RJNMSR
Review Journal of Neurological & Medical Sciences Review

Volume 4, Issue 2, 2026

HUMAN AND LIVESTOCK HEALTH RISKS OF *Parthenium hysterophorus* L.: A REVIEW

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DOI: https://doi.org/10.5281/zenodo.18654271

Received	Accepted	Published
17 December 2025	01 February 2026	16 February 2026

ABSTRACT

Parthenium hysterophorus L. *is a highly invasive weed of the family Asteraceae that has become a serious public health, veterinary and agricultural problem in many tropical and subtropical regions, including Pakistan. Its rapid spread is driven by prolific seed production, long seed viability, efficient dispersal through wind, water, livestock movement, farm machinery and strong allelopathic potential that suppresses native vegetation and pasture species. This review synthesizes published evidence (1990–2025) on the major health hazards of Parthenium hysterophorus for humans and livestock and highlights management options under a One Health framework. In humans, exposure to pollen, plant hairs, and airborne plant particles is strongly associated with allergic disorders. Studies from heavily infested rural settings report that approximately 10–25% of exposed individuals develop allergic contact dermatitis, while 8–15% experience respiratory problems such as allergic rhinitis, asthma and bronchitis. Eye and mucosal irritation, including conjunctivitis and tearing has been reported in 5–10% of exposed populations. Livestock grazing in Parthenium-infested rangelands shows reduced feed intake, weakness, diarrhea, oral lesions and dermatitis, with reported productivity losses including 10–30% reduction in milk yield and 10–15% loss in body weight. The weed also degrades grazing lands, indirectly increasing fodder scarcity and economic burden on rural communities. Integrated management combining mechanical removal, selective herbicides, biological control and awareness programs is essential to reduce exposure and protect human and animal health.*

Keywords: *Parthenium hysterophorus L., invasive weed, human health, livestock grazing, allelopathic potential, integrated management.*

INTRODUCTION

Parthenium hysterophorus L., commonly known as Parthenium weed or Congress grass, is a highly invasive annual plant of the family Asteraceae. Originally native to the tropical and subtropical regions of the Americas, it has now spread to more than 46 countries, including regions of Asia, Africa and Oceania, primarily due to human-mediated activities such as trade, livestock movement and contaminated seed transport (Gupta & Singh, 2021). The plant is notorious for its rapid growth, prolific seed production, and adaptability to diverse soils and climatic conditions, enabling it to colonize a wide variety of disturbed habitats such as croplands, pastures, wastelands and roadsides (Navie *et al.*, 1996; Kohli *et al.*, 2006; Adkins & Shabbir, 2014; Ahmad, Shekh, & Saiyad, 2018). Its seeds can remain viable in the soil for several years, contributing to a persistent seed bank and making eradication difficult. The widespread presence of Parthenium poses significant ecological, economic and health challenges. The plant produces allelochemicals such as parthenin, phenolic acids and other sesquiterpene lactones, which inhibit the growth of native plants and crops, reducing biodiversity and pasture quality (Pandey, 1996; Singh *et al.*, 2003; Bajwa *et al.*, 2016; Gupta & Singh, 2021). These compounds are also toxic and allergenic, affecting both humans and animals upon direct contact or ingestion. In rural agricultural regions, where human activities overlap with infested lands and livestock grazing, the threat of Parthenium exposure is particularly high (PMC Editorial Team, 2016).

Exposure to Parthenium in humans can occur through direct contact with plant parts, inhalation of airborne pollen or handling of contaminated material. Such exposure has been associated with a range of health problems, including dermatitis, eczema, allergic rhinitis, hay fever, conjunctivitis and asthma, with certain populations experiencing increased prevalence of allergic reactions after prolonged contact (Agarwal & D'Souza, 2009; Dogra & Mahajan, 2015; Sharma & Kumawat, 2023; Gupta & Singh, 2021). These allergic responses are mediated primarily by the plant's sesquiterpene lactones, which act as potent sensitizers and irritants. The resulting health burden is significant, particularly in rural communities, where access to medical care may be limited and awareness of the risks is low.

