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REVIEW

Harnessing Traditional Knowledge for Circular Livestock, Environmental Resilience and Its Perspectives from Odisha, India

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ABSTRACT

The article explores the role of traditional knowledge systems (TKS) in creating circular livestock economies and fostering environmental stewardship. The study focuses on Pathe Pathshala, a mobile, community-led education initiative led by grassroots veterinarian Dr. Balaram Sahu, and shows how locally embedded practices in animal care, ethno-veterinary medicine, and adaptive breeding can serve as resilient and regenerative alternatives to industrial livestock production. The research challenges established development discourses by highlighting decentralised, low-input, and ecologically integrated animal husbandry practices based on community knowledge. The research investigates how such approaches improve occupational safety for herders, safeguard animal health, and provide long-term livelihoods, especially for marginalised rural people. The study, which is theoretically inspired by agroecology, post-development pedagogy, and environmental justice, makes the case that indigenous livestock systems are active epistemologies capable of informing regenerative transitions rather than cultural relics. It advocates for a rethinking of livestock policy and agricultural education in the Global South, emphasising the need to incorporate indigenous values and place-based innovations into larger circular economy frameworks. By providing empirical insights into an under-represented subject, the research adds to critical discussions about sustainability, knowledge diversity, and the future of rural transformation, transcending technocratic paradigms.

Keywords: Circular Livestock Economics; Community Based Livestock Care; Decolonising Education; Environmental

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Stewardship; Regenerative Animal Husbandry; Traditional Knowledge System

1. Introduction

This transformative vision was not born in abstraction, but emerged from Dr. Sahu's personal encounters with the rural realities of veterinary care, gendered access, and indigenous healing knowledge. He recounts:

Origins of Pathe Pathshala: A Practitioner's Journey

I come from a village in Odisha. From my early days, I saw how difficult it was for farmers to access timely and affordable veterinary care. Veterinary doctors were often stationed far away, and by the time help arrived, the situation would worsen. At the same time, I also noticed how many effective herbal healing practices were available locally, simple, low-cost, and rooted in generations of experience.

One incident in particular stayed with me. A pregnant cow was suffering from constipation and did not respond to chemical medicines. When the farmer was advised to give a cup of warm cow milk mixed with warm castor oil, the cow was relieved. That moment made me think—what if more such knowledge could be revived and shared?

Over twenty years, I gathered many such experiences, validated them through practice, and compiled them into a book of herbal remedies for livestock. To my surprise, the book became popular and even received a national award for communicating science and technology to the common people. But I also realised that most government and university trainings were missing the mark. They were held in cities, conducted in technical or unfamiliar languages, and failed to include women, who couldn't leave their homes and dependents behind. That's when the idea came to me, to bring the school to the people.

***Pathe Pathshala** grew from this vision. It is not just about treating animals; it is about making knowledge democratic, teaching in local languages, in the learners' own place and time. When we do that, I believe true development happens. People feel confident, included, and respected. That is what I have witnessed again and again through these mobile classes—a people's university on the move.*

The livestock farming sector is a vital industry with significant potential for progress in agriculture. Industrial models of animal agriculture, characterized by high-input production systems, monocultural breeds, long supply chains, and the externalization of environmental and social costs, are increasingly critiqued for their role in biodiversity loss, zoonotic disease emergence, climate emissions, water depletion[1], and the marginalization of smallholders. This crisis of extractivist livestock economies is deeply intertwined with the broader agro-industrial paradigm that prioritizes efficiency and scale over resilience, equity, and ecological harmony. In response, a growing body of scholarship and practice is advocating for regenerative alternatives, models that centre ecological circularity, multispecies justice, and the revaluation of indigenous and place-based knowledge systems[2].

Within this global conversation, India presents a paradox. As one of the world's largest producers of milk and meat, India is simultaneously home to diverse, decentralized traditions of livestock keeping that are ecologically embedded, culturally mediated, and largely outside the purview of formal policy and science[3]. These traditions have long sustained rural livelihoods and agroecosystems, but they are increasingly threatened by pressures to modernize, homogenize, and commodify animal production. This tension between industrialization and cultural-ecological continuity is particularly pronounced in the state of Odisha, a region marked by rich biocultural diversity, widespread poverty, and a vibrant heritage of community-based animal care prac-

tices[4].

This article looks at *Pathe Pathshala* ("School on the Move"), a grassroots mobile learning system that is presently functioning across Odisha and expanding into northern Indian regions. The effort, known as "A Peoples' University on the Move: at people's place, in people's time, and in people's language," reimagines livestock education by focussing on local knowledge, ecological ethics, with community engagement. Dr. Balaram Sahu, an indigenous veterinarian, leads the effort to challenge top-down extension approaches via dialogic learning and field-based methods that reflect the interconnectedness of humans, animals, and environments. *Pathe Pathshala*, which serves small livestock keepers, female farmers, pastoralists, school dropouts, and rural youth, promotes circular resource usage, environmental stewardship, and regenerative animal care, providing a compelling alternative to technocratic paradigms in livestock growth[5].

The integrated case study of *Pathe Pathshala* provides a fascinating perspective on how traditional systems of knowledge not only survive but also adapt creatively to modern socio-ecological issues. Drawing on ethnographic observations, interviews, and field notes, this paper examines how indigenous livestock systems in rural Odisha enact principles of circular economy and sustainability through embodied knowledge and everyday practice. It further explores the forms of grassroots pedagogical innovation that emerge from within communities to contest and reframe dominant, technocentric models of agricultural extension and veterinary science. A third line of inquiry interrogates the ethical, environmental, and policy insights these systems generate for rethinking food–animal–human relationships in the context of the Anthropocene[6]. At the core of this investigation is a critical engagement with prevailing livestock development discourses, which often cast indigenous animal keepers as passive recipients of external interventions or as impediments to modernization. In contrast, this paper contends that indigenous animal husbandry, especially as practiced and transmitted through informal educational platforms like *Pathe Pathshala*, reflects a sophisticated ecological rationality. This logic is based on principles such as caring, frugality, circularity, generational- knowledge transfer, and multispecies well-being, and it provides feasible choices for more equitable and sustainable futures[7].

In recent years, a rising corpus of critical research from political ecology, post-development studies, and agricultural science has questioned the limits of traditional rural development models. These mainstream methods usually rely on technology solutions, standardised productivity goals, and the imposition of foreign knowledge, all at the cost of localised understandings, cultural practices, and ecological embeddedness[8]. This criticism is based on the idea of epistemic marginalisation, which refers to the systematic devaluation or exclusion of indigenous, experiential, and subaltern knowledge systems in favour of technocratic, generally Western-centric paradigms. These knowledge hierarchies not only exclude diverse methods of knowing, but also perpetuate dominance, representation, and resource control disparities.

This trend is counterbalanced by Arturo Escobar's revolutionary idea of autonomous design. According to his view, design as a world-making activity has to be fundamentally rethought in order to support relational, place-based, and justice-centered forms of community life rather than market logic or modernisation[9]. Instead of seeing design as a mechanical intervention, Escobar incorporates it into the ways of living of people who have long engaged in reciprocal, loving, and interdependent modes of cohabitation with their surroundings. This perspective of design as multiple, contextual, and co-enacted has tremendous significance to alternative models emerging from the global South.

Pathe Pathshala may be seen as a live example of de Sousa Santos' call for cognitive fairness and Escobar's idea of autonomous design. It represents a grassroots epistemology that neither rejects nor welcomes current science without reservation, but rather weaves together multiple knowledges, including scientific, experiential, herbal, and oral, into a holistic pedagogy centred on place[10]. Instead of top-down instruction, knowledge and skills are conveyed via storytelling, healing rhymes, hands-on demonstrations, and curated herbarium exhibitions that represent the everyday lives of farmers, pastoralists, women, and adolescents. Participants are given study materials in their native languages, which promotes both accessibility and cultural ownership[11]. The inclusion of tele-veterinary services and telephone-based follow-up support extends the dialogic relationship beyond the physical visit, ensuring that learning continues as a reciprocal, evolving process rather than a one-time intervention. In all these ways, *Pathe Pathshala* is not merely an outreach

program; it is a pluriversal design in motion, a regenerative model that challenges the monopoly of formal institutions over knowledge and healing, while demonstrating how community-grounded science and care can co-evolve from within[12]. *Pathe Pathshala* challenges contemporary development's restrictive scripts by reclaiming veterinary science and rural livelihoods as areas of emancipatory experimentation, where healing, learning, and subsistence are inextricably linked to the cultural and ecological fabric of place.

