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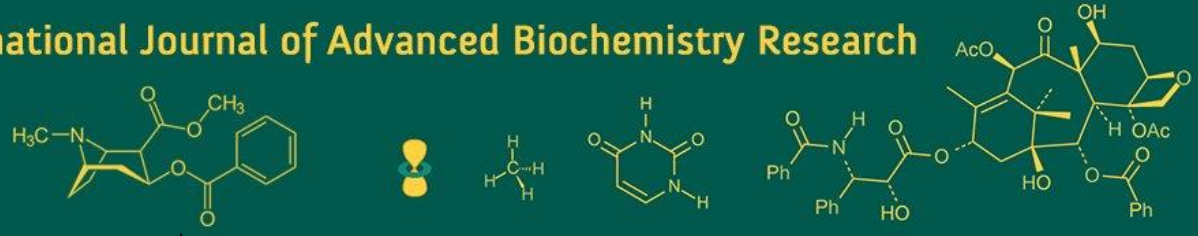

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Unregulated Dichlorodiphenyltrichloroethane (DDT) use and its consequences: A case study of tribal farmers in Arunachal Pradesh, India

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Abstract
Despite the global ban on Dichlorodiphenyltrichloroethane (DDT) due to its persistent environmental toxicity and detrimental health effects, its unauthorized usage persists among tribal farmers in Arunachal Pradesh, India. This study investigates the underlying factors driving DDT misuse, farmers' perceptions, and associated risks. A survey conducted from 2015 to 2025 across three districts viz., West Siang, Leparada, and Upper Subansiri, covering 150 farmers revealed that 95% were unaware of the ban, and 100% obtained DDT from public health programs. Its use was widespread in vegetable (78%) and staple crop cultivation (54%), posing significant risks to food safety and ecosystem health. Alarmingly, 94% of farmers sprayed DDT without protective measures, and 79% discarded empty containers in open fields or water sources. Among exposed individuals, 38% reported skin rashes, while respiratory (6%) and neurological symptoms (2%) were less common. Additionally, we observed a decline in predatory birds and beneficial insects, indicating ecological disruption. Despite recognizing risks, 88% of farmers perceived DDT as essential for high yields. However, 96% expressed willingness to transition to organic or government-supported sustainable farming, highlighting an urgent need for stricter monitoring, awareness programs, and the promotion of safer pest management alternatives.

Keywords: DDT, pesticide survey, farmer perception, Arunachal Pradesh, India

Introduction
Pesticides play a crucial role in global food security by protecting crops from insect-pests and diseases (Battu *et al*. 2005) [1]. However, their indiscriminate use leads to severe environmental and health consequences (Lakshmi 1993; Gupta 2004) [6, 2]. Dichlorodiphenyltrichloroethane (DDT), a persistent organic pollutant (POP), was widely used in India before its agricultural ban under the Insecticides Act of 1968, restricting its application solely to vector control under the National Malaria Eradication Programme (NMEP) (Subramanian *et al*. 2007) [9]. This study aims to assess the extent of DDT misuse among tribal farmers, investigate contributing factors, evaluate environmental and health impacts, identify knowledge gaps, and propose awareness strategies for educating farmers on pesticide regulations and safer insect-pest management alternatives while recommending policy interventions to strengthen enforcement and promote sustainable agricultural practices.

Methodology
The study employed random sampling to select 150 farmers from three districts of Arunachal Pradesh viz., West Siang, Leparada, and Upper Subansiri by surveying 25 farmers per village across two selected villages per district; Darka and Kombo-Pomte (West Siang), Sago and Tirbin (Leparada), and Ronia and Dumporijo (Upper Subansiri). Conducted between 2015 to 2025, the structured questionnaire survey utilized direct interviews and field observations to assess farmers' awareness of DDT regulations, sources of procurement, crops treated, perceived benefits and risks, and pesticide handling and application practices (Table 1).

