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Socio-Economic Impact of Ectoparasitic Diseases on Smallholder Farming Communities in India: A Review

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Abstract: The livestock sector is vital to India's rural economy, providing income and nutritional security to millions of smallholder farmers. This review focuses on recent literature on the pervasive but often underestimated socio-economic impact of ectoparasitic diseases (EPDs), primarily caused by ticks and mites, on these vulnerable communities. EPDs inflict substantial economic losses through direct effects (reduced milk, meat, and wool yields; hide and skin damage) and indirect effects [transmission of expensive-to-treat Tick-Borne Diseases (TBDs)]. Financially, the burden is quantified by annual losses of several million USD, compounded by the rising costs of ineffective treatments due to acaricide resistance (AR). Socially, EPDs increase livelihood instability, disproportionately affect women's labor burden, and pose significant zoonotic health risks to farm families. The review concludes that EPDs are a major constraint to achieving sustainable development goals in rural India. It underscores the urgent need for integrated, farmer-centric policies that prioritize local surveillance, promote cost-effective ethno-veterinary alternatives, and strengthen veterinary extension services to mitigate the escalating socio-economic hardship on smallholder communities.

Keywords: Ectoparasitic diseases, Smallholder farming, Socio-Economic impact, Acaricide resistance, Tick-Borne diseases

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Introduction

The livestock sector remains the financial and nutritional backbone of rural India, contributing approximately 5% to the national GDP and sustaining the livelihoods of nearly two-thirds of the rural population (Singh and Kumar, 2022). Within this structure, smallholder farming communities, defined by their reliance on small herds of cattle, buffalo, sheep, and goats, represent the most numerous, yet the most economically vulnerable, segment. Their low capital, limited access to formal veterinary care, and dependence on livestock as the primary asset make them highly susceptible to economic shocks induced by animal diseases.

One of the most persistent, geographically widespread, and financially damaging threats to

these smallholders is the scourge of ectoparasitic diseases (EPDs) (Garg and Sharma, 2024). Ectoparasites, predominantly ticks (*Rhipicephalus microplus*, *Hyalomma* spp.), mites (causing mange), and lice, compromise host health through direct actions, such as blood feeding, skin irritation, and trauma, and indirect actions, most critically as vectors for major infectious agents causing TBDs (e.g., Theileriosis, Babesiosis, Anaplasmosis) (Chaudhuri and Ray, 2020).

While the overall economic loss due to EPDs in Indian livestock is estimated to be astronomical (exceeding hundreds of millions of USD annually), these figures often fail to capture the nuanced, localized, and cascading socio-economic impact specific to the smallholder ecosystem. This review aims to fill this gap by synthesizing recent empirical studies and reviews (2020–2025) to provide a comprehensive understanding of how EPDs perpetuate poverty, affect household labor dynamics, and contribute to public health risks within smallholder farming communities across India.

The Economic Impact: Direct and Indirect Losses

Ectoparasitic infestations translate directly into quantifiable financial losses across the entire livestock value chain, eroding the thin profit margins of smallholder farmers.

Direct Productivity Losses

The most immediate effects of heavy ectoparasite load are visible in reduced animal output. Studies consistently demonstrate significant depression in production metrics:

- *Reduced Milk Yield*: Heavy tick infestations, particularly by *Hyalomma* and *Rhipicephalus* species, are linked to chronic stress, anemia, and disease transmission, resulting in a substantial reduction in daily milk yield, often reported between 20% and 40% in affected dairy animals (Dubey and Singh, 2022; Garg and Sharma, 2024). This directly impacts daily household income and nutritional availability.
- *Impaired Growth and Weight Gain*: In young and growing animals, blood-sucking ectoparasites cause anemia and hinder feed conversion efficiency. This leads to reduced market weight, commanding a lower selling price for meat animals (sheep, goats) and decreased draught power in bullocks (Singh and Kumar, 2022).
- *Loss of By-Product Value*: Mite and tick damage results in extensive scabbing, lesions, and blemishes, leading to the downgrading or outright rejection of hides and skins by tanneries. Losses due to poor hide quality frequently exceed 25% of potential revenue, severely impacting the small ruminant sector (Kaur and Randhawa, 2022).

