses were recorded as reciprocal matrices (5×5), with diagonal elements equal to 1 and reciprocal entries computed for consistency (e.g., if A is rated 5 times more important than B, then B is 1/5 as important as A).

Derivation of weights

The principal eigenvalue method was applied to each comparison matrix to derive normalized priority weights (Saaty, 1980).

Consistency check

The Consistency Index (CI) and Consistency Ratio (CR) were calculated for each expert's responses:

$$CI = \frac{\lambda max - n}{n - 1}, CR = \frac{CI}{RI}$$

where λ_{max} is the maximum eigenvalue of the matrix, n is the matrix order (5 in this case), and RI is the Random Index (1.12 for n = 5). Matrices with CR < 0.10 were considered consistent and included in the analysis.

Aggregation of judgments

Individual expert weights were aggregated using the geometric mean method, which is widely recommended for group decision-making in AHP (Forman & Peniwati, 1998). This generated consensus weights for themes and strategies.

Integration of cost considerations

In addition to priority weights, the study incorporated an assessment of the relative cost of implementing strategies. Based on literature (FAO, 2007; ICAR, 2015) and expert opinion, strategies were classified into:

Low-cost: e.g., training, awareness campaigns, improved feeding practices.

Medium-cost: e.g., composting, manure management, community biogas plants, digital monitoring.

High-cost: e.g., relocation of dairies, large-scale methane capture, and infrastructural investments.

Results and Discussion

The Analytical Hierarchy Process (AHP) results reveal a structured prioritization of themes and strategies for the sustainable management of urban and peri-urban dairies in Hyderabad. The judgments obtained from seventy experts, consisting of scientists, researchers, and policy makers, were subjected to eigenvalue analysis and consistency ratio checks.

Most responses demonstrated a consistency ratio (CR) of less than 0.10, ensuring the logical coherence of the pairwise comparisons and the robustness of aggregated results (Saaty, 1980; Forman & Peniwati, 1998).

Theme-level priorities

At the theme level (Figure 1), Capacity Building (29.1%) emerged as the most important area, followed by Emission Control (24.8%), Waste Recycling (19.9%), and Governance and Monitoring (16.2%), while Environmental Buffering (10.0%) was assigned the least priority. The strong emphasis on capacity building and emission control reflects expert recognition that many of the externalities of dairying in Hyderabad stem from knowledge gaps, poor waste handling, and suboptimal feeding practices. Similar findings have been reported in previous studies that highlight training, awareness, and feeding interventions as effective means of reducing methane emissions and improving manure management (FAO, 2007; Hristov et al. 2011).

Indicator priorities within themes

Within each theme, the intra-theme priorities further refined these insights. In Capacity Building (Table 2), strategies such as *training on waste handling and hygiene (S1.1)* and *awareness on zoonotic diseases (S1.2)* were rated highest. This underscores the concern over public health risks arising from close interactions between livestock and human populations in dense urban clusters, consistent with findings by Gillah et al. (2012) and Madhavan (2018). Similarly, technical workshops on manure management (S1.3) and training on composting and methane reduction (S1.4) were given higher weightage than mobile-based education, suggesting that face-to-face and practical interventions are seen as more impactful than digital outreach alone.

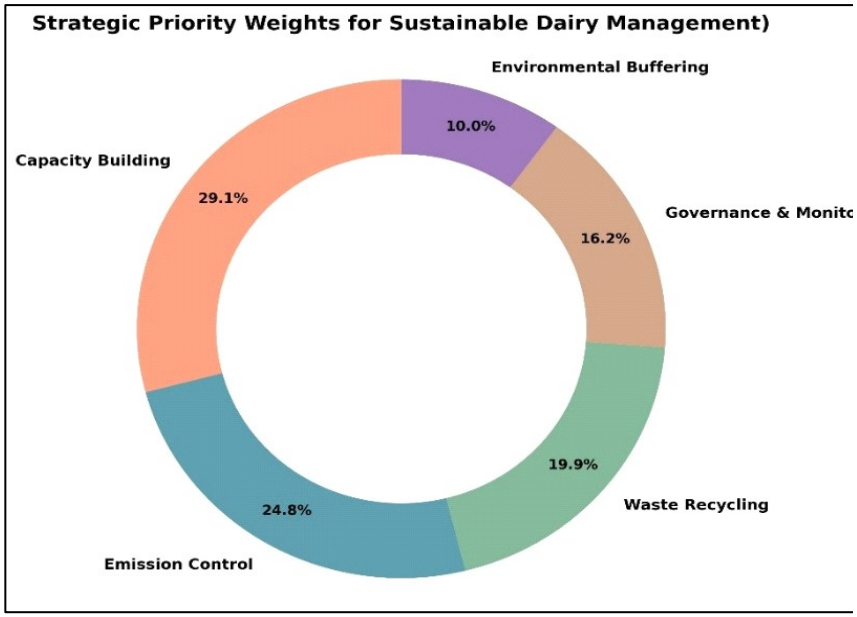
In the case of Emission Control (Table 3), the two leading strategies were *scientific feeding to reduce enteric methane (S2.1)* and *breed improvement for low-emission productivity (S2.2)*. Both interventions directly target greenhouse gas mitigation, aligning with global calls to address livestock-related emissions (IPCC, 2006; FAO, 2013). Methane capture technologies (S2.3) and optimized drying cycles for stall waste (S2.4) were moderately ranked, while measurement protocols (S2.5) received the least weight, indicating that experts favor action-oriented interventions over measurement-focused strategies.

