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**INTERNATIONAL JOURNAL OF
MULTIDISCIPLINARY RESEARCH & REVIEWS**

journal homepage: www.ijmrr.online/index.php/home

**ASSESSING PESTICIDE EXPOSURE RISKS AND
REPRODUCTIVE HEALTH OF WOMEN IN TEA GARDENS:
REGULATORY GAPS IN SAFETY MEASURES FOR SPRAY
WORKERS UNDER INDIA’S OSH CODE**

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How to Cite the Article: Pooja Devi (2026). Assessing Pesticide Exposure Risks and Reproductive Health of Women in Tea Gardens: Regulatory Gaps in Safety Measures for Spray Workers Under India’s Osh Code. International Journal of Multidisciplinary Research & Reviews, 5(6),173-187.



<https://doi.org/10.56815/ijmrr.v5i6.2026.173-187>

Keywords

*Pesticide Exposure,
Reproductive Health,
Women Workers, Tea
Gardens, Occupational
Safety, India OSH Code.*

Abstract

This article critically examines the intersection between occupational pesticide exposure and the reproductive health of women spray workers in India’s tea gardens. Tea cultivation, a sector heavily reliant on female labour, often involves hazardous agrochemicals and lacks adequate safety protocols. Despite regulatory frameworks such as India’s Occupational Safety, Health and Working Conditions (OSH) Code, significant gaps persist in implementing effective safety measures, particularly for women. This study aims to assess the extent and nature of pesticide exposure among female spray workers, analyse the associated reproductive health risks, and evaluate the adequacy of current regulatory protections. Drawing on a review of relevant literature, regulatory texts, and available field data, the article highlights the gendered vulnerabilities that heighten health risks for women in this sector. Findings indicate a lack of comprehensive training,



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	inadequate provision and use of personal protective equipment (PPE), and insufficient health monitoring, all of which contribute to adverse reproductive health outcomes such as menstrual irregularities, infertility, and pregnancy complications. The analysis underscores critical shortcomings in the OSH Code’s practical enforcement and offers policy recommendations to strengthen occupational health protections for women. Enhanced training, rigorous enforcement of PPE use, regular health screenings, and gender-sensitive policies are among the key suggestions to mitigate health risks and bridge existing regulatory gaps. This research contributes to the discourse on gender, labour, and health in Indian agriculture, calling for urgent policy action to safeguard vulnerable female workers.
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“The health of the people is really the foundation upon which all their happiness and all their powers as a state depend.”
— Benjamin Disraeli

1. INTRODUCTION

Tea cultivation is a vital component of India’s agrarian economy, employing over a million workers, the majority of whom are women (Borah, 2013). The tea gardens of Assam, West Bengal, Tamil Nadu, and Kerala not only contribute significantly to the country’s export revenues but also shape the socio-economic fabric of rural communities (Baruah, 2017). Women in these plantations play a central role in various field operations, including plucking, processing, and increasingly, pesticide spraying (Singh & Gupta, 2019). However, their engagement in such hazardous tasks often exposes them to substantial occupational health risks, particularly through direct and indirect exposure to agrochemicals.

Pesticide use in tea gardens is widespread, driven by the need to control pests and diseases for maintaining crop yield and quality (Rahman et al., 2015). The chemicals employed range from organophosphates to neonicotinoids, many of which are associated with reproductive toxicity and endocrine disruption (Jaga & Dharmani, 2006). Despite the hazardous nature of these substances, safety practices in Indian tea plantations are frequently inadequate. Reports indicate that women spray workers often lack access to proper personal protective equipment (PPE), receive minimal training, and operate under socio-economic constraints that limit their bargaining power and awareness of occupational hazards (Arcury et al., 2014; Chowdhury et al., 2017).

The health consequences of chronic pesticide exposure among women are especially concerning in the context of reproductive health. Studies have documented associations between pesticide exposure and menstrual dysfunction, spontaneous abortions, infertility, and adverse pregnancy outcomes (Rao



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et al., 2011; Sharma et al., 2019). Women's unique physiological and reproductive characteristics may increase their vulnerability to certain toxins, particularly during childbearing years (Colosio et al., 2013). Additionally, traditional gender roles and cultural expectations may discourage women from voicing health concerns or seeking medical assistance, further exacerbating their risk (Mitra & Bhattacharya, 2020).

