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Chemical Incidents and Prevention Practices Among Workers in Poultry Farms in the Southern Region of Botswana

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Abstract

The poultry industry in Botswana has expanded significantly, yet chemical-related incidents among farm workers remain a critical occupational health concern. This study investigated the prevalence of chemical incidents in selected poultry farms, identified associated risk factors, and assessed preventive measures. A descriptive cross-sectional design was applied, targeting District Poultry Officers and poultry laborers. Using multistage sampling, 191 participants were surveyed using semi-structured questionnaires, complemented by key informant interviews. Data were analyzed using descriptive and inferential statistics, including Chi-square tests. The overall incident rate was 11.7%, with skin irritation (n = 59), burns (n = 54), eye irritation (n = 49), and chemical ingestion (n = 48) being the most common. Incidence significantly varied with age ($\chi^2 = 14.66$, $p = .005$) and years of experience ($\chi^2 = 14.78$, $p = .005$). Occupational Health and Safety (OHS) training reduced incidents ($\chi^2 = 12.11$, $p = .001$), while high job demands increased risk ($\chi^2 = 6.01$, $p = .014$). The presence of health and safety committees ($\chi^2 = 7.394$, $p = .025$), trained first aiders ($\chi^2 = 5.200$, $p = .047$), reporting systems ($\chi^2 = 13.249$, $p = .001$), and safety protocols ($\chi^2 = 7.997$, $p = .019$) were all significantly associated with lower incident rates. General cleaning chemicals and aldehyde-based disinfectants were most frequently implicated. Despite high awareness and PPE provision, incident underreporting persisted. The study concludes that establishing health and safety committees, strengthening incident reporting, and implementing comprehensive chemical safety programs, including annual refresher training and competency-based practical training, are essential to improving workplace safety and reducing chemical-related risks in Botswana's poultry sector.

Keywords: *Chemical exposure, Occupational health and safety (OHS), Poultry industry, Incident prevention practices, Chemical risk assessment, Safety data sheets (SDS)*

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1. Introduction

The poultry industry plays a vital role in food security and employment, but faces persistent occupational health hazards, notably chemical incidents that endanger workers' safety and productivity. A chemical incident is defined as an uncontrolled release of a hazardous

substance capable of causing injury, illness, or death (CCOHS, 2023; WHO, 2023). In poultry operations, exposures typically occur via inhalation, dermal absorption, or ingestion during activities such as chemical mixing, disinfection, or pesticide application (Roberts & Miller, 2023). Chemical use is integral to pest and disease control in poultry production, where insects such as mites, lice, and mosquitoes threaten flock performance (Bhargava et al., 2023). However, inadequate handling, storage, and personal protective equipment (PPE) expose farmworkers to irritants, corrosive agents, and toxic residues. Routine tasks, including cleaning, egg collection, feeding, and environmental management, further increase exposure risk (Jacob, 2020).

Globally, intensification of poultry production in countries such as China, India, and Russia has heightened occupational safety concerns (Hamid et al., 2018). In Botswana, poultry farming is a significant success story in agricultural import substitution, producing about 11 million chickens annually valued at BWP 678 million (~USD 50 million) (Botswana Annual Agricultural Survey Report, 2019). However, the sector's growth has not been matched by parallel improvements in occupational health and safety (OHS) systems. Workers remain vulnerable to acute and chronic chemical exposures, ranging from skin irritation to respiratory and neurological disorders. Notably, ammonia leakage incidents in the United States and Pakistan have led to hospitalizations and impaired lung function among poultry workers (Jester & Malone, 2020; Hamid et al., 2018).

