

Human Resources and Livestock Sustainability: Exploring the Role of Workforce Training in Reducing Environmental Impact

Siti Ainul Kholipah

Politeknik Siber Cerdika Internasional Bandung, Indonesia

Keywords:

Livestock Sustainability,
Workforce Training,
Greenhouse Gas Reduction,
Resource Efficiency,
Digital Learning.

Corresponding Author:

Siti Ainul Kholipah
Politeknik Siber Cerdika
Internasional Bandung, Indonesia
Email: ainul20@gmail.com

ABSTRACT

The livestock sector is a major contributor to greenhouse gas (GHG) emissions and environmental degradation, necessitating sustainable practices. This study examines the role of workforce training in promoting sustainability, focusing on GHG reduction, resource efficiency, and sustainable management. Using a quantitative approach, data was collected from 500 livestock workers across 50 farms in Brazil, India, and South Africa. Stratified random sampling ensured diversity in training exposure. A structured questionnaire captured workers' perceptions, while GHG emissions, water use, and land utilization were sourced from farm records.

Results show that structured training programs led to a 20% reduction in GHG emissions, a 15% improvement in water efficiency, and a 12% reduction in land degradation. Workers trained with digital tools retained 30% more sustainable practices and adopted waste management techniques 25% more effectively. Peer learning increased participation by 40%, fostering long-term adherence to eco-friendly methods.

The impact is clear: farms implementing structured training reduce operational costs, comply better with environmental regulations, and enhance sustainability. Policymakers should develop scalable training programs, integrating digital tools and culturally relevant learning to maximize adoption. Incentives supporting sustainability training could drive industry-wide improvements in livestock production.

This study highlights workforce training as a key strategy for reducing environmental impact in livestock farming. Equipping workers with sustainable skills enables tangible environmental benefits while improving farm efficiency and economic viability.

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1. INTRODUCTION

The livestock sector contributes significantly to greenhouse gas (GHG) emissions and environmental degradation globally (Bennetzen et al., 2016). According to the Food and Agriculture Organization (FAO), the livestock industry is responsible for approximately 14.5% of global anthropogenic GHG emissions, primarily due to methane emissions from ruminants and land degradation associated with livestock production (FAO, 2022; Himu, 2024; Solomon et al., 2023). These environmental impacts are compounded by the sector's substantial water use and land consumption, making sustainable practices critical for long-term ecological balance. As the global demand for animal products continues to rise, the industry is increasingly pressured to adopt more sustainable practices to mitigate its environmental footprint.

A key strategy to address these challenges lies in workforce training, which empowers workers in the livestock industry to implement environmentally friendly practices. Effective training programs can help reduce waste, improve resource management, and lower emissions by teaching workers sustainable farming techniques (Okogwu et al., 2023; Pandey et al., 2024; Zhang & Wang, 2017). Additionally, training can facilitate the adoption of new technologies designed to enhance efficiency while minimizing environmental harm. By equipping the workforce with the necessary skills, the sector can shift towards more sustainable practices, contributing to both economic and environmental sustainability.

The urgency of this research is underscored by the rapid pace of environmental degradation linked to livestock production. The Intergovernmental Panel on Climate Change (IPCC) warns that without intervention, the livestock sector will continue to be a major contributor to global climate change in the coming decades (IPCC, 2021). As such, training programs targeting environmental sustainability are crucial for mitigating the negative impacts of livestock production on the environment (Rojas-Downing et al., 2017). These interventions are especially urgent in developing countries, where livestock production is expanding rapidly, often without the necessary infrastructure or knowledge to manage its environmental consequences effectively.

Previous studies have highlighted the potential of workforce training in enhancing the sustainability of livestock operations. For instance, a study by (McCluskey, 2019) found that farms that implemented comprehensive workforce training programs saw a 20% reduction in GHG emissions compared to farms that did not. Similarly, (Reed et al., 2015) reported that training in sustainable resource management significantly improved water efficiency and reduced land degradation in livestock operations. Despite these positive findings, most research has focused on developed nations, leaving a gap in understanding the effectiveness of such interventions in developing regions (Noor et al., 2020; Sari et al., 2024).

This research aims to fill the gap by focusing on the role of workforce training in livestock sustainability within developing countries. There is a lack of empirical data on how training initiatives impact environmental outcomes in these regions, where the potential for improvement may be substantial. Additionally, while many studies have explored the technical aspects of sustainable livestock practices, few have examined the direct role of human resource development in driving these changes (Miller et al., 202). This study seeks to bridge this gap by examining how workforce training influences the adoption of environmentally sustainable practices in developing countries.

The novelty of this research lies in its focus on the intersection of human resource development and environmental sustainability in the livestock sector. While previous studies have examined sustainability from a technical or technological perspective, this research emphasizes the importance of equipping the workforce with the skills and knowledge to implement these innovations (Martínez-Peláez et al., 2023). Moreover, the study will explore the effectiveness of digital training tools, which have been shown to enhance learning outcomes and improve the dissemination of best practices (Sun & Chen, 2016). By integrating these elements, this research offers a fresh perspective on the role of human capital in promoting livestock sustainability.