Livestock are also at risk due to grazing on infested pastures or consuming Parthenium-contaminated fodder. Animals may develop oral ulcers, excessive salivation, diarrhea, anorexia, dermatitis, and reduced weight gain, and in severe cases, high dietary intake of the weed can lead to death (Chippendale & Panetta, 1994; Kumar & Kumar, 2012; PMC Editorial Team, 2016). Such impacts translate into economic losses through decreased milk and meat production increased veterinary care costs and reduced productivity of grazing lands (Shah *et al.*, 2025a). Together, these human and animal health hazards underscore the need for effective management strategies to mitigate exposure and minimize risks. Given these challenges, this review aims to provide a comprehensive synthesis of the health hazards associated with *Parthenium hysterophorus*. The objectives include reviewing human and livestock health impacts, summarizing the toxic compounds and mechanisms of action and discussing prevention and management strategies to reduce exposure and mitigate risks. Understanding these effects is essential for developing integrated interventions that protect both public health and livestock productivity while controlling the spread of this invasive weed.

MATERIALS AND METHODS (Review Methodology)

Literature Search Strategy

To comprehensively assess the published evidence on the health hazards of *Parthenium hysterophorus* for humans and livestock, a structured literature review methodology was employed. Multiple scientific databases were systematically searched to identify relevant peer reviewed articles. The primary sources included Google Scholar, PubMed, Scopus and Web of Science, which together provide broad multidisciplinary coverage ranging from

biomedical to agricultural sciences. These databases were selected for their comprehensive indexing of studies in toxicology, clinical health effects, veterinary science and invasive species ecology, ensuring that diverse aspects of Parthenium's impacts were captured.

The literature search used a combination of Boolean search terms to capture relevant studies on both human and animal health effects. Core keywords included terms such as: *"Parthenium hysterophorus," "Parthenium weed," "health hazards," "allergy," "dermatitis," "respiratory effects," "livestock toxicity," "Parthenin,"* and *"toxicology"*. These keywords were used alone and in combinations (e.g., *Parthenium hysterophorus and dermatitis; Parthenium and livestock toxicity; Parthenin and health effects*) to maximize retrieval of relevant reports. Additional search terms related to clinical outcomes and epidemiology were also included when using specialized databases such as PubMed to ensure identification of studies focused on specific health outcomes.

Inclusion Criteria

Inclusion criteria were established to ensure that only scientific, evidence-based studies were considered. Articles were included if they were peer-reviewed, published in English and directly addressed the health effects of *Parthenium hysterophorus* in humans or livestock or provided relevant toxicological data applicable to health risk assessment. The time period for eligible studies was set from 1990 to 2025, a window chosen to capture both earlier foundational research and the most recent findings in the field. Reviews, original research articles, clinical case reports and epidemiological surveys that met these criteria were included in the final analysis.

Exclusion Criteria

Exclusion criteria were applied to filter out publications not directly related to the health hazards of interest. Non-scientific materials, such as news articles, opinion pieces, conference abstracts without full text and unpublished manuscripts were excluded. Additionally, studies focusing solely on unrelated uses of Parthenium (e.g., phytochemical extraction for industrial products) without discussion of health impacts were omitted. Research dealing exclusively with ecological effects or weed management without examination of human or animal health outcomes was also excluded, unless it provided toxicological insights relevant to exposure and health risk.

Data Collection and Analysis

Data collection was conducted by reviewing the full text of each included study and systematically collecting key information. For each article, details such as the author(s) and year of publication, geographical location of the study, study population or species (human or animal), research design and major findings were recorded. Health outcomes assessed (e.g., dermatitis prevalence, respiratory symptoms, signs of livestock toxicity), exposure routes and any quantitative measures reported (such as incidence or severity of symptoms) were noted. This extracted information was then synthesized to identify patterns, knowledge gaps and emerging themes regarding the health hazards posed by *Parthenium hysterophorus* exposure across different populations and settings.