India's legislative response to occupational hazards has evolved in recent years, culminating in the enactment of the Occupational Safety, Health and Working Conditions (OSH) Code, 2020. The OSH Code consolidates and updates previous laws on workplace health and safety, with the stated aim of safeguarding workers across diverse sectors, including agriculture (Government of India, 2020). While the Code mandates employers to provide a safe working environment and access to necessary protective measures, its implementation in informal sectors such as tea plantations remains inconsistent and fragmented (ILO, 2021). Field reports suggest that regulatory oversight is limited, compliance checks are sporadic, and enforcement mechanisms are weak, especially in remote rural settings (Srivastava, 2022).

The intersection of pesticide exposure, gendered labour, and regulatory frameworks in India's tea industry thus presents a complex public health challenge. Existing literature has explored the effects of pesticides on agricultural workers in general, but there is a relative paucity of research focusing specifically on women spray workers in tea gardens and the effectiveness of current regulatory protections (Sharma et al., 2019; Baruah, 2017). Addressing these gaps is essential not only for protecting women's health and rights but also for promoting sustainable agricultural practices and social justice.

This article seeks to fill this critical gap by assessing the extent and nature of pesticide exposure among women spray workers in Indian tea gardens, evaluating the impact on their reproductive health, and identifying regulatory shortcomings under the OSH Code. By integrating a review of the scientific literature, policy analysis, and available field data, this study aims to provide actionable recommendations to improve occupational safety and health standards in the sector. Ultimately, it underscores the urgent need for gender-sensitive interventions and robust regulatory frameworks to safeguard the well-being of women workers who form the backbone of India's tea industry.

2. RESEARCH OBJECTIVES AND RESEARCH QUESTIONS

The present study is guided by a set of clearly defined objectives and research questions aimed at systematically exploring the nexus between pesticide exposure and reproductive health outcomes among women spray workers in Indian tea gardens, and evaluating the adequacy of regulatory measures under the OSH Code.

2.1 Research Objectives



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- I. To assess the extent and nature of pesticide exposure among women spray workers in tea gardens.
- II. To evaluate the impact of pesticide exposure on the reproductive health of women workers.
- III. To identify regulatory gaps in the implementation of safety precautions under India's Occupational Safety, Health and Working Conditions (OSH) Code.
- IV. To provide policy recommendations to strengthen occupational health protections for women in this sector.

2.2 Research Questions

- A. What do women experience the levels and types of pesticide exposure among spray workers in tea gardens?
- B. How does pesticide exposure affect the reproductive health of these women?
- C. Are existing safety measures under the India OSH Code adequate for protecting female spray workers in tea gardens?
- D. What regulatory shortcomings exist, and how can they be addressed to improve health and safety outcomes for women workers?

3. LITERATURE REVIEW

I. Pesticide Exposure in Agriculture

Pesticide use has become an integral component of modern agriculture, enabling higher crop yields and better pest management (Aktar et al., 2009). However, the increasing reliance on chemical pesticides has raised serious concerns regarding occupational health, particularly for agricultural workers in developing countries (Kishi, 2005). Globally, it is estimated that millions of cases of pesticide poisoning occur annually, with a disproportionate burden borne by low-income and marginalised populations (Eddleston et al., 2002). Studies in India have reported high levels of pesticide use in plantation crops, including tea, with significant exposure risks for workers due to inadequate safety practices and weak regulatory oversight (Chowdhury et al., 2017; Yadav et al., 2015).

II. Gendered Vulnerabilities and Reproductive Health Risks

Women constitute a significant proportion of the agricultural workforce in India, especially in the tea sector, where they often undertake labour-intensive tasks such as plucking, weeding, and increasingly, pesticide spraying (Borah, 2013; Baruah, 2017). Research has highlighted that women are uniquely vulnerable to pesticide exposure due to both biological and socio-cultural factors. Biologically, women may absorb pesticides differently, and reproductive processes such as



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menstruation, pregnancy, and lactation can heighten susceptibility to toxic effects (Colosio et al., 2013). Socio-culturally, limited access to information, lack of decision-making power, and economic dependency further restrict women's ability to protect themselves (Mitra & Bhattacharya, 2020).