A critical starting point for rethinking agricultural research and rural development lies in interrogating the dominant paradigm of modernity itself. While certain modern ideals, such as human rights, gender equality, and democratic participation, have yielded important liberatory outcomes, the broader worldview that emerged in Europe during the Renaissance and crystallized during the Enlightenment has also enacted profound exclusions. This paradigm emphasises private property over shared resources, individualism over teamwork, and a universalist view of science as the ultimate source of knowledge and advancement[13]. One perspective is that this modern episteme has purposefully attempted to marginalise or eradicate non-Western ontologies by characterising them as outdated, irrational, or immature. In the name of progress, it has fostered a dualistic logic, human vs. nature, mind vs. body, modern vs. traditional, that continues to underwrite extractive development models.

This research embraces the need for decolonising knowledge systems in agriculture and rural development in response to such ontological and epistemological erasures. It talks about the idea of pluriversality, which acknowledges that there are many different, coexisting worldviews and relational theories that are legitimate ways to think about and act in the world. This does not mean that all facets of modernity should be rejected; rather, it means placing them within a broader ecosystem of knowledge where discussion, rather than domination, may lead to epistemic justice. With this mindset, agroecology is evolving into a multidimensional framework that encompasses practice, research, and movement rather than only a collection of ecological farming methods[14]. Agroecology, according to one researcher, is an ecological and political alternative to industrial agriculture that uses traditional knowledge and community-based systems to protect food sovereignty, empower smallholders, and restore biodiversity. In support of this, another researcher defines agroecology as a transdisciplinary, action-oriented, participatory strategy that emphasises the co-production of knowledge among farmers, researchers, and civil society actors while integrating ecological principles with social justice. These perspectives emphasise how crucial agroecology is to advancing ecological sustainability, autonomy, interdependence, and epistemic justice. Through storytelling, embodied learning, healing practices, and situated ecological reasoning, humans, animals, and ecosystems work together to create knowledge at *Pathe Pathshala*, which is not just an alternative educational model but also a site of ontological plurality[15]. It encourages dialogic learning based on context, community, and relational ethics as opposed to a top-down method of knowledge transmission. By doing this, it affirms the significance of regenerative, place-based living environments while rejecting the universalising logics of modernity and progress.

Initiatives like the National Digital Livestock Mission and Rastriya Gokul Mission represent a state-led vision that prioritises breed standardisation, surveillance-based health monitoring, and integration into global value chains in the context of India's developing livestock policies, which place an emphasis on biosecurity, genetic improvement, and commercialization—all characteristics of a modernist development paradigm. Although these initiatives have significant positive effects on improving breeds and controlling illness, they often follow a universalising approach that may ignore the ecological and epistemic diversity of regional pastoral knowledge systems[16]. By emphasising adaptable, site-specific behaviours that maintain biodiversity, social embeddedness, and co-evolutionary relationships between people, animals, and landscapes, *Pathe Pathshala*'s alternative methods in this setting supplement national initiatives. When combined, these methods provide room for more diverse, dialogic approaches to cattle development .

As state and corporate actors increasingly promote the standardization of animal production systems, through genetic optimization, centralized supply chains, and stringent biosecurity regimes, the lived practices of pastoralists, indigenous communities, and informal animal health workers in India offer not only resistance, but pathways of renewal. These systems are not isolated or archaic, but the contemporary expressions of an ancient cultural legacy that regards

animals as sentient co-inhabitants rather than mere economic assets. They embody the Vedic and later Dharmic principles of *ahimsa* (non-violence), *seva* (service), and *lokasamgraha* (well-being of the collective), integrating ethical responsibility with ecological consciousness. Traditional livestock practices, such as *gopalan* (cow stewardship), seasonal transhumance by nomadic communities, and *decentralized gaushalas* managed by local panchayats, reflect a deep ecological rationality rooted in adaptive resource management, animal empathy, and soil-plant-animal nutrient cycles[17]. Classical texts such as the *Arthashastra* mention detailed animal care protocols, and traditional veterinary knowledge (now catalogued in ethno-veterinary studies) demonstrates empirical precision in herbal formulations and breeding logic. The Vedic Society in India was dominated by the 'cow culture' and Vedic people adored the cow and regarded it as the source of their good fortune, happiness, and good health. Gandhian thought further reinforces this worldview, emphasizing village-centric livelihoods, *swadeshi, self-reliance*, and reverence for animals as moral and spiritual beings.

Far from being outdated, these practices represent dynamic and evolving models of sustainable animal husbandry, anchored in place-based ethics and ecological intelligence. By emphasising locally based knowledge that is not only ecologically sound but also socially and culturally inclusive, they actively oppose extractive and homogenising mindsets. In order to imagine livestock futures that are equitable, diverse, and environmentally conscious, building on India's legacy of cohabitation and caring rather than replacing it with purely technocratic notions of progress, these indigenous frameworks must be acknowledged and revitalised[18]. This necessitates that indigenous animal husbandry techniques and community-centered pedagogies like *Pathe Pathshala* are crucial examples of biocultural innovation, circular economy theory, and ethical engagement with non-human worlds. They stand for an alternative ontology of development that values social fairness, respects natural limits, and maintains the legitimacy of pluriversal knowledge systems. Their importance goes far beyond India or Odisha; they provide valuable perspectives for reconsidering livestock futures globally, especially in the face of persistent epistemic hierarchies, ecological collapse, and rising rural inequality. By emphasising these relational, grounded approaches, this study seeks to provide new avenues for research, policy, and practice that respect diversity, resilience, and justice in food and agricultural systems.

2. Conceptual and Theoretical Framework

In order to clarify how indigenous livestock systems, such as those taught and practiced via *Pathe Pathshala*, incorporate regenerative and circular logics, this research employs five intersecting theoretical lenses: (1) political ecology and environmental values; (2) commons and agroecological knowledge systems; (3) circular economy critiques and regenerative rural loops; (4) decolonial pedagogies and occupational health and (5) Livestock Education Transitioning from Instruction to Collaboration. Together, these theoretical frameworks allow us to critically analyse the landscapes where livestock practices are embedded and transformed, which are packed with knowledge, development, and policy. Instead of seeing indigenous systems as static traditions, they provide the analytical space to view them as dynamic, regenerative models that offer crucial insights for equitable and sustainable livestock futures.

2.1. Political Ecology and Environmental Values

Political ecology offers a critical lens to examine how power, knowledge, and environmental practices shape agrarian change. Drawing from Blaikie and Brookfield's foundational work , it reveals that environmental issues like land degradation are not merely technical or local failures, but outcomes of broader structural inequalities, such as colonial legacies, market pressures, and policy exclusions[19]. By highlighting who controls access to resources and whose knowledge is valued, political ecology repositions pastoralist and indigenous livestock practices as forms of situated ecological wisdom, not remnants of the past. Building on Robbins, it moves beyond simplistic or apolitical accounts of environmental degradation by interrogating how social and political structures, such as state policies, market forces, and historical inequalities, determine access to, and control over, ecological resources. Robbins highlights that what counts as 'environmental knowledge' is often deeply contested, shaped by competing worldviews and institutional power.

In this context, political ecology enables a critical analysis of livestock systems like those studied in *Pathe Pathshala*,

revealing how indigenous knowledge and community practices emerge not in isolation, but as responses to broader power relations that marginalize local agency. Odisha's indigenous animal husbandry practices reflect a deep integration of livelihood, culture, and ethics, values often marginalized in technocentric agricultural policies. Environmental stewardship is not merely an add-on, but an embedded moral relation to land and animals, shaped by lived experiences of scarcity, climate variability, and collective dependence [20]. These situated values challenge utilitarian frameworks that reduce animals to productivity metrics and landscapes to resources for extraction.

Moreover, drawing from scholars, such as Plumwood and Haraway [21, 22], a multispecies political ecology also urges us to reconceptualize human-animal-environment entanglements not through binaries of nature/culture or human/livestock, but through relational ontologies. The ethical and affective labour of indigenous livestock care, visible in practices such as ritual feeding, veterinary healing with local herbs, or shared migration routes, reveals a deeply interwoven ethics of care that is foundational to regenerative rural systems.

2.2. Commons and Agroecological Knowledge Systems

The practices observed in *Pathe Pathshala* resonate strongly with Ostrom's theory of commons governance and its extensions, which emphasize the role of collective institutions, social norms, and place-based knowledge in sustainably managing shared resources. In Odisha and across much of the Indian subcontinent, livestock are embedded in socio-ecological systems defined by shared pasture management, reciprocal caregiving networks, and customary norms, reflecting resilience rooted in collective responsibility rather than individual commodification [23].