In Botswana, evidence of chemical incidents such as the 2018 sodium hypochlorite inhalation case in Kgatleng District underscores a systemic lack of preventive frameworks and documentation (MoA, 2023). Broader workplace studies indicate that weak OHS implementation contributes to recurring injuries and accidents in the agricultural sector (Moeti-Lysson & Boy, 2019). Despite these observations, there is limited empirical data on the magnitude, causes, and preventive measures for chemical incidents on poultry farms. This study, therefore, investigates the prevalence, risk factors, and prevention practices associated with chemical incidents among poultry farm workers in southern Botswana. By generating evidence on chemical exposure patterns and safety management gaps, the study aims to inform policy, strengthen OHS systems, and promote a safer, more sustainable poultry industry.

This study aims to investigate the occurrence and management of chemical incidents among workers in selected poultry farms in Botswana. Specifically, it seeks to identify the types of chemicals commonly associated with such incidents, examine the individual, organizational, and environmental factors that contribute to their occurrence, and assess the preventive and safety measures in place to mitigate these risks. Through this investigation, the study aims to generate evidence to inform policy, enhance occupational health and safety practices, and promote a safer working environment in Botswana's poultry industry.

1.1 Problem statement

The use of chemical agents in poultry farming, primarily for pest control, disease prevention, and sanitation, has become indispensable but poses serious occupational health risks when mishandled. Inadequate chemical management exposes workers to hazards such as poisoning, respiratory complications, dizziness, and eye irritation (FAO, 2023). Although these risks are recognized globally, their scope and underlying causes in Botswana's poultry sector remain poorly documented.

Data from the Ministry of Health Statistics Division, captured through the District Health Information System (DHIS), indicate that chemical incidents on poultry farms account for approximately one in ten thousand reported injury or disease cases, with recurring incidents recorded annually across districts. However, the absence of a standardized reporting and investigation framework has led to underestimation and limited causal analysis. Although most farms reportedly maintain Safety Data Sheets (SDSs) and meet basic regulatory requirements, their effectiveness is compromised by inadequate worker training, limited awareness, and weak adherence to safe handling procedures, creating a persistent gap between formal compliance and actual safety practice, which sustains both unsafe behaviors and chronic underreporting.

Given these deficiencies, there is an urgent need for a comprehensive assessment of the prevalence, determinants, and prevention practices on poultry farms in Botswana. Such evidence is essential for guiding policy formulation, strengthening occupational health systems, and promoting a proactive, worker-centered safety culture within the agricultural sector.

2. Materials and Methods

An analytical cross-sectional design integrating qualitative and quantitative methods was used to examine chemical incidents in poultry farms in Botswana. Data were collected from selected farms in the South East and Kgatleng Districts, which together host 45 medium- and large-scale poultry operations. The study targeted poultry farm workers and District Poultry Officers. A multistage sampling approach was applied: two districts were randomly selected, District Poultry Officers were purposively chosen, and 19 of the 45 farms were selected through stratified sampling. From these, 191 respondents were recruited using systematic random sampling. Yamane's (1967) formula determined a minimum sample of 191 participants, using a 5% margin of error, and proportionate sampling ensured adequate representation across farms. Data were collected using semi-structured questionnaires and checklists administered as self-report and interviewer-assisted instruments. A pre-test involving 19 workers from a poultry farm in Kweneng District assessed clarity and feasibility, enabling refinement of the tool in line with recommendations for 10% pilot sampling. Independent variables included socio-demographic characteristics, individual attributes (knowledge, experience, PPE use, and OHS training), and facility-related aspects (chemical storage and SDS availability). Employer-related variables captured safety policies, housekeeping, and PPE provision, while the dependent variable was the occurrence of chemical incidents. Descriptive statistics (frequencies and percentages) summarized participant and facility characteristics, and chi-square (χ^2) tests were used to assess associations between independent variables and chemical incident occurrence.