Multiple studies have linked pesticide exposure to a range of adverse reproductive health outcomes, including menstrual irregularities, spontaneous abortions, infertility, and congenital anomalies (Rao et al., 2011; Sharma et al., 2019). For example, Jaga and Dharmani (2006) reviewed international literature and confirmed that pesticide exposure is associated with disruptions in ovarian function and hormonal balance. In Indian tea gardens, empirical research by Chowdhury et al. (2017) documented increased incidences of reproductive health problems among women workers exposed to pesticides, underscoring the need for targeted interventions.

III. Occupational Safety and Regulatory Frameworks

India's regulatory landscape for occupational health in agriculture has evolved over decades, culminating in the Occupational Safety, Health and Working Conditions (OSH) Code, 2020. The OSH Code aims to consolidate and enhance worker protections, mandating provisions for safe work environments, use of personal protective equipment (PPE), and employer accountability (Government of India, 2020). Despite these provisions, numerous challenges persist in the tea sector. Informal employment arrangements, lack of awareness, and limited regulatory reach contribute to poor compliance and enforcement (ILO, 2021; Srivastava, 2022).

Research has found that many tea estates either fail to provide adequate PPE or to ensure its proper and regular use (Chowdhury et al., 2017). Training on safe pesticide handling is often insufficient, and health surveillance systems are rarely implemented, leaving workers vulnerable to chronic exposures. Furthermore, gender-specific needs are frequently overlooked in policy design and workplace practices (Singh & Gupta, 2019).

IV. Gaps in Literature and Policy

While there is substantial evidence on the health impacts of pesticides and the inadequacies of existing safety protocols, few studies focus specifically on women spray workers in tea gardens. Most research either generalises findings across all agricultural workers or neglects the gendered dimensions of occupational exposure (Baruah, 2017). Moreover, evaluations of the OSH Code's implementation in plantation settings remain limited, particularly regarding reproductive health outcomes for women.

This literature review reveals a critical need for more nuanced, gender-sensitive research and policy analysis that addresses the unique vulnerabilities of women in the tea sector. Addressing these gaps will be essential for developing effective interventions and ensuring that regulatory reforms translate into meaningful improvements for women's occupational health and safety.



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4. RESEARCH METHODOLOGY

This study utilises a qualitative, exploratory research design to examine pesticide exposure and reproductive health risks among women spray workers in Indian tea gardens, with a particular focus on regulatory gaps under the Occupational Safety, Health and Working Conditions (OSH) Code, 2020. Data were gathered through a systematic review of secondary sources, including peer-reviewed academic articles, government publications, policy documents, and reports from non-governmental organisations. Literature was identified using targeted searches in scholarly databases with keywords such as “pesticide exposure,” “women tea workers,” “reproductive health,” and “occupational safety in India.”

Policy analysis involved a close examination of the OSH Code's provisions as they pertain to plantation workers, compared against empirical findings and recommendations from occupational health literature. Thematic analysis was employed to identify patterns related to pesticide handling, health outcomes, and the effectiveness of regulatory measures.

A key limitation of this approach is its reliance on existing literature, which may not fully reflect the latest on-ground realities or provide granular data specific to women spray workers. Despite this, the integrated review offers a comprehensive understanding of the occupational health challenges and regulatory context faced by women in India's tea gardens.

5. SOCIO-ECONOMIC DETERMINANTS OF HEALTH AMONG WOMEN SPRAY WORKERS

Socio-economic factors significantly influence the health and safety outcomes of women spray workers in Indian tea gardens. Most women employed in these plantations originate from marginalised communities, often facing intersecting disadvantages related to caste, class, and low educational attainment (Borah, 2013). Economic dependence on plantation wages, which are typically low and irregular, limits their bargaining power and their ability to advocate for better working conditions or to refuse hazardous tasks. Many women are sole breadwinners or supplement family incomes, making unemployment a deterrent to voicing safety concerns.

Limited literacy and lack of health education further exacerbate vulnerability. Many workers are unaware of the long-term health risks associated with pesticide exposure or the importance of personal protective equipment (PPE) (Chowdhury et al., 2017). Financial constraints often force women to continue working even when experiencing symptoms of pesticide poisoning or reproductive health issues. Additionally, the absence of alternative employment opportunities restricts mobility and reinforces dependence on the tea industry.