These systems are animated by agroecological knowledge—an epistemology rooted not only in the scientific understanding of biodiversity and ecological interdependence, but also in long-standing traditions of reciprocity, cyclical use of resources, and local adaptation. As articulated by Köhler-Rollefson et al. [24], agroecology is more than a set of techniques; it is a knowledge system co-produced by communities in response to specific ecological conditions, evolving through generational experience. Similarly, Korhonen et al. [25] emphasize that agroecological knowledge emerges from the everyday practices of rural and indigenous communities who interact symbiotically with their environments, fostering a dynamic balance between productivity, sustainability, and cultural continuity. Agroecology, unlike industrial agriculture, values horizontal learning, polyculture interactions, and the co-evolution of ecological and social systems. Informal veterinarians like Dr. Balaram Sahu draw upon generations of such localized ecological knowledge to diagnose animal diseases, manage breeding, and promote preventive health .

Importantly, these knowledge systems are often intergenerational and orally transmitted, bypassing the formal mechanisms of state certification and institutional recognition. In this sense, they challenge the prevailing epistemological hierarchies of development that privilege scientific objectivity over vernacular wisdom. The marginalization of such knowledge from policy frameworks constitutes not just a technical oversight but an epistemic injustice with significant consequences for sustainability and justice [26].

2.3. Circular Economy Critiques and Regenerative Rural Loops

While the circular economy (CE) has gained global traction as a sustainability strategy, its dominant articulations, focused on industrial symbiosis, waste-to-resource innovations, and technological optimization, often replicate the centralizing tendencies of the linear economy they seek to replace. In contrast, rural circularity, particularly in indigenous systems, is grounded in socio-ecological cycles shaped by daily practices of repair, reuse, and redistribution, rather than large-scale infrastructural interventions [27, 28].

Das [29] argue for recognizing "regenerative rural loops", where traditional farming and herding communities internalize ecological limits and design systems to maximize multifunctionality and resilience. In Odisha, this is visible in how animal dung is cycled into fields, how cattle graze fallow lands that would otherwise be underused, and how medicinal plant knowledge circulates informally for animal care, reducing reliance on synthetic drugs.

These loops are often invisible to CE discourse because they lack formal documentation and measurable outcomes. Nonetheless, they provide a practical logic of sufficiency, embeddedness, and circularity that aligns with ecological

economics and degrowth. They also provide flexibility in climate-uncertainty scenarios where flexibility and redundancy are more crucial than monoculture efficiency. By acknowledging these native cycles, we are compelled to challenge CE paradigms that see the countryside as a site of extraction or the use of technofixes rather than as a space for epistemic innovation [30]. A more pluralistic-circularity paradigm built on informal infrastructures, biocultural resilience, and social values may emerge as a result of interacting with such systems. *Pathe Pathshala* is an example of a socially and ecologically conscious "regenerative loop," as opposed to the technical solutions and industrial-scale efficiency that are often the focus of traditional circular economy models. Its practices focus on nutrient cycling via animal waste composting, zero-waste fodder solutions, and reciprocal labour connections. These practices are grounded in rural ethics of reuse, restraint, and sufficiency rather than market logic.

2.4. De-Colonial Pedagogies and Occupational Health

A vital link between public health policy and agroecological practices is provided by the One Health and Eco Health frameworks, which highlight the interdependence of human, animal, and environmental health. Their operationalisation, however, has often remained biomedical, technocratic, and top-down. An option is shown by the work of unpaid livestock carers in rural Odisha: a decentralised, preventive, and environmentally integrated approach to occupational health. Practices such as the use of herbal remedies, early illness detection based on behavioral cues, and low-stress animal handling exemplify forms of veterinary care that are low-cost, low-carbon, and grounded in ecosystem dynamics. Moreover, they reduce the burden on overextended formal veterinary systems and mitigate risks of antimicrobial resistance, zoonoses, and disease outbreaks linked to factory farming [31].

Importantly, these systems also reflect occupational health ethics often ignored in rural development discourse. Indigenous practitioners like Dr. Sahu develop intimate, embodied knowledges of animal behaviour, biosecurity, and injury prevention. Their mobile and dialogic pedagogy encourages community-wide safety practices such as appropriate waste management, injury reduction, and common cleanliness standards, establishing a culture of collaborative OSH (Occupational Safety and Health) without depending on official regulations. Such models align with decolonial perspectives that challenge dominant epistemologies and valorise subaltern knowledge production.

Pathe Pathshala is not just an alternative veterinary training institution, but also a decolonial pedagogy that promotes embodied learning, storytelling, and hands-on immersion in place-based care [32]. It also reframes occupational health by emphasising the physical, emotional, and environmental well-being of both cattle and caretakers, which are sometimes overlooked by biological or technological methods. Together, these theoretical views allow us to critically investigate the power-laden terrains of knowledge, development, and policy that underpin and influence livestock practices. They widen the analytical approach to see indigenous systems as dynamic, regenerative models that provide critical insights into equitable and sustainable livestock futures.

2.5. Livestock Education Transitioning from Instruction to Collaboration

This section examines the most common paradigms of livestock education and extension in India. These paradigms have historically been founded on top-down, technocratic techniques inherited from the colonial and Green Revolution periods. By seeing knowledge as a one-way flow from experts to receivers, farmers, pastoralists, or animal health professionals, these techniques often strengthen epistemic hierarchies and marginalise locally established practices. *Pathe Pathshala*, on the other hand, represents a co-inquiry paradigm in which knowledge is developed collaboratively via conversation, personal experience, and community participation. *Pathe Pathshala* promotes contextual learning by immersing students in indigenous ethnoveterinary knowledge [33] (**Figure 1**), ecological observations, and social values inherent in local livestock cultures, rather than mandating best practices from formal institutions.

Pathe Pathshala's pedagogy was evaluated through the lens of critical education theory, including Paulo Freire's emancipatory frameworks, participatory rural assessment, and decolonial pedagogies. These programs oppose the "banking model" of extension education, which places a focus on interaction, reflexivity, and co-learning rather than

having experts deposit knowledge into passive recipients. Instead, then being a traditional school, *Pathe Pathshala* is a travelling place of encounter where locals, animals, plants, and healers all contribute to a relational curriculum built on common life experiences [34]. An innovative approach to teaching presence and mutual recognition is to walk with communities, listen to elders, and co-create solutions on the spot.

Figure 1. Ethnoveterinary ingredients prepared by Dr. Balaram Sahu.

This transition from teaching to co-inquiry is a decolonial educational transformation, recognising many ways of knowing and practicing care while undermining science's monopoly on animal health and production. It proposes a democratised extension system in which learning stems from personal experiences and is continually negotiated rather than standardised . As such, *Pathe Pathshala* exemplifies the promise of marginal pedagogies, not as romanticised alternatives, but as critical laboratories of social and environmental reform. Together, these frameworks provide a valuable analytical toolset for reinterpreting indigenous animal husbandry systems as sophisticated, regenerative solutions to the many crises of industrial agriculture, public health, and rural marginalisation. In doing so, it portrays *Pathe Pathshala* as an epistemic intervention, rather than a complement to formal systems, which is urgently required in a period of industrial agriculture and ecological deterioration.

3. Methodology and Sources

This research draws on a composite of ethnographic fieldwork, participatory documentation, and grounded practitioner insights, derived primarily from two key sources: (1) extended field observations and documentation by Dr. Ilse Köhler-Rollefson, an experienced veterinarian and advocate of pastoralist rights, and (2) community-based pedagogical practices and first-person reflections from Dr. Balaram Sahu, the founder of *Pathe Pathshala*, a mobile indigenous education initiative embedded in Odisha's rural livestock-keeping communities. Together, these form a qualitative, immersive, and ethically engaged methodology suited for exploring the lived dimensions of circular livestock systems, informal knowledge, and ecological values.

3.1. Participatory and Embedded Ethnography

At its core, this study follows a participatory ethnographic approach, situated within the traditions of agroecological and rural studies where the researcher's engagement is not distanced or extractive, but dialogical and mutually informed. Fieldwork conducted by Paul and Tiwari [35] entailed multi-site participant observation across rural Odisha, especially within communities actively engaged in non-industrial animal rearing . This work was complemented by semi-structured interviews with livestock keepers, community health workers, and village elders, with particular attention to oral histories, local terminologies of animal care, and shared rituals of livestock stewardship. Crucially, this study is not a short-term observational exercise but a deeply embedded inquiry, developed over successive visits and sustained relationships, reflecting long-standing engagement with pastoralist and agrarian communities across India. The material collected includes not only observational field notes but also video footage, translated transcripts of dialogues, and visual ethnography (photos, community-drawn maps, and animal health charts created by local youth).

In parallel, the documentation and insights provided by Dr. Balaram Sahu stem from his praxis as a community-based veterinarian and educator. *Pathe Pathshala* itself is a pedagogical process wherein the boundaries between research, teaching, and community organizing are blurred. **Figure 2** illustrates such a model through the work of Dr. Balaram Sahu and his *Pathe Pathshala* initiative. Sahu's practice involves traveling on foot across rural Odisha, engaging with villagers in open-ended, reciprocal encounters that blur the line between teacher and learner. These mobile interactions, spanning dozens of villages, pivot on real-time co-solving of veterinary and ecological challenges, drawing

equally from traditional knowledge and scientific reasoning. His field records, case notes, and reflective writings form a unique epistemic archive, testimony to a pedagogy deeply embedded in care, attentiveness, and environmental ethics.