BOTANICAL AND ECOLOGICAL OVERVIEW

Taxonomy and Identification

Parthenium hysterophorus L. is a highly invasive annual herb belonging to the family Asteraceae, the same family as sunflowers and daisies (Shah *et al.*, 2025b). It is commonly known as Parthenium weed, Congress grass or carrot weed. Morphologically, Parthenium is erect and branched, usually growing 0.5–2 meters in height. Its leaves are alternate, pinnately lobed and covered with fine hairs, giving a grayish-green appearance. The plant produces small, white to pale green flowers arranged in panicles at the tips of branches which mature into ribbed, small, and light seeds(Navie *et al.*, 1996; Gnanavel & Natarajan, 2013). These seeds are easily dispersed by wind, water, livestock and agricultural machinery, contributing to its widespread colonization.

Table 1: Key Morphological Features of *Parthenium hysterophorus* L.

Feature	Description
Plant Type	Annual, erect, branched herb
Height	0.5–2 meters
Leaves	Alternate, pinnately lobed, hairy, grayish-green
Flowers	Small, white/pale green, in panicles
Seeds	Small, ribbed, light, easily dispersed
Stem	Erect, hairy, green

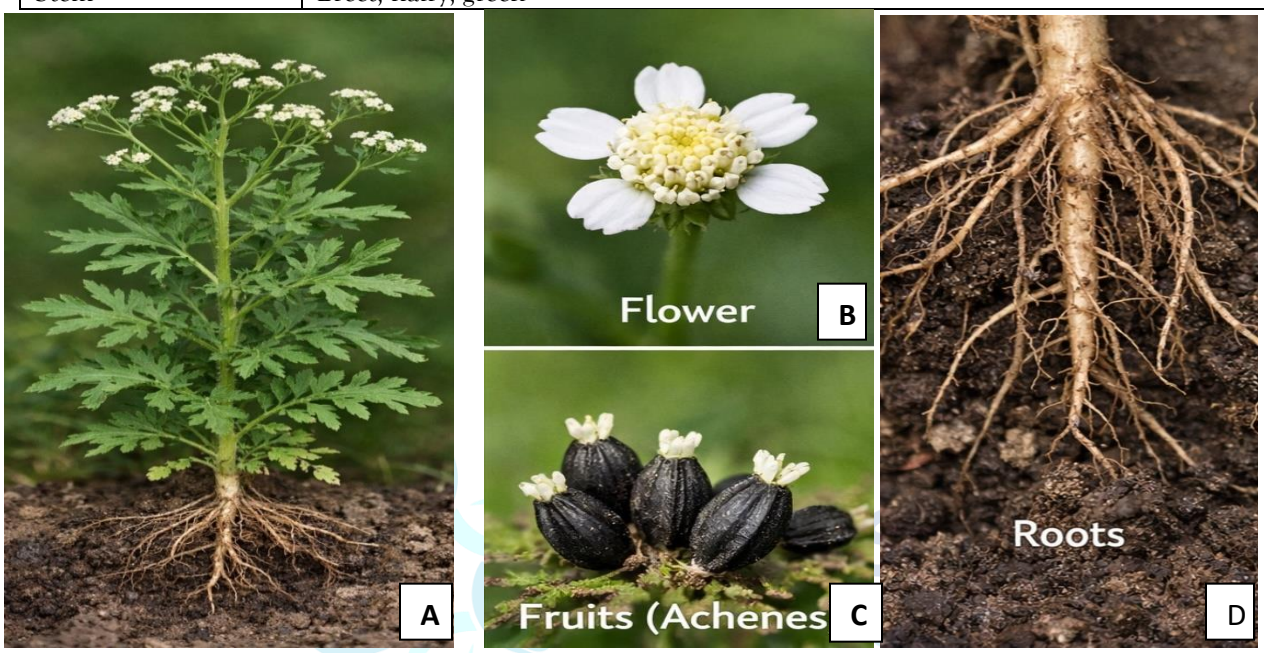

Fig. 1: Morphological characteristics of *Parthenium hysterophorus:* (A) Whole plant habit, (B) Flower head (Capitulum), (C) Fruit (Achenes), (D) Root system.