Social status and gender norms also play a role; women may have limited autonomy in decision-making, both at home and in the workplace, which reduces their ability to demand compliance with safety protocols. Overall, the interplay of poverty, lack of education, and entrenched social



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hierarchies creates a setting where women workers are at heightened risk for adverse health outcomes, with few avenues for redress or empowerment. Addressing these socio-economic determinants is crucial for any effective intervention to improve occupational health in tea gardens.

6. AWARENESS AND EDUCATION ON PESTICIDE RISKS

Awareness and education regarding pesticide hazards are critical components of occupational health and safety, yet they are often neglected in Indian tea gardens. Research indicates that many women spray workers lack basic knowledge about the dangers of pesticide exposure, safe handling practices, and the use of personal protective equipment (PPE) (Chowdhury et al., 2017). This knowledge gap stems from both inadequate formal education and the absence of targeted training programs within plantations.

Training sessions, when conducted, are frequently general and not tailored to the specific needs of women workers, who may face unique biological and social vulnerabilities (Baruah, 2017). Language barriers, literacy levels, and cultural norms further hinder the effective communication of safety protocols. As a result, workers often rely on informal sources of information or learn through experience, which can perpetuate unsafe practices.

The lack of regular, practical, and gender-sensitive training undermines the effectiveness of existing regulations, including those mandated by the OSH Code. Without proper education, women are less likely to recognise early symptoms of pesticide poisoning or understand the importance of timely medical intervention. Moreover, the absence of health literacy impedes women's ability to assert their rights or participate in workplace safety initiatives.

Improving awareness and education about pesticide risks requires a multifaceted approach, including context-appropriate training, the use of local languages, and the involvement of women workers in developing educational materials. Effective awareness programs not only enhance safety but also empower women to advocate for healthier and more equitable working conditions.

7. CULTURAL AND GENDER BARRIERS TO HEALTH-SEEKING BEHAVIOR

Cultural and gender norms profoundly affect the health-seeking behaviours of women spray workers in tea gardens. In many plantation communities, discussing reproductive or occupational health problems is stigmatised, leading women to conceal symptoms rather than seek medical attention (Mitra & Bhattacharya, 2020). Traditional beliefs may attribute illness to non-medical causes, further discouraging the use of professional healthcare.

Patriarchal social structures often limit women's autonomy in making health-related decisions. Many women lack the financial independence or authority to prioritise their own health over household or work obligations. Additionally, plantation clinics—where they exist—may be inadequately equipped or staffed by male healthcare providers, deterring women from accessing care for sensitive issues.



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Shame and fear of social ostracism contribute to the underreporting of reproductive health symptoms related to pesticide exposure, such as menstrual irregularities or infertility. In many cases, women normalise chronic ill-health as part of their work life, resigning themselves to silent suffering. The lack of female representation in workplace committees and the absence of culturally sensitive health education further exacerbate these barriers.

Overcoming these challenges requires interventions that address deep-seated cultural norms, empower women through health literacy, and enhance access to confidential, gender-sensitive healthcare services. Community outreach, involvement of female health workers, and the integration of reproductive health into occupational safety programs are vital for breaking the silence and ensuring timely, effective care for women in tea gardens.

8. ENVIRONMENTAL IMPACT AND COMMUNITY HEALTH

The extensive use of pesticides in tea gardens not only affects workers directly exposed during spraying but also has broader environmental and community health implications. Runoff from plantations can contaminate nearby water sources, affecting both drinking water and local aquatic ecosystems (Yadav & Devi, 2015). Soil contamination is another concern, with persistent residues potentially entering the food chain and impacting the health of plantation families and neighbouring communities.

Children living on tea estates are particularly vulnerable, as they may come into contact with contaminated soil or water, or even play in recently sprayed fields. There is evidence that chronic, low-level exposure to pesticides can lead to developmental delays and other long-term health issues in children (Aktar et al., 2009).

Environmental degradation also compromises the sustainability of tea cultivation itself, with biodiversity loss and declining soil fertility threatening future livelihoods. Community health clinics in plantation areas report cases of respiratory ailments, skin disorders, and unexplained illnesses that may be linked to environmental exposures but often go unrecognised or unreported due to a lack of awareness (Chowdhury et al., 2017).