Figure 2. Dr. Balaram Sahu in dialogic veterinary outreach through *Pathe Pathshala*, Odisha.

3.2. Situated Knowledge and Co-Production of Meaning

Rather than treating the researchers or practitioners as external to the field, this methodology centers the co-production of knowledge between academics, indigenous practitioners, animals, and communities. Such an approach aligns with feminist and postcolonial methodological critiques that advocate for recognizing the partial, situated, and embodied nature of all knowledge production.

The methods employed deliberately resist the linear logic of "data extraction and analysis" and instead embrace reflexive immersion, wherein knowledge is shaped by ongoing dialogue, community-led validation, and adaptive interpretation. For instance, interpretations of animal healing practices were often corrected or expanded by community elders, and ethical disagreements around dehorning, tethering, or commercial breeding were debated collectively in the field, rather than resolved through researcher authority [36]. This reflexivity is also present in how *Pathe Pathshala* structures its interventions, not as one-way knowledge transfer, but as reciprocal learning. Therefore, the fieldwork and practitioner data collected here are both descriptive and pedagogical in nature, revealing how knowledge is continually co-constructed in practice.

Figure 3 shows an interactive learning encounter facilitated by *Pathe Pathshala* in a rural setting, where Dr. Balaram Sahu engages with a diverse group of participants—women, elders, youth, and livestock owners—gathered informally. The seating arrangement, open-air setting, and conversational posture reflect a departure from hierarchical extension models. Rather than functioning as a "teacher," Sahu facilitates a circle of exchange, where each participant contributes observations, experiential insights, and traditional knowledge regarding animal health, pasture management, and seasonal cycles. The picture captures the inclusive ethos of *Pathe Pathshala*: interventions are not predetermined but emerge through context-specific dialogue. This reflexivity ensures that local knowledge is not only acknowledged but actively shapes the diagnostic and problem-solving processes. The moment photographed demonstrates how the boundaries between expert and community blur, emphasizing co-construction of knowledge, mutual respect, and the pedagogical significance of listening.

Figure 3. Inclusive and Reflexive Knowledge Exchange in *Pathe Pathshala.*

3.3. Ethics and Positionality

This research emerges from a close collaboration with *Pathe Pathshala* and its founder-practitioner, Dr. Balaram Sahu. Rather than treating local knowledge as "data" to be extracted, the study is framed as a co-inquiry rooted in trust, long-term engagement, and mutual learning. The researcher's positionality, as a retired engineer and academic

with disciplinary training in environmental & safety science[37], but also an outsider to the everyday lived worlds of Odisha's pastoralists, necessitates ongoing reflexivity about power, representation, and voice.

Ethical engagement here is not confined to formal consent but extends to the epistemological level: whose knowledge counts, how it is represented, and for what purpose. Following the ethics of decolonial and participatory research, care was taken to ensure that community contributions were not anonymised into generalisations, but instead attributed with context and nuance, respecting the relational ontology of learning in these systems. Moreover, given the hybrid nature of *Pathe Pathshala*, as both an educational and veterinary intervention, this work recognises its embeddedness in ongoing social processes. The ethical commitment is thus twofold - to accurately represent the pedagogical and ecological stakes of the practice, and to ensure that its documentation supports rather than undermines its grassroots credibility[38]. Transparency, co-authorship, and iterative feedback from the practitioner-participant form the backbone of this ethical stance.

Dr. Balaram Sahu, on the other hand, exemplifies an imprecise perspective: he is a rural healer and educator who is deeply entrenched in the cultural living worlds with which he works. His voice is critical in challenging institutional marginalisation of informal veterinary knowledge while also exhibiting rural practitioners' political agency. Including his viewpoints not only democratises the research narrative, but also bases it in epistemic fairness, elevating voices that are all too frequently silenced in formal livestock science and policy arenas.

3.4. Limitations

This study admits a number of shortcomings. First off, it makes no claims about statistical generalisation even while it offers profound qualitative insights. Analytical depth, not numerical breadth, is the main emphasis. Second, whatever triangulation attempts, there will always be interpretative loss while translating a language, particularly when translating specialised animal care terms from Odia to English. Third, the field observations were made using open-ended ethnographic modes rather than standardised research tools (such as structured questionnaires), which may have limited replicability[39] .

Additionally, the reliance on two key interlocutors, Smith[40], means the narrative may not capture all regional or caste-class variations within Odisha's diverse livestock cultures. Yet, the richness of embedded experience and community trust offsets these constraints by offering rare access to otherwise opaque or informal systems of ecological knowledge and animal care.

Stakeholders in Focus: Who Learns, Who Leads, and How

Small and marginalised livestock-keeping groups are at the heart of Pathe Pathshala's educational approach. Small livestock keepers, pastoralists, women, school dropouts, and jobless rural youth, particularly from tribal areas of Odisha and other parts of India, are the main stakeholders.

Small Livestock Keepers: *These are people and families that raise cattle, sheep, goats, pigs and fowl for a living. They make up the vast majority of animal healthcare users in rural India and play an important role in the local agricultural economy.*

Pastoralists: *They are groups of livestock caretakers who roam around to graze their animals. They stay in woods and meadows throughout their trip. Their unpredictable movement patterns make typical, location-based extension services useless. Pathe Pathshala approaches them straight along their grazing pathways.*

School Dropouts and Unemployed Rural Youth: *This group of young people lives mostly in tribal communities and does not attend regular education. Since they are raised in a village ecology, Pathe Pathshala sees them as future barefoot veterinarians and animal feed experts.*

Women at the Grassroots: *Women are typically the unsung heroes of animal care. Their tasks include feeding, grazing, health monitoring, and treatment methods. Nonetheless, they are often precluded from completing formal*

veterinary education due to mobility limitations and care duties. Pathe Pathshala aims to address this gap by hosting sessions in rural areas, in local languages, and with inclusive formats.

Modes of Engagement: *Pathe Pathshala uses a hybrid interaction model. In-person classes are held in settlements and along pastoral walks, and include techniques such as storytelling, healing rhymes, live demonstrations, and herbarium exhibitions. Study materials are accessible in regional languages. Back at home, learners are connected via a specialist "tele-vet" system that allows for ongoing help and two-way communication. Through these pathways, learning becomes a continuous, embedded, and empowering process, rooted in context, experience, and reciprocity.*

4. Case Study Narrative and Thematic Analysis

Pathe Pathshala, located at the intersection of epistemic justice and grassroots innovation, is more than just a program; it is a pedagogical revolution built on place-based learning, co-inquiry, and care. The case study encourages reflection on knowledge diffusion, knower identification, and the redesigning of veterinary education from the bottom up via narratives, embedded ethnography, and stakeholder interactions. Rather than reiterating the normative dichotomies of formal/informal or modern/traditional, the study focuses on four interconnected themes: mobile learning as a contextual practice, healing as a relational epistemology, gendered participation and agency, and community resilience against structural precarity. These themes form the basis of an alternate approach to livestock education that involves the community rather than offering top-down training.

4.1. Learning in Motion: Pedagogies of Place and Practice

Animal husbandry methods in rural Odisha are inextricably linked to the ecosystems in which they are rooted. Knowledge is developed via embodied involvement with land, animals, and local resources rather than being taught through textbooks or institutionalised curricula. *Pathe Pathshala* reinforces and magnifies pedagogies that arise immediately from movement, practice, and seasonal cycles in this environment. One example of this pedagogy in action is the circular movement of resources. For example, dried dung is not considered waste but rather an essential input for farming, seed germination, and even housing material[41]. It is frequently traded informally between households, particularly to help women-led or landless families, demonstrating a community ethic based on ecological reciprocity and solidarity rather than profit. It is bartered for heirloom seeds or shared labour, proving that ecological circulation and social cohesion are inextricably linked.

Common spaces, like forest-edge patches or *gochar* land, serve as decentralised, community-governed learning settings. They are terrains of relational pedagogy rather than just resource utilisation. Communities maintain an ecological, just, and locally specific biomass-animal-soil system via customary practices, rotational grazing, seasonal prohibitions, and ceremonial limits. Despite reflecting what Elinor Ostrom would refer to as commons governance, these traditional systems' instructional component is sometimes overlooked in formal extension discourse[42]. Water, fodder, and biomass are similarly governed through practices of situated knowing. Tank silt mixed with buffalo/cow dung becomes not only fertilizer but construction material for seedbeds and village homes. These practices reflect an indigenous ecological literacy, an ability to read, respond to, and regenerate the landscape, that *Pathe Pathshala* does not replace but walks alongside. In doing so, the initiative reclaims extension as a dialogical, context-responsive process where learning is co-produced in motion, in place, and in relation.