3. Results and Discussion

3.1 Socio-Demographic Characteristics of the Respondents

As shown in Table 1, the study sample predominantly comprised a young, moderately educated workforce. Most respondents were aged 26–35 years (29.9%), followed by those aged 36–45 years (23.4%) and 18–25 years (21.9%), reflecting the physically demanding nature of poultry farm work. Only 5.8% were aged 55 or older, indicating limited participation among older workers. In terms of education, the majority (79.6%) had attained secondary education, while 19.0% had attained primary education. A very small proportion held tertiary qualifications,

with only 0.73% holding a degree or a master's-level qualification. Overall, the findings indicate a relatively youthful workforce with moderate educational attainment, which may affect their ability to understand and apply occupational safety and chemical-handling protocols. This demographic pattern mirrors trends in Sub-Saharan Africa, where young, moderately educated workers dominate labor-intensive farming (FAO, 2023). However, limited access to tertiary education may hinder the effective adoption of occupational safety and chemical-handling practices (Thompson & Davis, 2023).

Table 1: Socio-demographic characteristics of the farm workers

Socio-demographic factors	Category	Frequency (n)	Percent (%)
Gender	Male	55	59.9
	Female	82	40.2
Age	18 to 25 years	30	21.9
	26 to 35 years	41	29.9
	36 to 45 years	32	23.4
	46 to 55 years	26	19.0
	Above 55 years	8	5.8
Education level	Primary	26	19.0
	Secondary	109	79.6
	Degree	1	0.73
	Masters	1	0.73
Position of employment	Top management	1	0.7
	Middle management	2	1.5
	Staff	109	76.6
	Casual workers	25	18.2
Work Experience	Below 1 year	29	21.2
	1-5 years	44	32.1
	6-10 years	43	31.4
	11-30 years	19	13.9
	Above 30 years	2	1.5

3.2 Chemicals Associated with Chemical Incidents in Selected Poultry Farms

According to Table 2, aldehyde-based disinfectants were the most commonly used chemicals in poultry farms (43.7%), with CID-20 (21.3%), a formaldehyde-containing WHO Group 1 hazard, being the predominant brand. Hydrogen peroxide disinfectants accounted for 18.3%, while quaternary ammonium compounds (8.4%), including Puresan (4.9%) and sodium chloride (3.0%), were also used. The alkaline cleaner Kenosan represented 3.8%. These concentrated chemicals pose significant health risks, including irritation, corrosiveness,

respiratory injury, and, for formaldehyde, potential carcinogenicity. Detergents and cleaning agents made up 25.9% of usage, comprising general detergents (12.5%), multipurpose detergents (2.7%), and personal hygiene soaps (10.6%). The chemical-use profile shows heavy reliance on aldehyde-based disinfectants, particularly CID-20, which aligns with global patterns but raises concern given their well-documented carcinogenic and respiratory risks (IARC, 2019; Chen et al., 2020). The substantial use of hydrogen peroxide, quaternary ammonium compounds, and alkaline cleaners further underscores the need for stronger chemical-handling controls to mitigate irritation, corrosive injuries, and inhalation hazards reported in similar agricultural settings (Smith & Johnson, 2021).

Table 2: Chemicals Used in the Poultry Farms

Active Ingredient	Branding	Freq(n)	Percent (%)
Aldehyde based	CID -20	56	21.3%
	ViroCid	15	5.7%
	Quart Fect	26	9.9%
	General Aldehydes/QAC disinfectants	18	6.8%
	Total	**115**	**43.7%**
Hydrogen peroxide based	Active HP	10	3.8%
	Peroxy Form	32	12.2%
	Hydrogen Peroxide	6	2.3%
	Total	**48**	**18.3%**
Quaternary Ammonium Compound (QAC) based	Puresan	13	4.9%
	Ammonia	1	0.4%
	Sodium Hypochlorite	8	3.0%
	Total	**22**	**8.4%**
Degreasers/ alkaline cleaners	Kenosan	10	3.8%
Detergents and General Cleaning	Hand soap	28	10.6%
	Multipurpose detergent	7	2.7%
	General cleaning chemicals	33	12.5%
	Total	**68**	**25.9%**

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3.3 Factors Associated with Chemical Incidents Among Poultry Farm Workers