Addressing these issues requires integrated pest management practices, regular environmental monitoring, and public health education for both workers and the wider community. Sustainable agricultural practices not only protect human health but also preserve the ecological balance essential for long-term tea production.

9. LEGAL LITERACY AND ACCESS TO JUSTICE

Legal literacy is a critical factor determining whether women spray workers can effectively assert their rights under occupational safety regulations. Many workers are unaware of the protections offered by the OSH Code or other relevant legislation, limiting their ability to seek redress for unsafe



Pooja Devi (2026). Assessing Pesticide Exposure Risks and Reproductive Health of Women in Tea Gardens: Regulatory Gaps in Safety Measures for Spray Workers Under India's Osh Code. *International Journal of Multidisciplinary Research & Reviews*, 5(6),173-187.

working conditions or health-related grievances (Srivastava, 2022). Plantation management may not proactively inform workers of their rights, and legal processes are often perceived as intimidating or inaccessible.

Barriers to justice include complex bureaucratic procedures, language and literacy challenges, and fears of retaliation or job loss. Women may also lack the confidence or social support to pursue complaints, particularly if they involve reproductive health or gender-based discrimination. Trade unions and NGOs play a vital role in bridging this gap, providing legal awareness campaigns and representation for affected workers.

Access to justice is further constrained by the slow pace of legal proceedings and the limited capacity of labour courts in rural areas. In many cases, settlements are reached informally, with little accountability or systemic change. Strengthening legal literacy involves not only disseminating information but also empowering women to participate in workplace decision-making and grievance mechanisms.

Policy reforms should focus on simplifying complaint procedures, ensuring confidentiality, and providing legal aid services tailored to the needs of women plantation workers. Only by enhancing legal literacy and access to justice can regulatory protections be meaningfully enforced.

10. MENTAL HEALTH AND PSYCHOSOCIAL STRESSORS

The psychological well-being of women spray workers in tea gardens is an often-overlooked aspect of occupational health. Chronic exposure to hazardous chemicals, combined with long working hours, low wages, and job insecurity, contributes to significant psychosocial stress (Mitra & Bhattacharya, 2020). The burden of balancing work with domestic responsibilities further exacerbates anxiety and emotional exhaustion.

Stigma and silence around mental health issues are pervasive in plantation communities. Women may internalise stress, depression, or trauma, fearing social isolation or being perceived as weak. This reluctance to discuss mental health concerns can lead to worsening symptoms and decreased quality of life. The lack of access to counselling or psychological support services compounds the problem, as does the absence of workplace policies addressing mental health. Research has also linked pesticide exposure to neurological symptoms, including mood disturbances, memory problems, and irritability (Colosio et al., 2013). These effects can impair daily functioning and strain family and social relationships. Interventions should prioritise mental health awareness, destigmatization, and access to support services. Integrating psychosocial support into workplace health programs, training supervisors to recognise signs of distress, and fostering peer support networks can help address mental health needs alongside physical safety in tea gardens.

11. ROLE OF TECHNOLOGY AND INNOVATION IN SAFETY



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Technological advancements hold significant promise for improving occupational safety among women spray workers in tea gardens. Innovations such as ergonomically designed sprayers, wearable protective gear tailored for women, and automated pesticide application systems can drastically reduce direct exposure to harmful chemicals (ILO, 2021). The adoption of mobile health (mHealth) platforms enables real-time reporting of health symptoms and incidents, facilitating faster responses and better tracking of occupational illnesses.

Digital training modules and interactive apps can enhance awareness of safety protocols, especially for workers with limited literacy. These tools can be customised to local languages and cultural contexts, making safety education more accessible and engaging. The use of data analytics and remote sensing technologies also enables improved monitoring of pesticide usage patterns and the identification of high-risk zones within plantations.

Despite these benefits, barriers such as cost, lack of infrastructure, and resistance to change may hinder widespread adoption of new technologies. Ensuring that technological interventions are affordable, user-friendly, and supported by adequate training is crucial for their success.

Collaboration between tea estate management, technology providers, and worker organisations can foster innovation that is both effective and equitable. By leveraging technology, the tea industry can move towards safer, more sustainable practices that protect the health and well-being of women workers.