Distribution and Spread

Originally native to Central and South America, *Parthenium hysterophorus* has now invaded more than 46 countries across Asia, Africa, Oceania and North America (Khairul Bashar *et al.*, 2021; Navie *et al.*, 1996; Kohli *et al.*, 2006). In Pakistan, it is commonly found in Punjab, Sindh, Khyber Pakhtunkhwa and Balochistan, particularly along roadsides, wastelands, agricultural fields and grazing lands. Its global success is attributed to its high reproductive capacity, long-term seed viability, rapid growth and adaptability to disturbed habitats. Seeds remain viable in soil for up to 5–6 years, ensuring persistent reinfestation even after removal.

Table 2: Global and Regional Distribution of *Parthenium hysterophorus* L.

Region / Country	Status	Notes
Central & South America	Native	Original habitat
India	Invasive	Widespread, major health and agricultural impacts
Pakistan	Invasive	Punjab, Sindh, KP, Balochistan
Africa	Invasive	Eastern, Southern, and Western regions
Australia	Invasive	Pastures and wastelands
North America	Invasive	Limited but expanding

Invasive Behavior

Parthenium's invasive potential is driven by several biological traits:

1. **High Seed Production:** Each plant can produce tens of thousands of seeds annually, contributing to rapid population growth (Adkins & Shabbir, 2014; Navie *et al.*, 1996).
2. **Allelopathic Effects:** The plant releases parthenin and other secondary metabolites into the soil, which inhibit germination and growth of neighboring crops and native plants, reducing biodiversity and pasture quality (Pandey, 1996; Singh *et al.*, 2003; Kaur *et al.*, 2021).
3. **Adaptability:** Parthenium thrives in disturbed habitats, including croplands, wastelands, roadsides, and degraded pastures. Its resistance to drought and soil variability allows it to dominate diverse ecosystems (Timsina *et al.*, 2011).
4. **Threat to Agriculture and Livestock:** Dense infestations reduce fodder availability, displace native flora, and increase exposure of humans and livestock to toxic compounds (Shah *et al.*, 2025b).

Table 3: Key Traits Contributing to Invasiveness of *Parthenium hysterophorus* L.

Trait	Description / Impact
Seed Production	Tens of thousands per plant; long viability (5–6 yrs)
Allelopathy	Releases parthenin, phenolic acids; inhibits crops and native plants
Adaptability	Thrives in diverse soils and disturbed habitats
Spread	Dispersed by wind, water, livestock, machinery
Ecological Impact	Reduces biodiversity, degrades pastures, threatens crops

