ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jul997

Enhancing Occupational Health and Safety Practices in Pig Farming in Chipata, Zambia: The Availability and Use of Personal Protective Equipment and Supporting Infrastructure

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Publication Date: 2026/07/29

Abstract: Pig farming is an increasingly important livelihood for smallholder households in Chipata District, Zambia, yet the protection of pig keepers from occupational hazards has received little attention. This article evaluates the availability and use of personal protective equipment and supporting infrastructure among pig farmers in the district. A mixed methods design was used, combining a quantitative survey of ninety-five pig farmers drawn from all veterinary camps through stratified random sampling, with qualitative key informant interviews and focus group discussions. Quantitative data were analysed in the Statistical Package for the Social Sciences using multiple response analysis and the chi-square test of independence, while qualitative data were analysed thematically in NVivo. Protective equipment was found to be scarce and unevenly distributed, with gloves the most commonly owned item at 64.6 per cent of equipped farmers and masks the least at 14.6 per cent, and with almost half of the full sample possessing no equipment at all. The consistent use of equipment lagged far behind its availability, so that gloves were consistently used by only about one in eight farmers and masks by about one in fifty. Safety infrastructure was weighted towards production-oriented facilities rather than dedicated safety provisions. The chi-square tests established significant associations between veterinary camp and both the availability of a documented safety policy and the presence of a safety committee, revealing a spatial inequality in safety governance. The study concludes that providing equipment alone does not secure protection and recommends subsidised provision through cooperatives, coupled with practical training.

Keywords: *Occupational Health and Safety, Pig Farming, Personal Protective Equipment, Safety Infrastructure, Smallholder Farmers, Veterinary Camps, Chipata District, Zambia.*

How to Cite: Michael Musonda Tembo (2026) Enhancing Occupational Health and Safety Practices in Pig Farming in Chipata, Zambia: The Availability and Use of Personal Protective Equipment and Supporting Infrastructure. *International Journal of Innovative Science and Research Technology*, 11(7), 1711-1720. https://doi.org/10.38124/ijisrt/26jul997

I. INTRODUCTION

Agriculture remains one of the most hazardous sectors of the global economy, and the people who work in it continue to record disproportionately high levels of occupational injury and disease. The International Labour Organization estimates that close to three million workers die each year from work-related causes, with agriculture, alongside construction and mining, among the sectors that carry the heaviest burden (International Labour Organization, 2024). The joint estimates prepared by the World Health Organization and the International Labour Organization confirm that occupational exposures account for a large and largely preventable share of death and disability, and that workers in low and middle income countries bear the greatest part of this burden (World Health Organization and International Labour Organization, 2021). Within agriculture, livestock keeping presents a distinctive combination of biological, physical, chemical, ergonomic and psychosocial hazards that arise directly from close and repeated contact between workers and animals, animal waste and the built environment of animal housing.

Pig farming occupies a particular place within this hazard profile. The confined and often poorly ventilated conditions in which pigs are commonly kept expose workers to airborne dust, ammonia and infectious aerosols that are known to contribute to chronic respiratory disease among livestock workers (Sigsgaard et al., 2020). At the same time, the close contact that pig keeping requires, in feeding, cleaning, restraining and treating animals, creates recurrent opportunities for the transmission of zoonotic pathogens such as brucellosis from animals to the people who care for them (Mfune et al., 2021). Against these hazards, the single most direct and immediate means of protection available to the individual farmer is personal protective equipment,

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jul997

comprising items such as gloves, boots, masks, aprons and overalls, together with the supporting infrastructure, such as ventilation, handwashing facilities and safe needle disposal systems, that enables safe working. The availability and consistent use of this equipment and infrastructure is therefore central to protecting the health of pig farmers.

In Zambia, pig production has grown in importance among smallholder and peri-urban households because of its comparatively short production cycle, its modest capital requirements and the steady domestic demand for pork. The sub-sector is dominated by smallholders with limited formal education and constrained access to extension and veterinary support, a profile that shapes both their exposure to occupational hazards and their capacity to acquire and use protective equipment (Abigaba et al., 2022). Eastern Province, and Chipata District within it, has seen a steady expansion of pig keeping as households diversify their livelihoods. Yet the occupational health and safety dimension of this activity, and specifically the protective equipment and infrastructure available to farmers, has received almost no research attention in the Zambian context. This article addresses that gap by evaluating the availability and use of personal protective equipment and supporting infrastructure among pig farmers in Chipata District.