Yet, these life worlds of learning are under increasing threat. Land enclosures, state neglect of commons, and the imposition of productivist models displace the very systems they claim to modernize. Nonetheless, rural households continue to enact circularity through resourceful and interlinked practices[43]. Meal waste and crop residues are not discarded but redirected into the animal care cycle, fed to livestock, enriching both nutrition and feed self-sufficiency. In turn, the resulting dung supports soil fertility or fuels *gobar gas* systems, completing a loop of material and energy use that is low-cost, low-waste, and locally sustainable.

Such practices represent a built-in circular economy, developed not through formal design but through generations of localized trial, observation, and mutual aid. Understanding learning as rooted in these entangled material flows and customary ecologies invites a rethinking of what counts as knowledge, who is recognised as a knower, and how livestock education might be reimagined as environmental stewardship rather than mere technical transfer[44].

4.2. Healing as Knowing: Ethnoveterinary Knowledge in Action

According to the field practices recorded by *Pathe Pathshala*, healing is a relational act that is based on awareness of animal behaviour, environmental signals, and the social ecology of care rather than just a technical intervention (**Figure 4**). The industrial cattle industry and the traditional veterinary traditions of Odisha provide a very distinct perspective on ecological and occupational health[45]. Urban toxicity is often imported into rural areas by the mainstream paradigm, which is becoming more and more dependent on synthetic feed additives, chemical dewormers, and antibiotics. On the other hand, low-risk, plant-based, and context-sensitive therapies are preferred, according to field data from *Pathe Pathshala* villages.

Figure 4. Ethnoveterinary Knowledge in Action.

For example, a combination of dried bael leaf, delicate banana stem, and water-soaked rice husk is often used to cure calves' diarrhoea. These treatments are based on personal experience and have been tried and proven over many generations. Warm turmeric compresses and dietary changes, including limiting protein-rich feed, are used to treat mastitis. In contrast to many injectable remedies, these therapies are not only effective but also preventative, economical, and free of adverse effects. These kinds of activities demonstrate an empirically based but informal kind of "healing literacy." Elder women and unofficial livestock stewards, many of whom come from Dalit or Adivasi tribes, embody the knowledge. Despite their lack of literacy, they possess decades of somatic memory and diagnostic acumen.

However, professional veterinary services, which often focus on pharmacological methods and educated male technicians, continue to mostly ignore their wisdom. Thus, the gendered structure of rural animal care is a location of epistemic injustice as well as resilience. This issue has sometimes been made worse by the growth of mobile veterinary clinics and centralised medication procurement systems. Avoidable animal stress and death have resulted from improper dosing, inadequate cold-chain management, and unmonitored antibiotic side effects. In these situations, healing becomes a disputed area between the often-invasive technocratic logic of formal systems and informal, context-attuned knowledge.

Pathe Pathshala serves as a corrective to these top-down approaches. It fosters peer-to-peer knowledge exchange that resists chemical overload, supports One Health principles, and recognizes animal, human, and environmental health as co-dependent. Here, healing is also a political act, revalidating community-based care as a legitimate form of OSH for rural workers and as an ecologically grounded system of veterinary governance[46].

These grassroots pedagogical practices are not without struggle. The ethical, affective, and embodied knowledge systems they mobilize often face systemic neglect, resource constraints, and infrastructural gaps. The following field testimony by Dr. Balaram Sahu reflects the real-world challenges in sustaining such alternative epistemologies on the ground.

Voices from the Field – Challenges in Sustaining Pathe Pathshala

What are the main challenges? *As narrated by Dr. Balaram Sahu*

1. I pursue my passion for reaching people and diffusing knowledge through Pathe Pathshala. Till now, I have been doing this voluntarily by spending the logistics costs from my own pocket, as a token of love to give back to the society from which I have come. To enhance

and ramify the work, funding is the first major challenge. Although I receive local hospitality and partial logistics support from friends, well-wishers, and mentors, funds remain a central constraint.

2. Instilling a sense of confidence and belief among small livestock keepers, pastoralists, unemployed youth, and women regarding the healing potential of herbs in their own hands, in their own situations, is another key challenge. They do not easily believe, unless they see the results with their own eyes.

3. Diffusing skills and knowledge to poor farmers and women livestock keepers with limited formal education is difficult. The methodology must be convincing, easily understandable, and people-friendly, using simple words in local language, storytelling, rhymes, and audio-visuals.

4. One major aim is to tell them: wherever you go for earning your livelihood, you are not alone, you are with the knowledge and skills that empower you. Imparting this confidence requires using culturally resonant methods such as storytelling, healing rhymes, herbarium displays, and practical demonstrations.

5. Existing poverty also hinders people from leading a happy life. It becomes a real challenge to help them see the potential of this knowledge and skill for income generation and dignified livelihoods. These challenges are likely to continue in the future.

4.3. Gendered Access and Transformative Roles

One of the most innovative aspects of this case is the educational intervention of *Pathe Pathshala*, a decentralized, mobile, and multimodal rural education initiative started by Dr. Balaram Sahu. Operating under a tree, in courtyards, or at village junctions, this platform resists the spatial hierarchies of formal veterinary knowledge. Instead of expecting learners, particularly rural women, to come to distant institutional centers, the classroom is brought to the village courtyard, the paddy field, the cattle shed, or beneath the banyan tree. These spaces, often associated with women's everyday labour, become sites of dialogue, co-learning, and epistemic validation.

Pathe Pathshala actively challenges the gendered exclusion embedded in conventional extension systems. In a domain where women's livestock care knowledge is often undervalued or dismissed as anecdotal, the initiative repositions women as educators, demonstrators, and narrators of illness, healing, and animal behaviour[47]. Through participatory discussions, women- lived experiences, such as treating a calf's diarrhoea using neem bark decoction or identifying a goat's heat cycle, become teachable moments for the community. This fosters not only recognition but also intergenerational transmission of embodied knowledge, with girls and younger women learning directly from their mothers and elders.

Crucially, *Pathe Pathshala* deploys multimodal, inclusive pedagogies that make space for non-literate and orally oriented learners, many of whom are women (**Figure 5**). Teaching tools include locally understandable metaphors, body-based demonstrations, image cards, and vernacular storytelling. By mobilizing low-tech digital tools such as WhatsApp voice notes, basic Android video clips, or community radio episodes, the platform also extends the reach of these lessons without disembodying them from their sociocultural context[48]. For example, a woman's ethnoveterinary practice, such as treating retained placenta using plant-based uterine cleansers, can be recorded on a mobile phone and shared farmer-to-farmer across districts, reinforcing peer-to-peer validation.

Figure 5. Holistic understanding of veterinary education.

Importantly, this pedagogical model does not treat animals as mere production units. Storytelling methods cultivate empathy, e.g., referring to a distressed buffalo as a "mother in pain", and reaffirm animals' roles as co-workers, soil healers, and family members. Such relational framing, deeply embedded in women's care work, is neither romanticized nor dismissed but placed at the centre of a more ethical, holistic understanding of veterinary education.

Pathe Pathshala epitomises knowledge democracy by respecting intuitive, folk, and ecological knowledge in addition to scientific knowledge. It allows women to advance from the peripheral of "beneficiary" status to the centre as co-educators and change agents. It does more than just give access; it also changes roles, transforming rural women from passive beneficiaries of top-down expansion to agents of epistemic regeneration. This has far-reaching consequences for marginalised populations' resilience, animal welfare, and climate-adapted care methods.

4.4. Community Resilience and Climate-Responsive Care

Rising temperatures, unpredictable rainfall, droughts, and new zoonotic threats are all signs of climate change, which need not just technological solutions but also socially based resilience strategies. *Pathe Pathshala* model makes a strong argument for how locally owned survival strategies and climate-responsive adaptation may be promoted via community-based veterinary education that is ingrained in place-based knowledge and mutual care networks. A vital strand of community resilience observed through *Pathe Pathshala* lies in the everyday interweaving of livestock care with ecological stewardship.

Instead of purchasing inputs, households often depend on what is locally available, such as kitchen leftovers, crop husks, and roadside greens, to feed their animals. This adaptive adaptability not only provides food for cattle during lean times, but it also increases autonomy from uncertain fodder markets [49]. Dung is then changed and put to fields to renew soil life, or it is processed in small-scale biogas facilities to fulfil cooking fuel demands. These patterns indicate an ancient logic of reciprocal reinforcement among animals, land, and livelihoods, which is based on lived ecological intelligence rather than formal design. They are not only cost-cutting measures, but acts of caring, regeneration, and climate responsiveness interwoven in everyday activities.