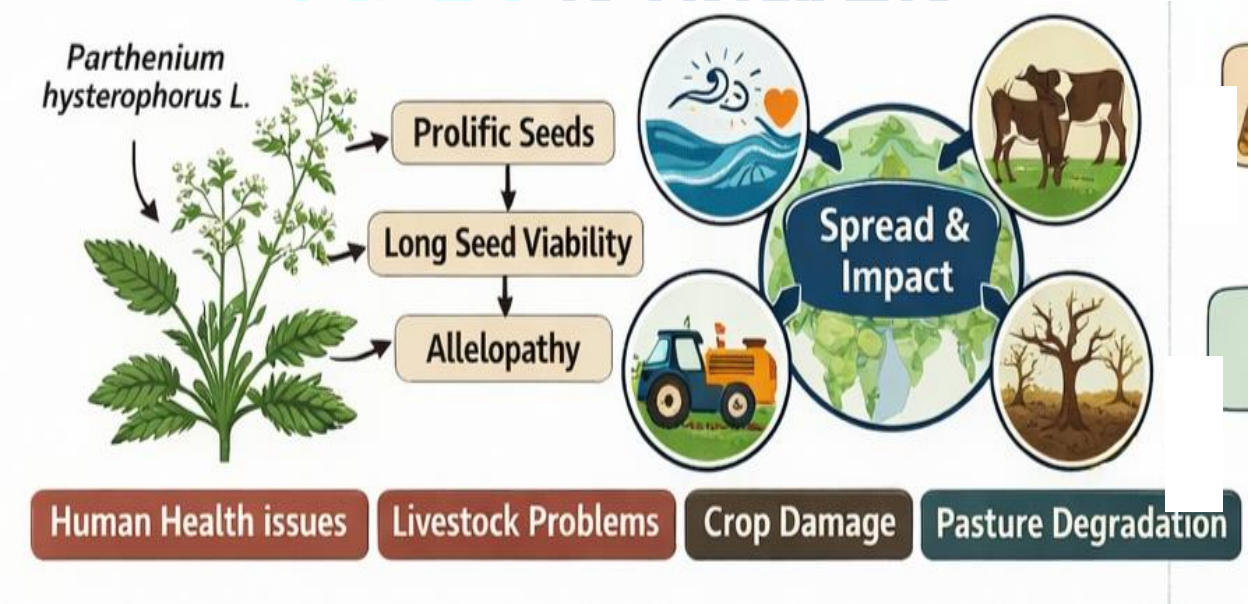

Fig.2: Spread and Impact of *Parthenium hysterophorus* L.

HEALTH RISKS IN HUMANS

Skin Diseases

Parthenium hysterophorus is a major cause of allergic contact dermatitis in exposed populations. The primary toxic compound responsible is parthenin, a sesquiterpene lactone present in leaves, stems and flowers, which acts as a potent skin sensitizer (Gupta & Singh, 2021). Direct contact with the plant can cause redness, itching, swelling, papules, vesicles and eczema-like lesions on exposed areas such as the hands, arms and face (Agarwal & D'Souza, 2009; Dogra &

Mahajan, 2015; Sharma & Kumawat, 2023). The severity of the skin reaction depends on the duration and frequency of exposure with repeated contact often resulting in chronic dermatitis. Epidemiological studies indicate that 10–20% of individuals regularly exposed to Parthenium develop severe dermatitis, highlighting its significance as a public health concern (Singh & Saini, 2012; PMC Editorial Team, 2016).

Respiratory Disorders

Inhalation of airborne pollen and dust particles from Parthenium plants can trigger respiratory disorders. Common conditions include allergic rhinitis, asthma, bronchitis, cough, sneezing and nasal congestion (Ahmad, Shekh, & Saiyad, 2018). Individuals with pre-existing respiratory conditions may experience exacerbated symptoms and chronic exposure can lead to persistent airway inflammation and hypersensitivity. Studies in rural agricultural areas have reported that frequent field workers and residents in heavily infested regions exhibit higher incidences of respiratory allergies, indicating a direct link between environmental exposure and respiratory morbidity (Datta & Saxena, 2001; Nath & Bhattacharya, 2011; Sharma & Kumawat, 2023).

Eye and Mucosal Effects

Exposure to Parthenium pollen and dust can also affect the eyes and mucous membranes, resulting in conditions such as conjunctivitis, eye irritation, tearing, redness and burning sensations (Nath & Bhattacharya, 2011; Gupta & Singh, 2021). These effects are typically more severe during flowering and seed dispersal seasons when airborne allergens are most abundant. Although less frequently reported than skin or respiratory symptoms, ocular irritation can contribute to reduced productivity, discomfort and increased susceptibility to secondary infections, particularly in agricultural workers and children who spend time in infested fields (PMC Editorial Team, 2016).

High-Risk Groups

Certain population groups are particularly vulnerable to Parthenium exposure. These include farmers, field laborers, gardeners, rural women and children, all of whom frequently come into contact with infested areas or plant materials. Children are often exposed while playing near roadsides or wastelands, increasing their risk of both dermal and respiratory reactions. Rural women involved in fodder collection and household agricultural activities are also highly susceptible, often experiencing repeated exposure over prolonged periods (Sharma & Kumawat, 2023; Ahmad *et al.*, 2018). Awareness and protective measures, such as wearing gloves, long sleeves and masks are often limited, compounding the public health risk.