Results and Discussion
A survey conducted among 150 farmers across West Siang, Leparada, and Upper Subansiri districts revealed that 95% of farmers were unaware of the ban, with 100% sourcing DDT

from public health programs. Its use was prevalent on vegetables (78%) and staple crops like paddy and maize (54%), raising concerns about food safety and environmental contamination. Alarmingly, 94% of farmers applied DDT without protective gear, while 98% overused pesticides to ensure effectiveness. Only 9% had received formal training on pesticide handling, with most (68%) relying on peer learning. Health issues were reported among exposed farmers, with 38% experiencing skin rashes, 6% suffering from respiratory problems, and 2% showing neurological symptoms. Additionally, 98% stored DDT openly inside their homes, and 79% improperly discarded empty containers, contributing to environmental pollution. Scientists observed a decline in predatory birds and beneficial insects, indicating ecological disruption. Despite these risks, 88% believed DDT was necessary for high yields; however, 96% expressed willingness to transition to organic or government-supported sustainable farming (Table 1).

These findings align with previous reports on pesticide misuse in India. A study by Gupta *et al*. (2021) [3] highlighted that unauthorized pesticide use in remote regions persists due to poor regulatory enforcement and limited access to alternative pest control strategies. Similarly, research by Sharma *et al*. (2020) [8] found that organochlorine pesticides, including DDT, were still detected in agricultural produce from northeastern states, indicating ongoing illegal use. The persistence of DDT residues in soil and water has been well-documented (Reddy and Rao 2019) [7], raising concerns about bioaccumulation and long-term ecological damage. Furthermore, exposure to DDT has been linked to adverse health effects, including endocrine disruption and carcinogenicity (Jayaraj *et al*. 2016) [4].

Table 1: DDT usage, farmer awareness, health and environmental impacts (n=150)

Category	Survey Parameter	Percentage (%)
Education level		
	No formal education	41
	Primary	59
	Secondary	00
	Higher Secondary	00
DDT regulations		
	Aware that DDT is banned in agriculture	05
	Unaware of any restrictions on DDT usage	95
	Believe DDT is an effective pesticide	89
	Aware of DDT's health risks	02
Source		
	Received from public health programs (malaria control)	100
	Purchased illegally from local markets	00
	Obtained from neighboring states	00
	Other sources	00
Use of DDT		
	Vegetables	78
	Fruits	17
	Paddy and Maize	54
Frequency of DDT use		
	Weekly	00
	Monthly	02
	Need based	98
Perceived benefits and risks		
	DDT effectively controls pests	93
	DDT improves crop yield	06
	Aware of potential harm to human health	02
	Believe DDT affects soil fertility	04
Pesticide handling behavior		
	Use protective gloves & masks	06
	Spray without any protective measures	94
	Follow recommended pesticide doses	02
	Overuse pesticides to ensure effectiveness	98
Training on Pesticide Handling		
	Received formal training	09
	Learned from fellow farmers	68
	No training or guidance	23
Storage and disposal of DDT		
	Store in a looked area	02
	Open inside the house	98
	Disposal of empty DDT containers properly	21
	Discard containers in open fields and near water sources	79
Prevalence of health issues among farmers exposed		
	Skin Rashes	38
	Respiratory Issues	06
	Neurological Symptoms	02
	Reproductive Disorders	00

Impact on predatory birds, livestock and environment		
	Observed livestock health issues	No
	Noticed decline of predatory birds (vultures, eagles, owls, hawks)	Yes
	Noticed decline in beneficial insects (bees, butterflies and earthworms)	Yes
Observation of any pest outbreaks in survey area		
	Tomato	*Helicoverpa armigera* Hübner
	King chilli	*Helopeltis theivora* Waterhouse
	Potato	*Solenopsis* spp.
	Maize	*Spodoptera frugiperda* Smith
	Paddy	*Mythimna separata* Walker
	Citrus	*Anoplophora versteegi* Ritsema
Economic dependency		
	Believe DDT are necessary for good yield	88
	Wiling to adopt organic or government supported organic farming	96

Conclusion

The continued misuse of DDT in Arunachal Pradesh highlights the urgent need for policy interventions, farmer education, and the promotion of sustainable pest management practices. Strengthening regulatory frameworks, coupled with the introduction of eco-friendly pest control alternatives such as biopesticides, could help mitigate the risks associated with pesticide overuse. Additionally, community-driven monitoring efforts, as suggested by Kaur and Singh (2022) [5], could play a crucial role in preventing the illegal diversion of banned pesticides. Addressing these challenges through a multi-stakeholder approach is essential to ensuring environmental safety and sustainable agricultural practices in the region.

Funding Declaration

This is from Institute approved research project (PME code: IXX09832), so there is no funding agencies involved.

Conflict of Interest

Authors states that there is no conflict of interest.

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