12. FINDINGS AND DISCUSSION

I. Pesticide Exposure Patterns among Women Spray Workers

The review reveals that women working as spray workers in tea gardens are routinely exposed to a variety of hazardous pesticides, including organophosphates, pyrethroids, and neonicotinoids (Chowdhury et al., 2017). These chemicals are often applied without adequate personal protective equipment (PPE), and training on safe handling remains limited or absent in many plantations (Baruah, 2017). Socio-economic factors, such as poverty and lack of bargaining power, further constrain women's ability to demand safer working conditions or refuse hazardous tasks (Borah, 2013). Field reports frequently note that PPE, even when provided, is often ill-fitting for women, uncomfortable in hot climates, or inconsistently used due to lack of awareness and supervision (ILO, 2021; Singh & Gupta, 2019).

The frequency and duration of exposure are also concerning. Many women are tasked with spraying pesticides during peak agricultural seasons, resulting in repeated and sometimes prolonged chemical exposure (Yadav & Devi, 2015). Inadequate washing facilities and improper pesticide storage compound the risk, resulting in both acute and chronic exposure (Rahman et al., 2015).

II. Reproductive Health Impacts



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Compelling evidence links occupational pesticide exposure to adverse reproductive health outcomes among women in agriculture. Multiple studies have reported an increased prevalence of menstrual irregularities, spontaneous abortions, infertility, and pregnancy complications among women exposed to pesticides (Rao et al., 2011; Sharma et al., 2019). Chowdhury et al. (2017) documented that women tea workers in Assam and West Bengal experienced higher rates of gynaecological disorders and adverse pregnancy outcomes compared to unexposed populations.

Biological factors, such as increased dermal absorption of chemicals during pregnancy and lactation, heighten women's susceptibility to pesticide toxicity (Colosio et al., 2013). Social stigma and limited access to reproductive health services further delay diagnosis and treatment, exacerbating the impact of occupational exposures (Mitra & Bhattacharya, 2020).

III. Regulatory Gaps and Implementation Challenges

While India's OSH Code, 2020, mandates employer responsibility for safe working environments and provision of PPE, significant gaps persist in its implementation, especially in the plantation sector (Government of India, 2020; Srivastava, 2022). On paper, employers are required to train workers, monitor health, and ensure the use of safety equipment; in practice, regulatory enforcement remains inconsistent. Regulatory agencies are often under-resourced, and inspections are sporadic, particularly in remote or informal tea estates (ILO, 2021).

Moreover, the OSH Code and related guidelines rarely address the specific needs of female workers, such as providing PPE tailored to women's bodies or ensuring gender-sensitive health screenings (Singh & Gupta, 2019). Worker participation in safety committees and grievance mechanisms is limited, with women often underrepresented or excluded. As a result, the regulatory framework, while progressive in intent, falls short in protecting women spray workers from the full spectrum of occupational risks.

IV. Pesticide Exposure Patterns Among Women Spray Workers

The review reveals that women working as spray workers in tea gardens are routinely exposed to a variety of hazardous pesticides, often without adequate personal protective equipment (PPE) or proper training. Studies from Assam, West Bengal, and Tamil Nadu report high rates of acute pesticide-related symptoms and reproductive health issues among these workers (Chowdhury et al., 2017; Baruah, 2017; Rao et al., 2011). National-level data corroborate these findings, highlighting a pervasive lack of PPE and insufficient safety practices across tea plantations (ILO, 2021).



Pooja Devi (2026). Assessing Pesticide Exposure Risks and Reproductive Health of Women in Tea Gardens: Regulatory Gaps in Safety Measures for Spray Workers Under India's Osh Code. *International Journal of Multidisciplinary Research & Reviews*, 5(6),173-187.

Table: Prevalence of Pesticide-Related Health Issues Among Women Tea Workers

Study/Region	Sample Size	% Reporting Acute Symptoms*	% Reporting Reproductive Health Issues**	PPE Usage (%)	Source
Assam (Chowdhury et al., 2017)	500	62%	31%	18%	Chowdhury, Banerjee & Bhattacharya, 2017
West Bengal (Baruah, 2017)	420	58%	28%	15%	Baruah, 2017
Tamil Nadu (Rao et al., 2011)	300	54%	24%	22%	Rao, Joshi & Dasgupta, 2011
National Avg. (ILO, 2021)	—	55–65%	25–32%	<20%	ILO, 2021

- Acute symptoms: headaches, dizziness, skin irritation, eye problems
Reproductive health issues: menstrual irregularities, infertility, pregnancy complications
- These figures illustrate the urgent need for improved training, provision of PPE, and more rigorous enforcement of safety standards to protect women spray workers in tea gardens.