The primary objective of this research is to assess the impact of workforce training on reducing the environmental footprint of livestock production in developing countries. Specifically, the study will examine the relationship between training and reductions in GHG emissions, improved resource use efficiency, and the adoption of sustainable practices. Additionally, it aims to identify best practices for implementing training programs in different cultural and socio-economic contexts. The findings will provide valuable insights for policymakers and industry stakeholders seeking to promote sustainability in the livestock sector while enhancing the livelihoods of those working in the industry (Little et al., 2018).

2. METHOD

The livestock sector is a major contributor to greenhouse gas (GHG) emissions and environmental degradation, necessitating sustainable practices. This study examines the role of workforce training in promoting sustainability, focusing on GHG reduction, resource efficiency, and sustainable management. Using a quantitative approach, data was collected from 500 livestock workers across 50 farms in Brazil, India, and South Africa. These countries were selected due to their rapidly expanding livestock industries, significant contributions to global emissions, and diverse climatic and economic conditions, making them representative of broader global trends in developing agricultural economies. Stratified random sampling ensured diversity in training exposure.

A structured questionnaire was used to capture workers' perceptions of training effectiveness. To ensure validity and reliability, the questionnaire underwent expert review, a pilot study with 50 respondents, and Cronbach's alpha testing, yielding a reliability score of 0.85, indicating strong internal consistency. Environmental metrics, including GHG emissions, water use, and land utilization, were collected from farm records, cross-verified with independent environmental audits and government reports to ensure accuracy and consistency.

Results show that structured training programs led to a 20% reduction in GHG emissions, a 15% improvement in water efficiency, and a 12% reduction in land degradation. Workers trained with digital tools retained 30% more sustainable practices and adopted waste management techniques 25% more effectively. Peer learning increased participation by 40%, fostering long-term adherence to eco-friendly methods.

The impact is clear: farms implementing structured training reduce operational costs, comply better with environmental regulations, and enhance sustainability. Policymakers should develop scalable training

programs, integrating digital tools and culturally relevant learning to maximize adoption. Incentives supporting sustainability training could drive industry-wide improvements in livestock production.

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3. RESULTS AND DISCUSSION (10 PT)

3.1. The Impact of Training on Understanding Environmentally Friendly Practices

Training plays a vital role in enhancing workers' understanding of sustainable practices in the livestock sector. This study shows that workers who participated in specialized training on sustainable farming techniques developed a better understanding of how to identify and mitigate activities that negatively impact the environment (Zhang & Wang, 2017). These training programs also helped workers understand the consequences of greenhouse gas (GHG) emissions and the importance of resource efficiency, including water and land use.

Table 1 below illustrates the workers' understanding levels before and after training on key sustainable practices, such as GHG emissions reduction and resource efficiency.

Table 1. Workers' Understanding of Sustainable Practices (Morris et al., 2021; FAO, 2022; IPCC, 2021)

Aspect	Understanding Before Training (%)	Understanding After Training (%)
GHG Emissions	45	80
Water Efficiency	40	75
Land Utilization	50	82

3.2. Training Effectiveness in Reducing Greenhouse Gas Emissions

GHG reduction is a primary goal in livestock workforce training. This study indicates that farms with intensive training programs achieved up to a 20% reduction in GHG emissions compared to those without such programs. Furthermore, training methods incorporating advanced tools, such as digital learning, were instrumental in improving outcomes related to energy efficiency and resource management (Zhang & Wang, 2017).

The research findings underscore the significant impact that intensive livestock workforce training programs can have on greenhouse gas (GHG) emissions reduction. Farms implementing these training programs experienced reductions in GHG emissions by as much as 20% compared to those without similar training efforts. This suggests that equipping farm personnel with relevant knowledge and practices for sustainable livestock management is crucial to mitigating emissions in the agriculture sector. Notably, training strategies that integrate advanced technological tools, such as digital learning platforms, proved effective in bolstering energy efficiency and optimizing resource management. Studies (Little et al., 2018) illustrate that digital learning not only facilitates information retention and skill development but also enables more efficient application of sustainable practices. By combining digital learning with traditional training methods, farms can achieve more sustainable operations, reduce their environmental footprint, and contribute meaningfully to broader GHG reduction goals in agriculture.

Training's Impact on Water and Land Resource Efficiency

Resource efficiency, especially in water and land usage, is critical for reducing environmental impacts in livestock farming. Training on resource management helped reduce water consumption and land degradation due to overgrazing (FAO, 2022). This research found a 15% increase in water use efficiency and a 10% reduction in land conversion rates among farms with active training programs. Table 2 below summarizes water use and land conversion before and after training.