For Waste Recycling (Table 4), the highest priority was accorded to *cluster-based community biogas plants (S3.2)*, followed closely by *on-farm composting (S3.1)*. Both strategies represent circular economy approaches that convert waste into energy

Table 1: Strategic themes and interventions for sustainable management of urban and peri-urban dairies

Theme	Code	Strategy Description
1. Capacity Building	S1.1	Training on dairy waste handling & hygiene
	S1.2	Awareness on zoonotic disease risks
	S1.3	Technical workshops on manure management
	S1.4	Training on composting & methane reduction
	S1.5	Mobile-based dairy education (IVRS/SMS)
2. Emission Control	S2.1	Scientific feeding to reduce enteric methane
	S2.2	Breed improvement for low-emission productivity
	S2.3	Methane capture using gas covers
	S2.4	Optimized drying cycles for stall waste
	S2.5	On-farm methane measurement protocols
3. Waste Recycling	S3.1	On-farm composting with support linkages
	S3.2	Cluster-based community biogas plants
	S3.3	Market linkages for organic manure
	S3.4	Dung-based bio-brick/vermicompost
	S3.5	Biogas-powered chilling units
4. Governance & Monitoring	S4.1	Monthly monitoring by municipal bodies
	S4.2	Digital registry of urban dairies
	S4.3	Waste tracking via mobile apps
	S4.4	Licensing & penalties for poor waste disposal
	S4.5	PPP model for waste collection
5. Environmental Buffering	S5.1	Green belt plantations around dairies
	S5.2	Relocating dairies beyond residential buffer zones
	S5.3	Enforce 500m distance from water bodies
	S5.4	Use of shade nets/fencing for odor control
	S5.5	Urban livestock zoning and manure market design

Fig1. Aggregated theme weights and ranks for management of urban dairies



and organic fertilizer, providing co-benefits of waste reduction and income generation (Sharma and Bhargav, 2015). Market linkages for organic manure (S3.3) were also important, but dung-based bio-bricks (S3.4) and biogas-powered chilling units (S3.5) ranked lower, possibly due to perceived technological and market barriers.

In Governance and Monitoring (Table 5), *licensing and penalties for poor waste disposal (S4.4)* emerged as the most important intervention, followed by *monthly municipal monitoring (S4.1)*. These findings emphasize that regulatory enforcement remains critical for ensuring compliance, echoing earlier recommendations by CPCB (2020) and Ravi et al. (2016). Interestingly, digital solutions such as waste tracking apps (S4.3) and dairy registries (S4.2) were ranked lower, suggesting that experts prioritize basic institutional enforcement before advanced digital tools can be effectively adopted.

Finally, in Environmental Buffering (Table 6), *green belt plantations around dairies (S5.1)* were ranked highest, while *relocation of dairies (S5.2)* and *enforcement of 500 m buffers from water bodies (S5.3)* received the lowest weights. This result is particularly significant given that many Indian cities have attempted to relocate dairies to urban fringes, a strategy shown

Table 2: Capacity Building – Weights, WSV, and consistency values

Code	Strategy	LW	TW (0.291)	GW	WSV	Rank	CR
S1.1	Training on waste handling & hygiene	0.195	0.291	0.057	1.01	1	0.07
S1.2	Awareness on zoonotic diseases	0.148	0.291	0.043	1.00	2	0.07
S1.3	Manure management workshops	0.122	0.291	0.036	0.99	3	0.07
S1.4	Training on composting and methane reduction	0.109	0.291	0.032	1.01	4	0.07
S1.5	Mobile-based dairy education	0.096	0.291	0.028	1.00	5	0.07

Note: LW-Local weight; TW: Total Weight; GW-Global Weight; WSV- Weighted Sum Value