3.3.1 Chemical Incident in the Workplace

Respondents identified the most common farm incidents (Fig. 1), with skin irritation reported most frequently (F = 59, 24.8%), followed by skin burns (F = 54, 22.7%), eye irritation (F = 49, 20.6%), and chemical ingestion (F = 48, 20.2%). Chemical inhalation was the least reported (F = 28, 11.7%). The predominance of skin-related incidents suggests a direct link to the physical state of the chemicals, mainly liquid or soluble forms, and the heightened risk of exposure during dilution and mixing. Inhalation-related cases were comparatively rare. Awareness of potential incidents, their prevention through occupational safety and health (OSH) training, and familiarity with incident reporting procedures were also assessed.

The predominance of skin-related incidents highlights direct dermal exposure as the primary hazard pathway, likely driven by handling of liquid and soluble chemicals during mixing and application, an issue widely documented in agricultural settings (Williams et al., 2022). The relatively lower frequency of inhalation cases may reflect either reduced airborne exposure or under-recognition of respiratory symptoms, underscoring the need for strengthened OSH training and clearer incident-reporting practices (Thompson & Davis, 2023).

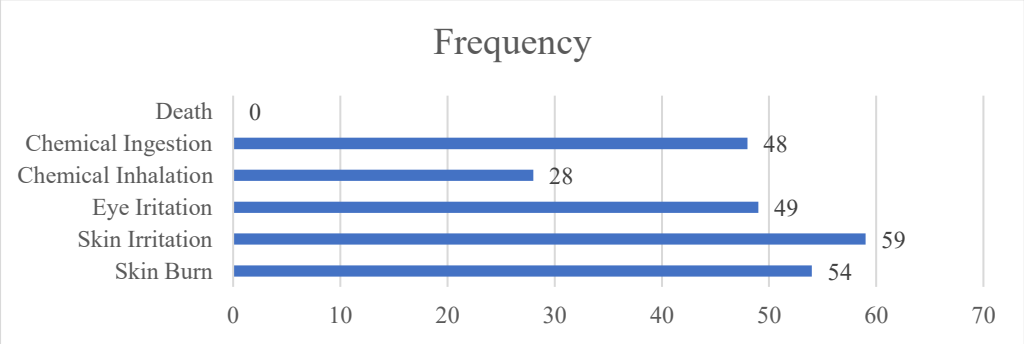

Figure 1: Common Incidents in the Poultry Farms

3.3.2 Incident Awareness via OHS Trainings

Table 3 shows that less than half of respondents had received training in either general safety (44.5%) or occupational health and safety (46.7%). Among those trained, most considered the training sufficient. The majority of courses (60.9%) were outsourced to external vendors, while 39.1% were conducted in-house. Awareness of incident-reporting procedures was relatively high, with 72.2% indicating familiarity, reflecting a moderately safety-conscious organizational culture. Although training uptake was below average, its perceived sufficiency, knowledge transfer, and the prevailing safety culture were assessed as average. Training uptake was low, with fewer than half of workers having received general safety or OHS training, consistent with regional findings of limited safety education in agricultural settings (Okareh et al., 2021; Thompson et al., 2022). Although most trained workers viewed the content as sufficient, reliance on external trainers and moderate awareness of reporting procedures suggest that safety culture is developing but remains uneven (Martinez et al., 2022).

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Table 3: Incident Awareness via OHS Trainings

Statement	No n(%)	Yes n(%)	Uncertain n(%)
Have you been trained in safety issues?	76 (55.6)	61 (44.5)	-
Have you ever been trained in occupational safety & Health	73 (53.3)	64 (46.7)	-
Do you think the training was sufficient	5 (7.8%)	59 (92.8)	-
Do you know the procedure for reporting workplace incidents?	29 (21.2)	103 (75.2)	5 (3.6)

3.3.3 Incident reporting

Figure 2 shows that most incidents went unreported: only five were reported to immediate supervisors and three to management, highlighting significant underreporting likely linked to limited awareness of reporting protocols or perceptions that reporting was ineffective. Post-reporting actions included providing medical attention (F = 6) and necessary PPE (F = 6), while no action was taken in four cases.