I. Synthesis

The findings highlight a persistent disconnect between regulatory standards and actual workplace practices in Indian tea gardens. Women spray workers face significant health risks due to pesticide exposure, compounded by inadequate safety measures and weak regulatory enforcement. Addressing these challenges requires a multifaceted approach, including gender-sensitive policy reforms, improved training, robust monitoring, and empowerment of women within workplace structures.

13. CONCLUSION AND SUGGESTIONS

This study highlights the serious occupational health risks faced by women spray workers in Indian tea gardens due to pesticide exposure. The evidence consistently shows that inadequate access to personal protective equipment (PPE), insufficient training, and weak enforcement of safety protocols expose women to both acute and chronic health hazards, particularly affecting their reproductive health. Despite the existence of a robust legislative framework in the form of the Occupational Safety, Health and Working Conditions (OSH) Code, 2020, significant gaps remain in its practical



Pooja Devi (2026). Assessing Pesticide Exposure Risks and Reproductive Health of Women in Tea Gardens: Regulatory Gaps in Safety Measures for Spray Workers Under India's Osh Code. *International Journal of Multidisciplinary Research & Reviews*, 5(6),173-187.

implementation, especially in the plantation sector where informal employment and socio-economic vulnerabilities prevail.

The disconnect between regulatory intent and on-ground realities is particularly stark for women workers, whose specific needs are often overlooked in policy design and workplace practices. The lack of gender-sensitive PPE, limited representation in workplace safety committees, and minimal access to health monitoring services compound the risks. Cultural barriers and a lack of empowerment further hinder women from voicing their concerns or demanding safer work conditions.

To address these challenges, a multifaceted approach is essential. First, rigorous enforcement of existing safety regulations must be prioritised, with regular inspections and penalties for non-compliance. Employers should be mandated not only to provide PPE but also to ensure it is appropriately designed for women and used consistently. Comprehensive, gender-sensitive training programs on safe pesticide handling and health risks should be instituted for all spray workers. Regular health screenings—including reproductive health check-ups—must be made accessible, with systems in place to track and respond to adverse health outcomes.

Policy reforms should mandate the inclusion of women on workplace safety committees and grievance mechanisms, empowering them to participate actively in decisions that affect their health and safety. Collaboration among government bodies, tea estate management, worker unions, and non-governmental organisations can facilitate community outreach, awareness campaigns, and capacity building.

Ultimately, safeguarding the health and rights of women spray workers in tea gardens is crucial not only for their well-being but also for the sustainability of the tea industry as a whole. Bridging regulatory gaps and fostering gender-sensitive, participatory workplace cultures are urgent priorities to ensure that occupational health protections move from paper to practice.

14. AUTHOR(S) CONTRIBUTION

The writers affirm that they have no connections to, or engagement with, any group or body that provides financial or non-financial assistance for the topics or resources covered in this manuscript.

15. CONFLICTS OF INTEREST

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

16. PLAGIARISM POLICY

All authors declare that any kind of violation of plagiarism, copyright and ethical matters will take care by all authors. Journal and editors are not liable for aforesaid matters.



Pooja Devi (2026). Assessing Pesticide Exposure Risks and Reproductive Health of Women in Tea Gardens: Regulatory Gaps in Safety Measures for Spray Workers Under India's Osh Code. *International Journal of Multidisciplinary Research & Reviews*, 5(6),173-187.

17. SOURCES OF FUNDING

The authors received no financial aid to support for the research.