Table 3: Emission Control – Weights, WSV, and consistency values

Code	Strategy	LW	TW (0.248)	GW	WSV	Rank	CR
S2.1	Scientific feeding for methane reduction	0.179	0.248	0.044	1.02	1	0.08
S2.2	Breed improvement for low-emission productivity	0.153	0.248	0.038	1.01	2	0.08
S2.3	Methane capture using gas covers	0.126	0.248	0.031	1.00	3	0.08
S2.4	Optimized drying cycles for stall waste	0.104	0.248	0.026	1.00	4	0.08
S2.5	On-farm methane measurement protocols	0.092	0.248	0.023	0.99	5	0.08

Note: LW-Local weight; TW: Total Weight; GW-Global Weight; WSV- Weighted Sum Value

to be unsustainable in the face of rapid urban expansion. Experts in this study highlighted that relocation merely displaces the problem temporarily, as peri-urban zones are eventually reabsorbed into urban areas. Instead, in-situ solutions such as green buffers and localized odor control are perceived as more feasible.

Global ranking of strategies

The global ranking of all 25 strategies showed that the top five were *training on waste handling (S1.1)*, *scientific feeding (S2.1)*, *awareness on zoonotic diseases (S1.2)*, *breed improvement (S2.2)*, and *manure management workshops (S1.3)*. This clearly indicates that capacity building and emission control dominate expert preferences. Waste recycling interventions such as community biogas plants (S3.2) were also highly ranked, while governance and environmental buffering strategies occupied middle and lower positions, respectively. Given that Hyderabad's dairies produce 25,600 tonnes of dung daily, the prioritization of community biogas plants and composting acquires added urgency. Even partial diversion of this waste stream to biogas or organic fertilizer could substantially mitigate methane emissions and align with circular economy goals. The consistent de-prioritization of relocation-based measures confirms expert skepticism about their long-term sustainability (Table 7).

Cost–priority analysis

Overlaying AHP priorities with cost classifications produced three categories (Table 8). The integration of cost considerations provided additional insights. Strategies such as training, awareness, and feeding interventions fall into the category of quick wins, being both high priority and low cost. Breed improvement and biogas plants, though resource-intensive, were categorized as strategic investments necessary for long-term transformation. In contrast, relocation and buffer enforcement were classified as low-priority, high-cost measures, suggesting they are least feasible under current urbanization dynamics. Such cost–priority overlays are crucial in guiding phased investment strategies in resource-constrained policy environments.

Taken together, the results highlight a clear roadmap for policy. In the short term, governments should invest in low-cost, high-impact measures such as training, awareness campaigns, and

Table 4: Waste Recycling – Weights, WSV, and consistency values

Code	Strategy	LW	TW (0.199)	GW	WSV	Rank	CR
S3.2	Cluster-based community biogas plants	0.144	0.199	0.029	1.01	1	0.09
S3.1	On-farm composting with support linkages	0.125	0.199	0.025	1.00	2	0.09
S3.3	Market linkages for organic manure	0.116	0.199	0.023	1.00	3	0.09
S3.5	Biogas-powered chilling units	0.098	0.199	0.020	0.99	4	0.09
S3.4	Dung-based bio-bricks/vermicompost	0.087	0.199	0.017	1.00	5	0.09

Note: LW-Local weight; TW: Total Weight; GW-Global Weight; WSV- Weighted Sum Value

Table 5: Governance and Monitoring – Weights, WSV, and consistency values

Code	Strategy	LW	TW (0.162)	GW	WSV	Rank	CR
S4.4	Licensing & penalties for poor waste disposal	0.117	0.162	0.019	1.01	1	0.06
S4.1	Monthly monitoring by municipal bodies	0.101	0.162	0.016	1.00	2	0.06
S4.2	Digital registry of urban dairies	0.095	0.162	0.015	1.00	3	0.06
S4.5	PPP model for waste collection	0.087	0.162	0.014	0.99	4	0.06
S4.3	Waste tracking via mobile apps	0.078	0.162	0.013	1.00	5	0.06

Note: LW-Local weight; TW: Total Weight; GW-Global Weight; WSV- Weighted Sum Value

Table 6: Environmental Buffering – Weights, WSV, and consistency values

Code	Strategy	LW	TW (0.100)	GW	WSV	Rank	CR
S5.1	Green belt plantations around dairies	0.085	0.100	0.009	1.01	1	0.08
S5.4	Shade nets/fencing for odour control	0.072	0.100	0.007	1.00	2	0.08
S5.5	Urban livestock zoning & manure markets	0.065	0.100	0.007	1.00	3	0.08
S5.3	Enforce 500m buffer near water bodies	0.010	0.100	0.001	0.99	4	0.08
S5.2	Relocation of dairies beyond residential areas	0.011	0.100	0.001	1.00	5	0.08