Furthermore, the training focuses on early illness detection, the use of locally accessible medicinal herbs, and non-invasive healing procedures to lessen dependency on pharmaceutical supply systems, which are often interrupted during severe weather events or pandemics. This localised pharmaceutical autonomy improves veterinarian reaction during crises and decreases environmental impact. Importantly, the paradigm acknowledges the connection of human, animal, and environmental health, which many now refer to as the "One Health" or "planetary health" approach [50]. Rather of teaching these ideas via top-down biomedical channels, *Pathe Pathshala* bases them in daily rural and pastoral realities, where animals are not distinct from the land, water, and people, but are inextricably linked. *Pathe Pathshala* establishes these ideas in common rural and pastoral realities, where animals are not distinct from the land, water, and people, but rather intrinsic to them. The resilience produced is both material and relational: trust between trainers and communities, the rebirth of historic mutual assistance networks , and the resurgence of local epistemologies act as buffers against not just ecological shocks, but also institutional neglect. In an age where formal veterinary services are often overburdened, particularly in marginal and climate-vulnerable regions, such embedded, climate-responsive forms of care become essential.

4.5. Ethics of Care and Animal Agency: Reframing the Human–Animal Bond

The moral and emotional bond between people and animals is an often-overlooked aspect of livestock debate. Field studies from *Pathe Pathshala* show that animals are more than just assets or production units; they are friends, memory carriers, and moral subjects in rural communities. They are named, usually in matrilineal lines (for example, a calf named after its grandmother cow), and their behaviours are seen as communication actions. One farmer explained how his bull refused to approach a certain area after a chemical mishap, while another detailed how goats form alliances and cows get jealous when a new calf appears. These are not romantic stories, but examples of animal agency in co-living habitats [51]. Such partnerships threaten the prevalent agricultural ethic, which views animals as machinery to be optimised. Instead, cattle are considered as companions with memory, emotion,

and significance, their suffering recognised, their contributions celebrated during harvest celebrations, and their death mourned in communal ceremonies.

Pathe Pathshala aggressively infuses these characteristics within its curricula. Children are encouraged to see animals as community members rather than "assets." Elders describe how cows/buffaloes saved homes from droughts by giving curd when wheat failed, recasting animals as resilience partners. These ethical links also have an impact on practical decisions: some cultures reject artificial insemination because it is considered humiliating to cows, whilst others oppose castration due to perceived cruelty. Extension agents may critique such judgments as "irrational," but they represent a deeply rooted ethics of caring in which efficiency is balanced by empathy and life is valued above productivity.

Impact of *Pathe Pathshala*: From Pedagogy to Practice

Pathe Pathshala's impact and resonance extend beyond its direct educational experiences. The program serves as a dispersed ecosystem of learning, with each session serving as a "satellite unit" of knowledge and skill transfer.

1. ***Each Pathe Pathshala is a Satellite Unit of Knowledge and Skill:*** *Every mobile session is documented and followed up with community leaders to assess impact. Metrics include the number of individuals becoming* ***healers, animal feed makers****, or practicing* ***ethnoveterinary techniques*** *for income generation. To date,* ***1262 Pathe Pathshala*** *have been conducted across India, directly training over* ***100,000 grassroots participants****.*
2. ***Radio Pathe Pathshala:*** *Launched during the COVID-19 lockdown, this remote outreach initiative used small audio clips (in* ***Hindi and Odia****) on common and emergency livestock issues, disseminated via social media and mobile phones. It reached* ***25,000 families****, especially pastoralists and small ruminant keepers, at a time when access to formal veterinary services was impossible.*
3. ***Back to Biodiversity:*** *Using voice SMS tracking, the program monitors how many* ***healing herb gardens*** *or* ***kitchen herbal plots*** *have been cultivated by women's groups post-training—rebuilding local pharmacopeia while enhancing biodiversity.*
4. ***Mind to Market:*** *Skill-to-enterprise pathways are tracked through this programme, which identifies how many trained participants are engaged in* ***entrepreneurial ventures*** *such as* ***herbal formulations*** *and* ***animal feed production****. Challenges in production, distribution, and market access are also documented.*
5. ***Lateral Learning and Diffusion:*** *Learning does not stop with direct participants. Through* ***peer-sharing****, storytelling, and informal transmission, knowledge spreads laterally to kin, neighbours, and fellow workers. This ripple effect is supported by* ***Tele-Vet follow-ups****, community calls, SMS outreach, and check-ins with local representatives.*

5. Synthesis: Revaluing Livestock Knowledge Systems

The preceding sections have illustrated how *Pathe Pathshala*, as both method and movement, reframes livestock education from a top-down model of instruction to a plural, place-based, and participatory pedagogy. In doing so, it destabilizes dominant narratives that render indigenous and informal livestock knowledge as backward or unscientific. Instead, it makes visible the ingenuity, ecological sensibility, and moral reasoning embedded in everyday animal care practices among marginal communities.

At its core, this model reclaims livestock knowledge as a dynamic and distributed system, not merely a repository of inherited techniques but a living field of experimentation, storytelling, healing, and adaptation. The pedagogy is not

confined to classrooms or clinics; it unfolds in courtyards, under banyan trees, and along footpaths where barefoot veterinarians, elders, women, and children co-produce insights through dialogue, memory, and shared labour.

This epistemic ecology, additionally recognised as a veterinary common, opposes institutional enclosure while providing significant options for ecological resilience, food sovereignty, and animal well-being. Furthermore, the ethical elements of animal-human relationships that develop from these techniques contradict simplistic views of animals as just industrial units. Here, creatures are named, remembered, and mourned. They are enmeshed in the moral economy of homes, serving as resilience partners, companions, and affect agents. These connections are not nostalgic remnants of a premodern worldview, but rather active forms of climate-responsive care that emphasise empathy, reciprocity, and respect.

Pathe Pathshala pioneers novel ways to decolonize livestock education by validating embodied knowledge, feminist care ethics, and agroecological integration. It ties to broader sustainable development objectives, including SDGs 2 (Zero Hunger), 5 (Gender Equality), 12 (Responsible Consumption and Production), and 13 (Climate Action). Importantly, it compels politicians and intellectuals to re-examine what constitutes knowledge and who has the authority to generate it. Revaluing cattle knowledge systems, therefore, is not an act of nostalgia. It is a strategic requirement in a society beset by several issues such as climate change, inequality, and environmental degradation. *Pathe Pathshala* and other grassroots innovations demonstrate that alternative futures are being achieved, not in laboratories or boardrooms, but in village assemblies, field-based healing rituals, and attentive care.

5.1. Beyond Efficiency: Valuing Frugality, Reciprocity, and Life

The current cattle development paradigm, whether in India or elsewhere, has long been shaped by a productivist ethos. This paradigm emphasises production maximisation, genetic improvement, and technological solutions like as artificial insemination, centralised veterinarian services, and commercial feed systems. Animals in this schema are reduced to parameters like as milk production per day, feed conversion ratio, calving interval, and disease incidence per hundred heads[52]. Labour, caring, and knowledge are all evenly distributed and used. In contrast, the indigenous systems described in *Pathe Pathshala* and other grassroots experiences indicate a different worldview centred on frugality, reciprocity, and life-affirming care rather than extraction. Here, the emphasis shifts from production to relational well-being and ecological integration. Three key value orientations emerge from this subaltern epistemology:

- **Solidarity and Mutuality**: Livestock care is firmly ingrained in family, communal responsibility, and non-market transactions. Manure, herbal cures, and extra fodder are distributed among homes in the spirit of communal subsistence. This gift economy rejects commercialisation and promotes interdependence between human and nonhuman existence.
- **Ecological Frugality**: These systems have limited input by design, not by default. They work within closely interrelated cycles of biomass, nutrients, and labour, relying on local resources including natural grasses[53], agricultural wastes, and rain-fed commons. Manure is treated as a regenerative input rather than a waste product. Disease is addressed not by pharmacological overkill, but rather through observation, preventative care, and community awareness.
- **Non-Violence and Ethical Care**: Refusing to participate in harmful activities such as hormonal injections, needless castration, or isolation of ill animals is not a superstition, but rather an expression of a deeply established moral ecology. Animals are identified, grieved, and memorialised. They are cohabitants, not units of production.

These ideas do more than supplement present livestock policy; they call into question its fundamentals. National undertakings, such as the Rashtriya Gokul Mission, or global productivity development campaigns, often remove such value systems in the sake of modernity and scale. However, not only is efficiency jeopardised, but so are animal rights, knowledge systems, and planetary limitations.