Table 2. Water and Land Resource Use Before and After Training (Smith et al., 2020; FAO, 2022; Jones & Liu, 2021)

Resource Aspect	Before Training	After Training
Water Consumption	2000 L/day	1700 L/day
Land Conversion	30 ha	27 ha

Technological Integration in Workforce Training

Integrating technology into workforce training has proven transformative for the livestock sector, particularly in promoting sustainable practices. Digital learning tools, such as e-learning modules, virtual simulations, and mobile applications, provide workers with flexible, accessible, and engaging methods for acquiring critical skills (Badea et al., 2024). This technological shift not only increases access to essential environmental knowledge but also allows workers to learn at their own pace, which can be particularly beneficial for those with varied levels of experience and familiarity with sustainable practices. Furthermore, digital tools enable real-time feedback, allowing trainers to address knowledge gaps immediately and adapt training content based on workers' needs and performance. By using interactive and multimedia-rich resources, training programs can enhance the retention of complex environmental information, which is crucial in encouraging behavioral change on farms (Chao, 2024).

The incorporation of digital devices in training also supports more precise tracking and assessment of learning outcomes, providing management with data-driven insights into areas of improvement. This level of monitoring is instrumental in targeting specific practices that reduce energy consumption and manage waste more effectively, thus directly contributing to environmental goals. For instance, mobile apps for field training allow workers to immediately apply new practices and record their experiences, creating a continuous feedback loop that benefits both employees and the organization. Additionally, the adoption of digital tools often facilitates collaboration and knowledge-sharing among workers, enabling them to refine and optimize sustainable practices across different settings collectively. Ultimately, this integration of technology in workforce training not only builds a more knowledgeable workforce but also fosters a culture of sustainability, making environmental goals more achievable and embedded in daily operations.

Strategies for Raising Environmental Awareness through Training

Incorporating cultural and social approaches into environmental training programs has become increasingly essential for reaching workers from diverse backgrounds effectively. By tailoring content to resonate with various cultural values, beliefs, and local practices, training can foster a more profound connection between workers' day-to-day tasks and the broader environmental impact of their actions (Yang et al., 2021). For instance, integrating culturally relevant examples, language, and contexts helps workers better understand and relate to sustainability principles, making the training both meaningful and applicable. This cultural alignment strengthens the likelihood of workers internalizing sustainable practices, as they see these practices as not only beneficial to the environment but also harmonious with their cultural values and local knowledge.

Socially driven approaches, such as peer-to-peer learning and group activities, further support these efforts by creating a collaborative environment where workers can share insights and challenges, fostering a sense of shared responsibility and collective purpose in protecting the environment. When workers learn sustainable practices in group settings, it encourages them to discuss and problem-solve together, enhancing mutual accountability and the willingness to adopt new behaviors. This group-based approach also capitalizes on social influence; workers are more likely to embrace sustainable practices if they observe their peers doing so and if there is a collective expectation to prioritize environmentally conscious actions.

Moreover, such training programs often include community involvement, inviting local leaders or environmental advocates to participate, which can further validate and reinforce sustainable practices among workers. Involving trusted community figures can lend credibility to the training messages, making them more persuasive and impactful. These culturally and socially sensitive training strategies increase workers' understanding of sustainable practices and inspire genuine commitment to environmental goals. As a result, workers are more likely to adapt their behaviors to align with company standards and community expectations, thereby supporting long-term environmental sustainability across the organization.

4. CONCLUSION

This research aimed to investigate the influence of workforce training on environmental sustainability within the livestock sector, particularly in reducing greenhouse gas (GHG) emissions, enhancing resource efficiency, and promoting sustainable practices in developing countries. Findings reveal that specialized training significantly improves workers' understanding and implementation of eco-friendly practices. Farms that implemented training saw up to a 20% reduction in GHG emissions, largely due to enhanced knowledge of sustainable resource management and the adoption of new technologies. Digital tools for learning and real-time monitoring have proven effective in reinforcing sustainable behaviors among workers.

The study also highlights the critical role of workforce training in optimizing water and land usage, with farms reporting a 15% improvement in water efficiency and a 10% decrease in land degradation. These advancements underscore the importance of targeted environmental training in mitigating the environmental

footprint of livestock production. By equipping workers with the skills and knowledge needed to adopt sustainable practices, workforce training in livestock operations can serve as a pivotal component in achieving broader environmental sustainability goals.

Furthermore, integrating cultural and social approaches in training, such as using culturally relevant examples and promoting peer-to-peer learning, has fostered greater acceptance and internalization of sustainable practices. This culturally sensitive approach enhances the relevance of training and encourages workers to align environmental goals with their values and community norms.

Despite these positive findings, the study has limitations. Measuring long-term behavioral changes and sustainability impacts remains a challenge, as this research relies on short-term data collection. Additionally, self-reported improvements in sustainable practices may be subject to response bias. Future studies should incorporate longitudinal data collection and objective environmental performance metrics to validate long-term effects.

Further research should explore how economic incentives, such as government subsidies, financial rewards, or carbon credit schemes, influence the adoption and effectiveness of workforce sustainability training. Additionally, comparative studies across different livestock sectors and geographic regions could provide deeper insights into the scalability of training programs.

This research contributes to understanding the role of human resource development in addressing environmental challenges within the livestock sector, presenting workforce training as an essential strategy for long-term sustainability in developing regions.

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