Indirect Losses and Escalating Costs

Indirect losses, predominantly driven by the secondary diseases transmitted by ticks, often carry a higher cost burden:

- *Tick-Borne Disease (TBD) Management*: The cost of treating TBDs (Theileriosis, Babesiosis, Anaplasmosis) is significant, involving veterinary consultation fees, expensive proprietary drugs, and supportive care. This often necessitates farmers incurring debt or selling other assets, leading to financial distress (Babu and Suresh, 2021).
- *Acaricide Resistance (AR) and Treatment Failure*: The widespread, non-standardized use of chemical acaricides by smallholders, often due to poor training or cost-cutting, has fueled the evolution of multi-drug resistance in key tick populations (Deshmukh et al., 2023). Treatment failure forces farmers to purchase stronger, more expensive chemicals or apply them more frequently, creating a negative feedback loop of rising costs and diminishing returns (Kumar and Yadav, 2024).
- *Mortality and Asset Loss*: In acute TBD cases, especially in young or imported crossbred animals, mortality rates can be high. The death of a high-yielding dairy animal represents the sudden loss of a major household asset,

pushing vulnerable families into deep poverty (Yadav and Singh, 2023).

The Socio-Cultural Impact: Health, Equity, and Livelihoods

The impact of EPDs extends beyond financial metrics, fundamentally affecting the social equity and human well-being of smallholder families.

Livelihood Instability and Poverty Perpetuation

For smallholder farmers, livestock serves as a "living bank" for social events, health emergencies, and education expenses. Chronic or acute disease episodes due to EPDs and TBDs destroy this safety net. The need to repeatedly sell or butcher livestock at low prices to cover veterinary bills or manage decreased productivity creates a constant state of financial precarity (Sharma and Thakur, 2023). This economic instability is a direct constraint on the adoption of improved farming technologies, trapping families in a cycle of poverty.

Gendered Burden and Time Poverty

Women are overwhelmingly responsible for the daily care, feeding, and disease management of livestock in Indian smallholder systems. EPDs significantly increase this labor burden. The time spent on manual tick removal, applying ineffective local remedies, or taking sick animals to distant veterinary centers diverts time and energy away from other productive activities, education, or childcare. This increased time poverty disproportionately affects women, hindering rural development efforts focused on female economic empowerment (Jain and Kumar, 2023).

Zoonotic and Public Health Risks

Ectoparasites are vectors for several zoonotic pathogens, creating a direct public health threat for smallholder families who live in close proximity to their animals. The most critical example is the Hyalomma tick, which vectors the highly lethal Crimean-Congo Haemorrhagic Fever (CCHF**)** virus. Close contact during milking, de-ticking, or slaughtering increases the exposure risk for farmers, particularly in high-prevalence areas (Gupta and Jaiswal, 2020). The lack of awareness regarding these zoonotic threats and inadequate biosafety practices amplify the danger within these communities (Pal and Singh, 2022).

Control Challenges and the Need for an Integrated Approach

The smallholder context presents unique challenges to EPD control, demanding a shift from reliance on chemical control to Integrated Pest Management (IPM).

Gaps in Farmer Knowledge and Veterinary Access

Many smallholders lack adequate scientific knowledge regarding the full life cycle of ectoparasites, leading to incorrect timing, under-dosing, or over-dosing of acaricides—the very drivers of AR (Kumar and Yadav, 2024). Furthermore, the limited reach and high cost of formal veterinary services, especially in remote areas, force farmers to rely on readily available but often ineffective remedies or use chemical treatments without professional guidance (Prasad and Sarma, 2021).

The Role of Climate and Ecology

Recent studies indicate that climate chang**e** is altering the epidemiology of ectoparasites. Warmer temperatures and altered rainfall patterns are extending the transmission season, expanding the geographic range of tick species, and accelerating their reproductive cycles, increasing the overall disease challenge for farmers (Mahalingam and Rao, 2021).

Opportunities in Ethno-Veterinary Medicine (EVM)

Given the high cost and resistance issues associated with synthetic acaricides, there is a growing body of evidence supporting the use of Ethno-Veterinary Medicine (EVM)—plant-based remedies with acaricidal properties—which are often locally sourced, cost-effective, and culturally acceptable (Ray and Ghosh, 2024). Integrating validated EVM practices, such as those involving extracts from Neem (*Azadirachta indica*), into formal IPM programs offers a sustainable path

forward for resource-poor farmers (Girish and Sreenivasulu, 2021).

Conclusion

Ectoparasitic diseases pose a profound, multi-dimensional socio-economic challenge to smallholder farming communities in India. The cumulative burden of direct productivity losses, the high cost of TBD management, the emergence of widespread acaricide resistance, and the social costs of increased labor and zoonotic risk create a powerful constraint to poverty reduction and rural prosperity. Addressing this challenge is crucial for enhancing the sustainability of the Indian livestock sector. Future policy must pivot towards a One Health approach that prioritizes regional surveillance, invests in decentralized diagnostic facilities, validates and promotes sustainable and cost-effective alternatives like EVM, and empowers smallholder farmers through targeted veterinary extension and participatory education programs.

Ethical Statement

This is a review article hence no Ethical Approval needed.

Author Contributions

Author has read and agreed to the published version of the manuscript.

Conflict of Interest

The author declares no conflicts of interest.

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