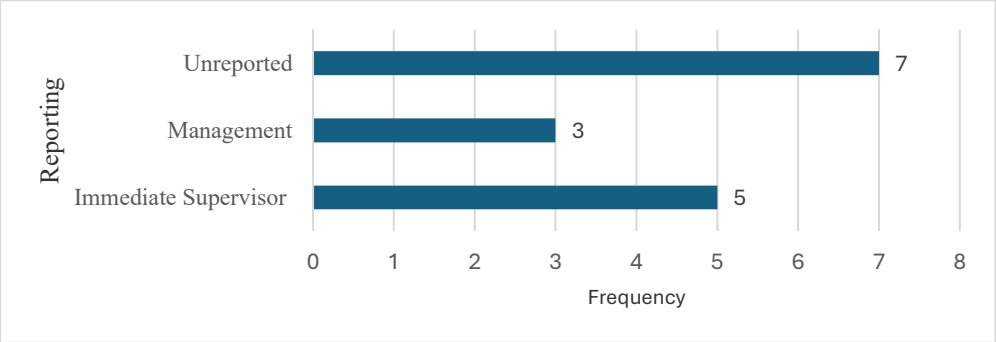

Figure 2: Incident reporting

3.4 Individual - Level Factors Associated with Chemical Incidents

3.4.1 Social Demographic Characteristics Associated with Incident Occurrences

The results (Table 4) revealed significant associations between the occurrence of chemical incidents and several socio-demographic factors.

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Table 4: Incidents across varied Social-Demographic Variables

Variable	Category	Incidents (%)	χ^2	P-Value
Gender	Male	8 (14.5)	.732	.392
	Female	8 (9.8)		
Age	18-25 Years	1 (3.3)	14.655	.005
	26-35 Years	3 (7.3)		
	36-45 Years	5 (15.6)		
	46-55 Years	3 (11.5)		
	Above 55 Years	4 (50.0)		
Educational Level	Primary	5 (19.2)	1.968	.579
	Secondary	11 (10.1)		
	Degree	-		
	Master's and above	-		
Employment Level	Top Management	-	6.774	.081
	Middle management	1 (50.0)		
	Staff	15 (13.8)		
	Casual Workers	-		
Work Experience	Below 1 year	-	14.779	.005
	1-5 years	2 (4.5)		
	6-10 years	8 (18.6)		
	11-30 years	5 (26.3)		
	above 30 years	1 (50.0)		

Table 4 shows that incidents varied the respondents' ages ($\chi^2 = 14.66$, $p = .005$) and years of experience ($\chi^2 = 14.78$, $p = .005$), with older respondents and those between 6 and 30 years (6 to 10 years; $F = 18$; 11 to 30; $F = 5$) recording the highest proportion of incidents. Older and more experienced respondents may have greater cumulative exposure to various chemicals over their tenure, increasing the likelihood of adverse events. Alternatively, this could be as a result of experience-based complacency resulting from less vigilance in adhering to safety protocols when handling chemicals.

On the contrary, there were no significant gender differences in the recorded incidents, with equally as many men as women recording incidents ($F = 8$). Further, respondents with a secondary level of education had higher incidents (F = 11), although this was not statistically significantly different ($\chi^2 = 1.97$, p = .579) from those with a primary level of education. Similarly, staff primarily involved in the daily operations of the farms had more recorded incidents (F = 16) than the other categories. These were not different from the other categories but were approaching significance ($\chi^2 = 6.77$, $p = .081$).

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3.4.2 Knowledge and Awareness Factors Linked to Prevalence of Chemical Incidents

The findings (Table 5) indicate that most poultry farm workers had high levels of chemical safety awareness: 89.1% were aware of chemical use, and 56.2% could read labels. However, only 44.5% had received general safety training, and 46.7% had undergone occupational safety and health (OSH) training.