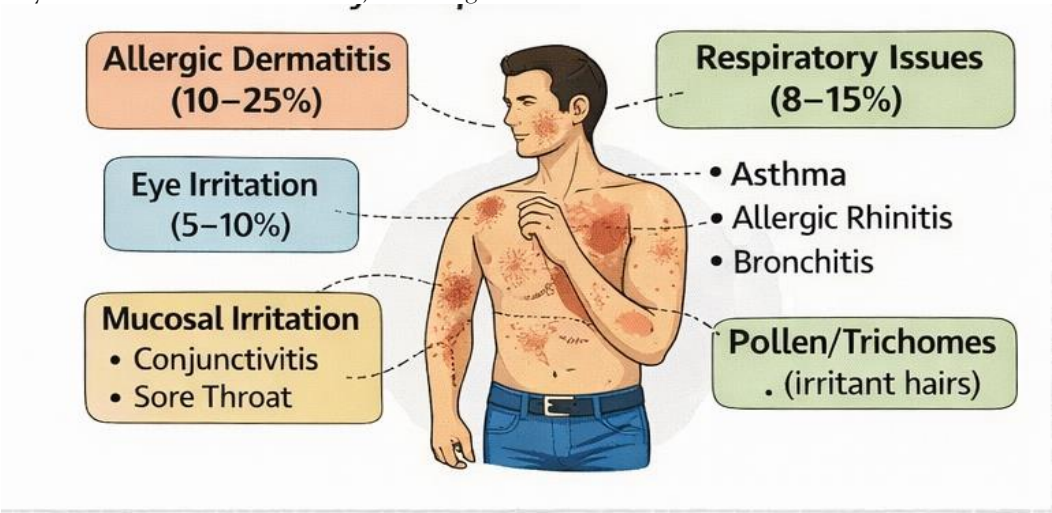

Fig.3: Health impacts of *Parthenium hysterophorus* L. on human

Table 4: Summary of Human Health Hazards of *Parthenium hysterophorus* L.

Health Category	Symptoms / Clinical Signs	Prevalence (%)	Affected Population / Notes
Skin Diseases	Allergic contact dermatitis, redness, itching, eczema-like lesions	10–25	Farmers, laborers, rural women, children
Respiratory Disorders	Allergic rhinitis, asthma, cough, sneezing, nasal congestion	8–15	Outdoor workers, individuals in infested areas
Eye and Mucosal Effects	Conjunctivitis, tearing, redness, burning sensation	5–10	Children, field workers, general population
High-Risk Groups	Increased susceptibility due to repeated exposure	15-35	Farmers, gardeners, rural women, children

HEALTH RISKS IN LIVESTOCK

Toxicity from Grazing

Parthenium hysterophorus poses significant toxicological risks to livestock when consumed, either directly from pastures or as contaminated fodder. The toxic compounds, primarily parthenin and other sesquiterpene lactones, can cause reduced feed intake, weakness, lethargy, and diarrhea (Gupta & Singh, 2021). Livestock may also develop oral lesions, mouth ulcers, and excessive salivation, particularly when large quantities of Parthenium are ingested over time (Sharma & Kumawat, 2023). Cases of severe toxicity in cattle and goats have been documented with prolonged consumption sometimes leading to fatal outcomes (Chippendale & Panetta, 1994). The severity of clinical signs depends on species, age, quantity ingested and duration of exposure.

Effects on Milk and Meat

In dairy animals, ingestion of Parthenium-contaminated fodder can lead to reduced milk yield and quality, and in some cases, impart a bitter taste or unusual odor to the milk, rendering it less acceptable for consumption (Chippendale & Panetta, 1994;PMC Editorial Team, 2016). Meat-producing livestock may experience reduced weight gain, lower growth rates and poor body condition, impacting overall productivity. These effects are particularly problematic in rural communities where livestock represent a major source of income and nutrition.

Skin and Allergic Reactions in Animals

Similar to humans, livestock exposed to Parthenium can exhibit dermatological and allergic reactions. Common signs include dermatitis, hair loss, skin lesions, rashes and swelling, often accompanied by scratching and restlessness (Adkins & Shabbir, 2014). These reactions occur primarily through direct contact with plants in pastures or exposure to plant dust, affecting animal welfare and grazing behavior.