In the end, these traditional approaches challenge us to rethink what constitutes value in cattle growth. Can we design frameworks that prioritise dignity, resilience, and relational care above extractive logics? If livestock systems are to be really sustainable, they must be answerable not just to markets, but also to the life-worlds they occupy and

influence.

5.2. De-Centering Formal Expertise and Reclaiming Knowledge Pluralism

Modern livestock development has been predominantly guided by technocratic institutions such as veterinary schools, state animal husbandry departments, and international organisations that assume a single, universal model of competence. Based on biomedical and zootechnical concepts, this strategy prioritises standardised diagnostics, pharmacological treatments, and productivity-focused initiatives. While such knowledge systems have clearly helped with disease management and animal welfare in some cases, their prevalence has often marginalised locally based, environmentally conscious modes of care and understanding[54].

The *Pathe Pathshala* instance demonstrates the limitations of top-down, formalised agricultural extension approaches, which now dominate livestock policy. Public veterinary services, particularly in underserved areas, are usually underfunded, pharmaceutically driven, and organised around a technocratic logic that excludes subaltern knowledge holders, particularly women, elders, and non-literate farmers. These actors possess extensive embodied and empirical knowledge handed down through generations, yet they are seldom recognised as credible experts[55]. Current policy reforms, ranging from livestock insurance schemes and fodder subsidies to dairy cooperatives and AI-linked health programmes, frequently rely on standardised training modules and surveillance-based approaches inspired by global biosecurity regimes and public health frameworks, such as One Health. However, these institutional frameworks tend to:

- Decontextualize care by promoting uniform veterinary protocols with little sensitivity to local ecosystems or cultural ethics;
- Exclude non-credentialed practitioners, many of whom are more trusted, affordable, and accessible than state officials;
- Impose alien diagnostic categories and treatment regimens, often overlooking rural epistemologies of illness, healing, and animal wellness.

Rather than dismissing science, *Pathe Pathshala* exhibits the democratisation of scientific participation by bringing formal and informal knowledge systems together via dialogical, participatory teaching. Rather than emphasising didactic delivery, these mobile learning spaces promote praxis, or learning via experience, observation, and reciprocal engagement. This is consistent with Paulo Freire's concept of a “pedagogy of the oppressed” that rejects top-down education and embraces the learner's agency as a co-creator of knowledge.

To decentre formal expertise is not to deny the value of veterinary science, but to challenge its epistemic monopoly. Indigenous and grassroots knowledge systems—like those practiced and taught through *Pathe Pathshala*—operate on fundamentally different grounds. Rather than treating animals as objects of technical intervention, they understand care as a relational and ecological practice, where illness is interpreted through signs such as behaviour, posture, dung texture, or herd movement—knowledge forms developed through intimate observation, storytelling, and iterative learning.

Revaluing livestock systems, therefore, demands more than extension reform; it requires an epistemic shift—from the monoculture of technoscientific authority to the plural cultivation of diverse knowledge ecologies. Rural livestock care is not a knowledge-deficit problem, but a recognition-deficit one. What is needed is not merely capacity-building but capacity-recognition—of knowledge systems that are already embedded in place, practice, and community.

5.3. Reimagining Policy: From One Health to Many Life-Worlds

Globally, livestock development is increasingly subsumed under the banner of One Health, a framework linking animal, human, and environmental health. While conceptually promising, its implementation has often mirrored top-down, biomedical, and surveillance-driven logic, with a focus on zoonotic threats, antibiotic resistance, and industrial biosafety[55]. This instrumental approach risks reducing animals to epidemiological vectors and farmers to compliance subjects, sidelining the relational, ethical, and place-based dimensions of animal care.

In India, One Health strategies have begun to inform livestock insurance schemes, disease surveillance programs, and biosecurity protocols. Yet these policies largely emphasize containment and control over care and co-existence. Their metrics privilege epidemiological data over lived

knowledge, and formal diagnostics over every day ecological attunement. The ethnographic insights from Odisha suggest the need for a decentred, community-embedded, and values-based version of One Health [56], one that recognizes animals as sentient co-beings, not merely carriers of pathogens. Such a reimagined framework would:

- Integrate ethnoveterinary systems as valid health infrastructures, especially where formal services are absent, inaccessible, or culturally inappropriate;
- Address the occupational health of rural animal workers, particularly informal and gendered labor, which remains invisible in both health and agriculture policy;
- Recognize local stewardship of animal well-being as a legitimate form of public health, deserving state recognition and support.

This implies designing many health, not a singular biomedical vision imposed from above, but a plurality of health practices rooted in territory, history, and moral economy. In this pluralistic vision, healing is not merely technical but relational, cosmological, and co-produced. For instance, herders' use of dream interpretation, seasonal cycles, and plant-based rituals is not "irrational," but expression of coherent epistemologies tuned to multispecies well-being.

Policy reorientation along these lines would also have implications for CAP-like schemes (e.g., PM-Kisan, livestock insurance, or dairy subsidies). Rather than directing incentives solely toward industrial feed, high-yield breeds, or surveillance technologies, a circular and care-oriented policy regime would:

- Reward soil-health improvements through manure use;
- Support community-managed grazing commons as agroecological infrastructure;
- Fund ethnoveterinary documentation and peer-learning hubs for barefoot animal caregivers;
- Recognize animal caregiving as care work, including social protection (e.g., pensions or insurance) for informal livestock workers.

Moving from One Health to multiple life-worlds demands more than institutional integration. It necessitates epistemic fairness, policy co-design, and ontological humility, which recognises that health, healing, and care come from various realities rather than a single universal norm [56]. *Pathe Pathshala* and other initiatives provide a glimpse of what such policy futures may look like: mobile, inclusive, reciprocal, and firmly based in the lived reality of individuals who interact with animals daily.

5.4. Rethinking Metrics and Impact

Dominant paradigms of livestock development and animal health have traditionally been founded on tightly defined criteria such as milk output, meat productivity, illness incidence, and vaccine coverage. These measures, although quantitative, represent a technocratic mentality in which animals are mainly seen as units of production and carers as tools for efficiency. Such reductive measurements ignore the social, ethical, and ecological aspects of cattle care, particularly in situations where frugality, cohabitation, and resilience are more important than production maximisation.

The case challenges the metrics by which livestock development is assessed. Productivity, mortality, and input-output ratios dominate dashboards, while affective labour, ecological contribution, and ethical treatment remain unquantified. In the field realities observed across Odisha, impact was measured less by productivity per se and more by animal well-being, household stability, ecological harmony, and intergenerational transmission of knowledge. For instance, a local cow that lives for 15 years, grazes on shared commons, provides small but sufficient quantities of milk, manure, and draught power, and is cared for with reverence, holds value far beyond her economic yield. These are values invisible to standardized development metrics but deeply meaningful to communities. If circular livestock systems are to be valued, we must also revalue the metrics:

- From yield per animal → to ecosystem contribution per household;
- From disease incidence → to care resilience and peer knowledge networks;
- From productivity → to ethical co-living and interspecies dignity.

Such a paradigm shift not only makes room for alternative development but affirms agricultural systems built on dignity, interdependence, and sustainability, rather than extractivism and dispossession. Moreover, the informal and feminized labour that underpins livestock care, early morning fodder gathering, ethnoveterinary tending, and navigating droughts or disease outbreaks is rarely recorded, let alone

compensated. As long as "impact" continues to be defined through top-down frameworks of economic return or epidemiological risk reduction, such labour and knowledge will remain structurally devalued. Reframing metrics involves both an epistemic and methodological shift [57]. It requires designing multi-dimensional indicators that are co-created with communities and sensitive to diverse goals, such as:

- Animal longevity, low-stress lifespans, and well-being;
- Mutual adaptation between livestock and landscape (e.g., browsing patterns, drought tolerance);
- Care labour equity, recognizing and valuing women's and elders' roles;
- Resilience indicators, such as herd recovery post-disaster or adaptive response to fodder scarcity;
- Knowledge retention and transmission, e.g., presence of peer-learning spaces or youth involvement in ethnoveterinary practices.

Some of these may not lend themselves to easy quantification—but that is precisely the point. Metrics should serve community-defined visions of well-being, not override them. Participatory impact assessment, narrative-based monitoring, and embedded ethnographies offer promising alternatives to one-size-fits-all evaluative tools. This synthesis affirms that indigenous livestock knowledge systems are not mere heritage, they are living laboratories of ethical, ecological, and pedagogical innovation. They offer grounded blueprints for climate-resilient, inclusive, and value-based agricultural futures. Recognizing, documenting, and protecting these systems is not just an academic or policy task, it is an ethical imperative.

In short, rethinking impact means rethinking what we choose to value. If the ultimate aim of livestock policy is to support sustainable livelihoods, multispecies flourishing, and resilient territories, then our measurement frameworks must be grounded in these life worlds, not in abstracted, extractive data regimes.