Table 5: Knowledge on chemical usage and the occurrence of chemical incidents

Variable	Category	Chemical incidence		χ^2	p-value	Cramér's V
		Yes, n(%)	No / Unsure, n(%)			
Ability to read a chemical label	Can read	17(21.8)	61 (78.2)	0.002	0.964	0.004
	/Unsure	6 (22.2)	24 (77.8)			
Safety training received	Yes	18(29.5)	43 (70.5)	10.9	0.001	0.283
	No	6 (7.9)	70 (92.1)			
Awareness of chemical use	Yes	24 (19.7)	98 (80.3)	3.58	0.059	0.162
	I do not know	0 (0.0)	15 (100.0)			
Trained in Occupational Safety and Health (OSH)	Yes	21 (32.8)	43 (67.2)	19.4	0.001	0.377
	No	3 (4.1)	70 (95.9)			
Perception of training sufficiency	Yes	17 (29.3)	41 (70.7)	5.32	0.021	0.291
	No	4 (80.0)	1 (20.0%)			
Knowledge of required PPE	Know required PPE	22 (17.7)	102 (82.3)	0.007	0.934	0.007
	Unsure	2 (16.7)	10 (83.3)			
Knowledge of incident reporting procedures	Know procedure	22 (21.4)	81 (78.6)	3.57	0.059	0.161
	Do not know / Unsure	2 (5.9)	32 (94.1)			
Received clear safety instructions and protocols	Yes	19 (18.3)	85 (81.7)	0.17	0.681	0.035
	No / Unsure	5 (15.2)	28 (84.8)			

Among knowledge-related variables, safety training ($\chi^2 = 10.9$, $p = 0.001$), OSH training ($\chi^2 = 19.4$, $p = 0.001$), and perceived training sufficiency ($\chi^2 = 5.32$, $p = 0.021$) showed significant associations with incident occurrence, indicating that structured and adequate training plays a central role in chemical safety. In contrast, the ability to read labels ($\chi^2 = 0.002$, $p = 0.964$), knowledge of PPE ($\chi^2 = 0.007$, $p = 0.934$), and awareness of chemical use ($\chi^2 = 3.58$, $p = 0.059$) were not statistically significant, suggesting that awareness alone does not guarantee safe practices. These results underscore that training quality and frequency, rather than mere awareness, are the strongest predictors of workplace safety. Studies by Thompson et al. (2022) and the International Labour Organization (2022) confirm that competency-based, practical

OSH training enhances hazard recognition and reporting. Similarly, FAO (2023) and Martinez et al. (2022) emphasize that hands-on learning fosters behavioral change, whereas paper-based compliance without reinforcement has a limited impact. The weak association between PPE knowledge and incidents mirrors findings from Okareh et al. (2021) and Jallow et al. (2017), indicating that even with established safety systems, operational gaps persist. Therefore, continuous refresher training, clear communication of protocols, and intense supervision are essential to translate safety knowledge into consistent preventive practice and to cultivate a sustainable safety culture.

3.5 Organization-level factors associated with chemical incidents prevalence

Chemical incident occurrence was significantly associated with organizational-level safety management systems, including the presence of health and safety committees ($\chi^2 = 9.63$, $p = 0.002$, $V = 0.266$), first aiders ($\chi^2 = 6.12$, $p = 0.013$, $V = 0.212$), incident reporting procedures ($\chi^2 = 14.02$, $p = 0.001$, $V = 0.320$), and formal safety protocols ($\chi^2 = 9.99$, $p = 0.002$, $V = 0.271$).