Note: LW-Local weight; TW: Total Weight; GW-Global Weight; WSV- Weighted Sum Value

Table 7: Global ranking of strategies

Rank	Code	Strategy	Global Weight (%)	Theme
1	S1.1	Training on waste handling and hygiene	5.9	Capacity Building
2	S2.1	Scientific feeding to reduce methane	5.6	Emission Control
3	S1.2	Awareness on zoonotic diseases	4.3	Capacity Building
4	S2.2	Breed improvement for low-emission productivity	3.8	Emission Control
5	S1.3	Manure management workshops	3.6	Capacity Building
6	S3.2	Cluster-based community biogas plants	2.9	Waste Recycling
7	S4.4	Licensing & penalties for poor waste disposal	1.9	Governance

Note: LW-Local weight; TW: Total Weight; GW-Global Weight; WSV- Weighted Sum Value

Table 8: Cost priority matrix

Category	Strategies	Examples
Quick Wins (High priority, Low cost)	Training, awareness, and feeding interventions	S1.1, S1.2, S2.1
Strategic Investments (High priority, High cost)	Breed improvement, community biogas plants	S2.2, S3.2
Low Priority Options (Low priority, High cost)	Relocation, buffer enforcement	S5.2, S5.3

improved feeding practices. In the medium term, resources should be allocated to community biogas plants and strengthened governance mechanisms. In the long term, environmental buffering measures may be pursued selectively, but relocation should be considered a last resort given its high costs and limited sustainability. These findings align with broader sustainability frameworks such as the Sustainable Development Goals (SDGs 2, 11, and 13) and provide actionable strategies for integrating urban livestock into resilient food systems.

Policy implications

The findings of this study carry significant implications for policy and practice in the management of urban and peri-urban dairies. The prioritization results clearly demonstrate that capacity building and emission control are the most critical areas for intervention. This suggests that policymakers should first emphasize low-cost, high-impact measures such as training on waste handling, awareness creation about zoonotic diseases, and improved feeding practices. These interventions can be rapidly deployed through municipal authorities, extension agencies, and farmer cooperatives, and they directly address public health and environmental concerns at minimal cost.

At the medium-term level, greater emphasis should be placed on strategic investments such as community-based biogas plants and breed improvement programs. These require higher capital inputs and institutional coordination but have strong potential for creating long-term systemic change, including reductions in methane emissions, sustainable energy generation, and improved manure management. Public–private partnerships (PPP) can play a critical role here, as demonstrated by successful waste-to-energy projects in other Indian states. For instance, leveraging the concentrated dairy clusters in Hyderabad, where waste generation is exceptionally high, offers a strong case for establishing cluster-based biogas units. With Telangana's 32,000 dairies forming a critical mass, linking such initiatives to carbon credit markets could provide both environmental benefits and financial incentives.

In the long term, environmental buffering measures, such as establishing green belts and enforcing zoning regulations, can be selectively implemented to mitigate land use conflicts. However, relocation of dairies, though often attempted in other metropolitan areas, was consistently ranked as the least preferred option in this study. This indicates that relocation may be an inefficient and unsustainable solution, as urban expansion invariably absorbs peri-urban zones over time. Instead, strengthening in-situ management through training, regulation, and recycling-based approaches offers a more resilient pathway. Overall, the policy message is clear: governments should adopt a phased approach, beginning with quick wins that are low-cost and high-priority, followed by strategic medium-term investments, while treating relocation as a measure of last resort. Such a roadmap not only aligns with India's commitments under the Paris Agreement but also contributes to multiple Sustainable Development Goals (SDGs 2, 11, 13).

Conclusion

This study applied the Analytical Hierarchy Process (AHP) to systematically prioritize strategies for managing the externalities of urban and peri-urban dairies in Hyderabad. Based on judgments from 70 experts, the results highlight capacity building and emission control as the most critical thematic areas, with strategies such as training on waste handling, scientific feeding for methane reduction, awareness on zoonotic diseases, and manure management workshops emerging as top priorities. Waste

recycling and governance measures were moderately ranked, while relocation and buffer enforcement were consistently deprioritized.

The integration of cost considerations revealed that many of the highest-priority interventions are also low-cost measures, providing immediate opportunities for implementation. Breed improvement and community biogas plants were identified as strategic investments that can drive long-term sustainability, whereas relocation strategies were considered both costly and unsustainable.

By combining expert-derived priorities with economic feasibility, this research offers a decision-support framework for policymakers. The novelty of this study lies in its comprehensive approach, which integrates technical, environmental, governance, and cost dimensions into a single prioritization framework. Beyond Hyderabad, the methodology offers a replicable model for other Indian and global cities facing the dual challenge of meeting urban milk demand while minimizing environmental and health externalities.

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