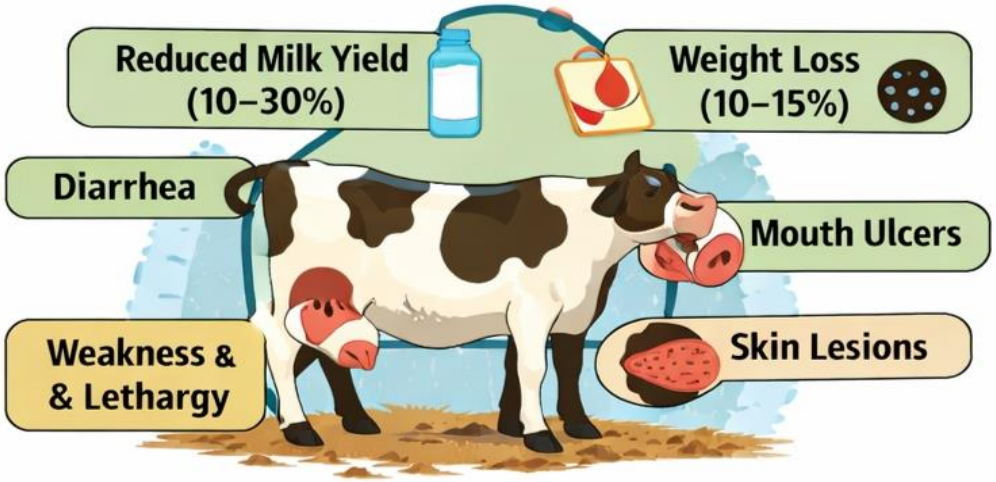

Fig.4: Health effects of *Parthenium hysterophorus* on livestock

ECONOMIC IMPACTS

The health hazards posed by Parthenium result in significant economic losses to livestock owners. These include:

1. Veterinary costs for treating clinical signs such as mouth ulcers, dermatitis, and gastrointestinal disturbances.
2. Productivity losses, including lower milk production, reduced meat yield, and decreased reproductive performance. (Chippendale & Panetta, 1994).
3. Pasture degradation, as dense Parthenium infestations reduce available forage, forcing livestock to graze suboptimally or consume toxic weeds (*Bajwa et al.*, 2016).

Table 6 summarizes the major health effects of Parthenium on livestock along with observed clinical signs and economic implications.

Table 6: Health Hazards of *Parthenium hysterophorus* L. in Livestock

Category	Clinical Signs / Effects	Economic / Productivity Impact
Toxicity from Grazing	Reduced appetite, weakness, diarrhea, mouth ulcers, salivation	Reduced feed efficiency, 10–30% milk reduction, 10–15% weight loss
Effects on Milk and Meat	Reduced milk yield, bitter taste/odor in milk, reduced weight gain	Loss of income, reduced food quality
Skin and Allergic Reactions	Dermatitis, hair loss, lesions, rashes	Decreased grazing efficiency, animal welfare loss
Pasture Degradation & Spread	Dense weed infestation limiting fodder availability	Increased cost of supplemental feed, pasture rehabilitation

Livestock exposure to *Parthenium hysterophorus* highlights the interconnected risks of ecological invasion and economic burden, especially in rural communities heavily dependent on animal husbandry. Integrated weed management, prevention of grazing in infested areas, and awareness among farmers are critical to mitigate both health and economic impacts.

PUBLIC HEALTH AND VETERINARY SIGNIFICANCE

Parthenium affects rural communities, livestock-based livelihoods, and pasture ecosystems, emphasizing a One Health perspective.

Burden on Rural Communities

In rural areas, Parthenium exposure imposes a considerable health and economic burden. Individuals involved in farming, fodder collection, and other outdoor activities are prone to dermatitis, respiratory allergies, and ocular irritation, which often result in reduced work capacity, absenteeism and decreased productivity (Gupta & Singh, 2021). Treatment of skin and respiratory conditions requires medical attention, increasing health expenditure for families who may already have limited resources. Epidemiological studies suggest that up to 15–25% of populations in heavily infested areas experience moderate to severe health effects, highlighting the public health significance of this invasive weed (Sharma & Kumawat, 2023).

Food and Livestock Sector Impacts

Parthenium also impacts the livestock and food production sector. Grazing on Parthenium-contaminated pastures can lead to reduced milk yield, poor-quality meat, oral lesions, gastrointestinal disturbances, and dermatitis in livestock (PMC Editorial Team, 2016). These health issues result in lower productivity and income for livestock-dependent households, indirectly affecting food security and rural livelihoods. Dense Parthenium infestations further reduce available fodder, forcing farmers to purchase additional feed and increase operational costs. Table 7 summarizes the key human and livestock impacts and their socioeconomic consequences.