Table 6: Availability of Safety Management Systems and Incident Occurrence

Variable	Category	Chemical incidence		χ^2	p-value	Cramér's V
		Yes, n(%)	No / Unsure, n(%)			
Existence of a health and safety committee	Yes	5 (45.5)	6 (54.5)	9.63	0.002	0.266
	No/unaware	18 (13.2)	118 (86.8)			
Presence of a first aider	Yes	18 (25.0)	54 (75.0)	6.12	0.013	0.212
	No / Unaware	6 (9.8)	55 (90.2)			
Existence of an incident reporting procedure	Yes	11(40.7)	16 (59.3)	14.02	0.001*	0.320
	No / Unaware	13 (12.9)	88 (87.1)			
Existence of safety protocols	Yes	6 (46.2)	7 (53.8%)	9.99	0.002	0.271
	No / Unaware	18 (15.0)	102 (85.0)			

Farms with these systems reported higher incident reporting rates 45.5% with committees, 25% with first aiders, 40.7% with reporting procedures, and 46.2% with safety protocols, indicating that structured safety mechanisms enhance awareness and documentation rather than exposure. These findings align with FAO (2023) and ILO (2022), which emphasize that institutionalized safety structures strengthen hazard communication and accountability. Similarly, Thompson & Davis (2023) and Becker (2018) note that participatory safety frameworks and trained first responders foster compliance, proactive risk management, and improved emergency response capacity. Overall, the study highlights that the existence and functionality of safety management systems are critical in shifting poultry farms from reactive to preventive safety cultures, promoting transparency, continuous learning, and improved occupational health outcomes.

EdinBurg Peer-Reviewed Journals and Books Publishers
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Vol. 6||Issue 1||pp 12-25||February||2026
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3.6 Facility-level variables linked to the prevalence of chemical incidents

Table 7 indicates that the occurrence of chemical incidents was significantly higher among workers engaged in physically or mentally demanding tasks (OR = 8.9, p = 0.014) and marginally higher in farms lacking Safety Data Sheets (SDS) (OR = 2.9, p = 0.051). Workers performing strenuous or high-concentration tasks were nearly nine times more likely to report a chemical incident, suggesting that excessive workload and task intensity may heighten exposure risk or reduce compliance with safety protocols. Similarly, the absence of SDS nearly tripled the likelihood of incidents, underscoring the crucial role of accessible chemical safety information in promoting safe handling practices. These findings are consistent with recent evidence from FAO (2023), ILO (2022), and Thompson and Davis (2023), which highlight that elevated task pressure and inadequate hazard communication significantly contribute to occupational injuries in agricultural and industrial settings.

Table 7: Facility Level Variables Linked to Prevalence of Chemical Incidents

Variable	Category	Chemical Incidence		χ^2	p-value	OR [95% CI]
		No n(%)	Yes n(%)			
Job demanding or challenging	No	45 (97.8)	1 (2.2)	6.07	0.014	8.9 [1.1:73.5]
	Yes	76 (83.5)	15 (16.5)			
Safety Data Sheets (SDS) available	No	60 (80.0)	15 (20.0)	5.93	0.050	2.9 [0.96:8.7]
	Yes	23 (92.3)	8 (7.7)			

3.7 Preventive Measures in Place to Prevent Chemical Incidents

3.7.1 Deficiency in Formal Safety Governance and Protocol Awareness

Most poultry farms lacked a health and safety committee (67.9%), and nearly a third of workers were unaware of its existence (30.7%), underscoring a profound gap in institutional oversight of safety (Table 8). Similarly, awareness of incident management protocols was strikingly low: only 19.7% of respondents knew about them, while over 80% were unaware or uncertain (Table 9). This deficiency in structured safety governance and procedural communication indicates systemic weaknesses in organizational safety culture and accountability frameworks, consistent with findings from FAO (2023) and ILO (2022) that weak governance structures amplify occupational risks in agricultural enterprises.