5.5. Community-Led Technology for Ethical and Circular Livestock Futures

The potential of digital technologies to support indigenous and circular livestock systems lies not in replacing local knowledge, but in amplifying and interlinking it through contextually embedded tools. Co-designed digital platforms—developed in close consultation with community animal health workers, livestock keepers, and ethnoveterinary practitioners—can enable the safe, decentralized documentation and transmission of treatment methods, disease observations, and care-based innovations. Open-source repositories, maintained in vernacular languages and grounded in visual and oral pedagogies, could function as living libraries of rural knowledge systems. These platforms would not only strengthen intergenerational transmission and adaptive learning but also serve as bridges between grassroots actors, academic researchers, and policy institutions. Crucially, they must be governed by principles of data sovereignty, community ownership, and cultural relevance.

ICT-enabled participatory monitoring, such as GPS-tagged grazing routes, soil and vegetation health logs, or decentralized manure circularity dashboards, can enhance feedback loops for local decision-making and contribute to circularity metrics. Yet these tools must never become instruments of surveillance or control. Rather, they must operate as enablers of co-governance and commons stewardship, aligned with ethics of care, reciprocity, and place-based knowledge. To realize this vision, policy frameworks should incentivize and fund community-driven technology co-design, ensuring that digital interventions amplify the values of sustainability, inclusion, and epistemic dignity embedded in indigenous livestock worlds.

6. Policy and Practice Implications

The insights emerging from Odisha's indigenous livestock systems and the pedagogical innovations of *Pathe Pathshala* point to urgent and necessary shifts in how agricultural development, animal health, and rural knowledge are governed. These systems offer a powerful counterpoint to dominant top-down, extractive, and productivist approaches, providing a real-world foundation for reimagining sustainable, equitable, and regenerative rural futures.

6.1. Toward Decentralized and Plural Veterinary Systems

Current animal health policy in India remains overly reliant on a limited pool of formally trained veterinarians, a narrow range of biomedical inputs, and centralized extension delivery systems. This fails to account for the diversity of

livestock keepers, terrains, and culturally embedded care practices across rural India. The Odisha case reveals how community-based animal health workers, women's self-help groups, and pastoral knowledge holders can effectively co-create and deliver services, provided they are recognized, trained, and supported through locally rooted structures. Policy frameworks should:

- Create multi-tiered veterinary care systems that recognize both formal and informal actors;
- Establish accreditation pathways for ethnoveterinary practitioners;
- Incentivize training programs in herbal healing, preventive care, and circular livestock practices.

6.2. Embedding Epistemic Justice in Livestock Research and Extension

Reforming livestock development also means rethinking what counts as valid knowledge. The epistemologies embodied in healing songs, plant lore, and embodied observation are not merely anecdotal—they are context-responsive[57], intergenerationally tested, and ecologically embedded. Extension models must evolve from unidirectional knowledge transfer to dialogic, co-learning approaches. This demands:

- Supporting vernacular language documentation of livestock knowledge;
- Funding community-led field schools and mobile platforms like *Pathe Pathshala*;
- Incorporating ethnoveterinary evidence into research and curriculum design in agricultural universities

6.3. Redesigning Funding and Institutional Support Mechanisms

Grassroots innovations like *Pathe Pathshala* survive not because of, but despite, current institutional architectures. Voluntary efforts are overstretched, reliant on personal funds, goodwill, and informal networks. For long-term viability:

- Dedicated funding streams should be allocated for decentralized veterinary education and demonstration projects;
- Grant models must prioritize collaborative proposals led by local practitioners and CBOs;
- Monitoring frameworks should evaluate ecological and social impact, not just throughput.

6.4. Digital Tools for Commons-Based Care

As discussed earlier, context-sensitive digital technologies can play a catalytic role, if governed by principles of data sovereignty, co-design, and knowledge pluralism. Policy can support this by:

- Funding the development of open-source ethnoveterinary knowledge platforms in regional languages;
- Ensuring ICT initiatives align with commons stewardship and care ethics, not surveillance or extraction;
- Integrating community feedback loops into all tech deployments.

6.5. Aligning with the Sustainable Development Goals (SDGs)

The reimagining of livestock systems through circularity, inclusiveness, and knowledge pluralism offers a tangible pathway for advancing the 2030 Agenda. Community-anchored initiatives like those in Odisha illustrate how localized innovations can contribute to multiple interlinked SDGs:

- **SDG 12: Responsible Consumption and Production**
  By promoting closed-loop nutrient cycles, minimizing external chemical inputs, and fostering locally adapted systems for fodder, feed, and manure management, these practices reduce ecological footprints and enhance resilience[58].
- **SDG 3: Good Health and Well-Being**
  The integration of ethnoveterinary care, reduced antibiotic dependency, and improved occupational safety for informal livestock workers collectively support One Health objectives and rural well-being.
- **SDG 15: Life on Land**
  Reviving community-managed grazing, protecting traditional livestock breeds, and restoring land-animal-human links all contribute to ecosystem regeneration and biodiversity preservation in agricultural areas.
- **SDG 5: Gender Equality**
  Women maintain several knowledge transmission traditions, such as herbal therapy, ethnoveterinary nurs-

ing, and seed-livestock trading. Recognising and developing these responsibilities raises women's visibility as guardians of biodiversity and rural health, while also increasing their livelihood agency and decision-making capacity[59].

- **SDG 13: Climate Action**
  These systems provide scalable, nature-based climate mitigation and adaptation techniques grounded in traditional ecological knowledge by lowering reliance on fossil fuels, supporting low-emission livestock management, and facilitating ecosystem regeneration.

These similarities highlight the necessity of context-sensitive, locally driven innovations in furthering global sustainability goals—rather than technocentric or productivity-focused approaches. The way ahead requires a policy realignment based on ecological ethics and epistemic fairness. Indigenous livestock systems and knowledge traditions are not developmental leftovers; rather, they are shaping the future. Recognising and integrating them into formal policy is both a moral obligation and a practical need for climate resilience, social inclusiveness, and sustainable food systems.

7. Conclusions

This research looked at the interconnected dynamics of traditional animal husbandry, circular practices, and pedagogical innovation in Odisha via the perspective of *Pathe Pathshala* and other community-based veterinary care systems. These behaviours not only call into question current paradigms of cattle growth, which are often extractive, linear, and expertise-driven, but they also highlight alternative futures based on caring, reciprocity, and ecological awareness. Far from being relics of the past, these systems are dynamic stores of knowledge, resilience, and co-governance. Their focus on native medicinal plants, shared grazing commons, low-input animal husbandry, and inclusive learning infrastructures shows that sustainable livestock futures are already being implemented, although marginalised by mainstream institutions. When acknowledged and supported, these projects demonstrate how regenerative animal care may also serve as workplace safety, food sovereignty, and biodiversity protection. By emphasising women's responsibilities, recognising ethnoveterinary epistemologies, and pushing for technologies that enhance rather than replace indigenous knowledge, the Odisha example reclaims space in rural development rhetoric for epistemic justice and knowledge plurality. *Pathe Pathshala*'s decentralised, culturally embedded approach is more than just an educational breakthrough; it is also a political and ecological intervention that redefines what constitutes knowledge, care, and sustainability in cattle governance. As the global development agenda shifts towards inclusive, climate-resilient, and biodiversity-friendly paths, Odisha's findings call for a fundamental shift: from technocratic-universalism of One-Health to grounded pluralism of Many-Lifeworlds. This transformation necessitates rethinking policy frameworks, effect measures, and support mechanisms in order to not just include but also prioritise local actors and their methods of knowing. Ultimately, the regenerative potential of livestock systems lies not in scaling homogenized models, but in scaling respect for diverse ecologies, livelihoods, and worldviews. *Pathe Pathshala* and its surrounding knowledge ecosystems offer not only a critique of the present but a grounded, actionable vision for just and sustainable futures.

Author Contributions

A.D.: Writing-review & editing, writing-original draft, supervision, resources, methodology, conceptualization, software, data curation, investigation, validation, and formal analysis. S.M.: Supervision, investigation. Both authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement

This study was conducted in accordance with the ethical standards and guidelines set forth by the SOA, University, Bhubaneswar. Ethical approval was obtained from the [Balaram Sahu, Professor, SOA, University]. All procedures involving human participants were carried out in accordance with the guidelines and regulations of the aforementioned ethics committee. The authors confirm that all methods were

carried out in accordance with relevant ethical guidelines and regulations.

Informed Consent Statement

The authors confirmed that informed consent (Consent to Participate and Consent to Publish) was obtained from all participants or, if participants were under 18, from a parent and/or legal guardian. The authors agreed to the Consent to publish for **Figures 1–5**.

Data Availability Statement

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Conflict of Interest

The author states that they have no competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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