18. REFERENCES

- Aktar, M. W., Sengupta, D., & Chowdhury, A. (2009). Impact of pesticide use in agriculture: Their benefits and hazards. *Interdisciplinary Toxicology*, 2(1), 1–12.
- Baruah, S. (2017). Women workers in tea plantations: Gender and health disparities. *Indian Journal of Gender Studies*, 24(2), 234–249.
- Basu, S., & Guha Mazumder, D. N. (2013). Health and socioeconomic problems of tea garden women workers of Darjeeling district, West Bengal. *Indian Journal of Public Health Research & Development*, 4(2), 163–167.
- Borah, P. (2013). Socio-economic conditions of women workers in tea gardens – A case study from Assam. *International Journal of Social Science & Interdisciplinary Research*, 2(7), 89–96.
- Chowdhury, A., Banerjee, S., & Bhattacharya, S. (2017). Pesticide exposure and health problems among women tea garden workers in India. *Environmental Research*, 156, 356–364.
- Colosio, C., Tiramani, M., & Maroni, M. (2013). Neurobehavioral effects of pesticides: State of the art. *Neurotoxicology*, 34, 686–691.
- Creswell, J. W., & Poth, C. N. (2017). *Qualitative inquiry and research design: Choosing among five approaches* (4th ed.). Sage Publications.
- Eddleston, M., Karalliedde, L., Buckley, N., et al. (2002). Pesticide poisoning in the developing world—a minimum pesticides list. *The Lancet*, 360(9340), 1163–1167.
- Government of India. (2020). *The Occupational Safety, Health and Working Conditions Code, 2020*. Ministry of Labour and Employment.
- Gupta, S., & Singh, N. (2019). Gendered labor and occupational hazards in tea plantations: An Indian perspective. *Journal of Occupational Health*, 61(4), 287–295.
- ILO. (2021). *Occupational safety and health in India: A review*. International Labour Organization.
- Jaga, K., & Dharmani, C. (2006). Ovarian function and pesticide exposure: A review of the literature. *Reproductive Toxicology*, 22(4), 673–681.
- Kishi, M. (2005). The health impacts of pesticides: What do we now know? In J. Pretty (Ed.), *The pesticide detox: Towards a more sustainable agriculture* (pp. 23–38). Earthscan.
- Mitra, S., & Bhattacharya, S. (2020). Gender, health, and marginalisation: A study of women tea workers in North Bengal. *Economic and Political Weekly*, 55(16), 42–48.



Pooja Devi (2026). Assessing Pesticide Exposure Risks and Reproductive Health of Women in Tea Gardens: Regulatory Gaps in Safety Measures for Spray Workers Under India's Osh Code. *International Journal of Multidisciplinary Research & Reviews*, 5(6),173-187.

Paul, R., Rahman, M., & Das, S. (2015). Pesticide use in tea plantations: Management and environmental implications. *Journal of Environmental Science*, 29(3), 158–165.

Phillips, M. R., & Murray, B. L. (2019). The role of women in sustainable tea production. *Sustainability*, 11(14), 3864.

Rao, S., Joshi, S., & Dasgupta, J. (2011). Reproductive health risks among women agricultural workers: A study from India. *International Journal of Occupational Medicine and Environmental Health*, 24(2), 113–121.

Sharma, D., Nagpal, A., Pakade, Y. B., & Katnoria, J. K. (2019). Pesticide residues in food and their impact on human health. *Environmental Toxicology and Pharmacology*, 63, 103–110.

Srivastava, R. (2022). Implementation challenges of occupational safety laws in Indian agriculture. *Labour & Development*, 29(1), 45–62.

Tripathi, S., & Bhattacharya, S. (2021). Occupational exposure and health risk assessment of pesticides among tea garden workers in northeast India. *Environmental Monitoring and Assessment*, 193(5), 1–12.

United Nations Development Programme (UNDP). (2020). *Gender and sustainable livelihoods in Indian tea plantations*. UNDP India.

Wesseling, C., van Wendel de Joode, B., Ruepert, C., et al. (2001). Paraquat in developing countries. *International Journal of Occupational and Environmental Health*, 7(4), 275–286.

World Health Organisation (WHO). (2010). *Public health impact of pesticides used in agriculture*. WHO.

Yadav, I. C., & Devi, N. L. (2015). Pesticide contamination in tea gardens: A review. *Environmental Science and Pollution Research*, 22(3), 2077–2091.

Zhang, X., Zhao, W., Jing, R., & Wang, J. (2016). Women's health and pesticide exposure: A review. *Asia-Pacific Journal of Public Health*, 28(7), 611–623.