Table 8: Existence of Health and Safety Committee and Functionality of First Aiders

Variable	Yes n (%)	No n (%)	Unaware n (%)	Observation (n = 19 farms)
Health & Safety Committee	26(19.4)	91 (67.9)	41 (30.7)	None present in 19 farms
Designated First Aider	73(53.3)	37 (27.0)	27 (19.7)	10 farms (52.6%) had one

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Vol. 6||Issue 1||pp 12-25||February||2026
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Table 9: Awareness of Safety Protocols and Procedures

Variable	Yes n (%)	No n (%)	Unaware n (%)
Incident Management Protocols	27 (19.7)	74 (54.0)	36 (26.3)
Safety Protocols in Place	5 (3.6)	91 (66.4)	41 (29.9)

3.7.2 Limited Safety Training and Knowledge of Chemical Hazards

Only 44.5% of respondents had received general safety training, and 46.7% had participated in Occupational Safety and Health (OSH) programs; over half of these programs were outsourced to private providers (60.9%). Moreover, although all farms possessed Safety Data Sheets (SDS), only 22.6% of workers were aware of them, and nearly half could not interpret chemical labels. This reveals a profound knowledge-practice gap, where compliance exists on paper but not in practice. The finding underscores the urgent need for context-specific, continuous safety education to promote chemical literacy and hazard prevention, an observation echoed by Thompson and Davis (2023) and Becker (2018), who emphasize that effective risk mitigation depends on empowered, well-trained personnel rather than procedural formalities.

Table 10: Training and Education Programs

Training Type	Received n (%)	Not Received n (%)	Provider Type (External / Internal)
General Safety Training	61 (44.5)	76 (55.5)	—
Occupational Safety & Health (OSH) Training	64 (46.7)	73 (53.3)	60.9% / 39.1%
Training Considered Adequate	59 (43.1)	78 (56.9)	—

Table 11: Chemical Safety Management

Variable	Yes n (%)	No n (%)	Unaware n (%)	Observation
Safety Data Sheets (SDS) Available	137 (100)	—	—	Present in all farms
Workers Aware of SDS	31 (22.6)	74 (54.0)	32 (23.4)	Limited awareness
Able to Interpret Chemical Labels	77 (56.2)	22 (16.1)	38 (27.7)	—
Proper Chemical Storage	89.5% of farms	—	—	Sound housekeeping observed

4. Conclusion

This study demonstrates that although poultry farms in Botswana exhibit high levels of regulatory adherence in chemical management, evidenced by universal labeling, extensive availability of Safety Data Sheets (SDSs), and appropriate storage practices, these measures have not yielded effective safety outcomes. Insufficient worker awareness of Safety Data Sheets (SDSs), ongoing underreporting of accidents, and inadequate hazard interpretation abilities indicate that compliance is predominantly procedural rather than operational.

Demographic and organizational indicators, such as age, work experience, job demands, and the existence of safety committees, underscore the complex determinants of chemical safety hazards. Despite a robust supply of personal protective equipment, inadequate participation in safety training and reliance on external providers reveal fundamental deficiencies in addressing workplace-specific hazards. The findings confirm that regulatory compliance alone is inadequate to protect worker health. Preventing chemical incidents sustainably in poultry operations requires a planned transition to a worker-focused safety culture, enhanced communication systems, and governance structures that integrate chemical safety into routine practices.

5. Recommendations

To improve chemical safety in poultry farms, interventions must extend beyond compliance and focus on operational effectiveness. This requires chemical-specific handling protocols, particularly for aldehyde-based disinfectants and cleaning agents, as well as engineering controls, such as automated dilution and structured emergency procedures. Strengthening workplace governance through joint worker–management safety committees, ergonomic evaluations, and age-sensitive safety measures will help institutionalize accountability. At the same time, underreporting of incidents can be reduced by adopting anonymous reporting systems, enforcing non-punitive policies, and standardizing incident documentation. Equally critical is training, with annual refreshers. By embedding these measures, policymakers and industry stakeholders can cultivate a preventive, worker-centered safety culture that enhances resilience, reduces chemical-related risks, and ensures sustainable productivity in the poultry sector.

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