Table 7: Public Health and Livestock Sector Impacts of *Parthenium hysterophorus* L.

Impact Category	Observed Effects	Socioeconomic Consequences
Human Health	Dermatitis, respiratory allergies, eye irritation	Reduced work capacity, increased health costs
Livestock Health	Reduced milk yield, weight loss, oral lesions, dermatitis	Lower income, poor animal productivity
Pasture & Fodder Availability	Dense weed growth reducing grazing areas	Increased feed costs, pasture degradation
Community Livelihoods	Dependence on farming and livestock affected	Food insecurity, reduced economic resilience

One Health Perspective

The One Health approach highlights the interconnectedness of environmental, human and animal health, which is clearly illustrated by the impacts of Parthenium (Kaur *et al.,* 2021). Parthenium invasions degrade ecosystems, reduce biodiversity and contaminate pastures, creating shared exposure pathways for humans and animals. For example, humans develop allergies from handling contaminated fodder or crops, while livestock suffer toxicity from grazing, resulting in both health and economic losses. This integrated perspective emphasizes the need for coordinated interventions that simultaneously address plant management, human health protection, and livestock safety. Effective strategies include weed eradication, public awareness campaigns and personal protective measures, which collectively reduce the burden on rural communities and improve ecosystem health.

Table 8: One Health Implications of *Parthenium hysterophorus* L.

Domain	Effect of Parthenium	Integrated Implication
Environment	Dense weed infestations, allelopathy, reduced biodiversity	Degraded ecosystems, reduced pasture quality
Human Health	Allergic dermatitis, respiratory disorders, eye irritation	Reduced labor productivity, increased medical costs
Animal Health	Reduced milk/meat yield,	Economic losses, poor livestock welfare

	gastrointestinal disorders, dermatitis	
One Health Action	Integrated management, awareness, protective measures	Simultaneous improvement in human, animal, and ecosystem health

Table 9: Summary of Health Impacts of *Parthenium hysterophorus* L. on Humans and Livestock

Host	Health Impact	Clinical Signs / Symptoms	Approx. Prevalence / Severity	References
Humans	Skin Diseases	Allergic contact dermatitis, eczema, itching, rashes	10–25% in heavily infested rural areas	Gupta & Singh, 2021; Sharma & Kumawat, 2023
	Respiratory Disorders	Allergic rhinitis, asthma, cough, sneezing, nasal congestion	8–15% of exposed individuals	Ahmad *et al.*, 2018; PMC Editorial Team, 2016
	Eye and Mucosal Effects	Conjunctivitis, tearing, redness, burning sensations	5–10% of exposed individuals	Gupta & Singh, 2021
Livestock	Toxicity from Grazing	Reduced appetite, weakness, diarrhea, mouth ulcers	10–30% reduction in milk yield; 10–15% weight loss in cattle and goats	Sharma & Kumawat, 2023; Shah *et al.*, 2025a; PMC Editorial Team, 2016
	Skin and Allergic Reactions	Dermatitis, hair loss, lesions, itching	Moderate prevalence in infested pastures	Adkins & Shabbir, 2014
	Productivity & Economic Impact	Reduced milk yield, poor meat quality, lower reproductive performance	Significant income loss for smallholders	Gupta & Singh, 2021; Kaur *et al.*, 2021

CONCLUSION

Parthenium hysterophorus is a highly invasive, toxic weed with significant human and livestock health impacts. Humans are affected through dermatitis, respiratory allergies and ocular irritation, particularly in farmers, laborers and children while Livestock suffer from toxicity, reduced milk/meat production, and dermatological issues, causing economic losses in rural communities. The burden on rural communities is both health-related and economic, affecting livelihoods, productivity and food security. Integrated management, including mechanical, chemical and biological control coupled with awareness programs, is crucial for minimizing exposure. A One Health-based approach is recommended, linking environmental management, human health and animal welfare for sustainable control.

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