The rationale for focusing on protective equipment and infrastructure rests on their position as the last line of defence between the farmer and the hazards of the work. Where hazards cannot be eliminated at source, as is largely the case in smallholder pig keeping, the consistent use of appropriate protective equipment becomes the principal means of reducing the risk of injury, respiratory illness and zoonotic infection. Gloves protect against bites, scratches and contact with body fluids during handling and treatment; boots protect against injury on wet and uneven pen floors; masks protect against the inhalation of dust, ammonia and infectious aerosols; and aprons and overalls protect against contamination during cleaning and slaughter. Supporting infrastructure, including adequate ventilation, running water for handwashing, first aid provision and safe needle disposal, complements this equipment by reducing exposure at the level of the farm environment. The availability and use of these items therefore offers a direct and practical measure of how well pig farmers are protected.

The specific objective of the study reported here was to evaluate the availability and use of personal protective equipment and supporting infrastructure in pig farming in Chipata District. In pursuing this objective, the study drew a deliberate distinction between the availability of protective equipment, that is, whether farmers possessed each item, and its utilisation, that is, whether those who owned an item actually used it, since the two are not the same and the gap between them is of central practical importance. The study further examined whether key elements of occupational health and safety governance, namely documented safety policies and workplace safety committees, were evenly distributed across the veterinary camps of the district. In doing so, it sought to move beyond a simple audit of what equipment farmers possess towards an understanding of why possession does not always translate into protection, and of how the institutional environment shapes the safety of pig farming across the district.

II. LITERATURE REVIEW

The international literature consistently shows that the availability and use of protective equipment remain low among smallholder and resource-constrained farmers, even where hazard awareness is comparatively high. A study of dairy farmworkers in Colorado, conducted after the detection of highly pathogenic avian influenza on affected farms, found that although the overall use of protective equipment rose once the specific biological threat was recognised, the use of respiratory protection remained persistently low, a pattern the authors attributed to the practical discomfort of respirators during physically demanding tasks and to gaps in the timely distribution of equipment (Marshall et al., 2024). This finding illustrates a recurring theme in the literature, namely that awareness raising alone, without simultaneous attention to the practical availability, comfort and appropriateness of protective equipment, tends to produce only partial improvements in protective practice.

Evidence from low and middle income countries more broadly confirms that shortages and inconsistent use of protective equipment predate and outlast specific health emergencies, and that access to a complete set of appropriate equipment is frequently the exception rather than the rule (Drouard et al., 2023). Within Zambia, a study of the availability and accessibility of protective equipment among nurses and midwives in Lusaka found meaningful shortfalls in supply even in the formal health sector, underlining how much greater the challenge is likely to be in the informal, smallholder agricultural sector where no employer bears a statutory duty to provide equipment (Mayimbo et al., 2023).

For pig farming specifically, evidence from elsewhere in Southern and East Africa points to pervasive weaknesses in farm-level protection and biosecurity. A survey of smallholder pig farmers in the Eastern Cape Province of South Africa found that all the farmers interviewed had poor biosecurity measures on their farms, that women made up a slight majority of farmers, and that low levels of education and a lack of training were defining features of the sub-sector (Simbizi, Moerane and Gummow, 2025). A rapid risk assessment of smallholder pig farms in Tanzania similarly found that biosecurity gaps were pervasive, that no single farm implemented all the recommended measures, and that the sharing of equipment and the absence of farm-level protocols were dominant drivers of disease risk (Fasina et al., 2024). Because many of the same behaviours, such as the use of dedicated protective clothing and the disinfection of equipment, serve simultaneously to protect farm workers from zoonotic infection and to protect the herd from disease, these findings on biosecurity are directly relevant to the occupational protection of farmers.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jul997

A recurring theme in this literature is that the barriers to protective equipment use are not primarily ones of unwillingness but of cost, comfort and access. Farmers in resource-constrained settings must weigh the price of protective equipment against the modest returns of smallholder production, and they must balance the protection that equipment offers against the practical burden it imposes on physically demanding work. The evidence suggests that this calculus frequently resolves against consistent use, particularly for items such as masks and respirators that interfere most with breathing and movement during strenuous tasks. Understanding this hierarchy of practical constraint, rather than treating protective equipment adoption as a uniform outcome of awareness, is essential for designing interventions capable of achieving meaningful improvements in farm-level protection.

The gendered character of smallholder pig farming further shapes access to protective equipment. Evidence from Southern Africa indicates that women make up a substantial and, in some settings, a majority share of smallholder pig farmers, often among households with the smallest herds and the most limited access to capital, training and extension support (Simbizi, Moerane and Gummow, 2025). Because extension and safety programmes have historically been designed around male-dominated, formal-sector employment, women in smallholder pig production may be comparatively underserved in their access to protective resources, a consideration that reinforces the importance of delivering equipment and training through channels, such as cooperatives, that reach women farmers directly.

Zambia's legal framework recognises the importance of protective equipment. The Occupational Health and Safety Act No. 36 of 2010 places a duty on employers to provide protective equipment and clothing and to maintain safe workplaces, and it establishes the institutional architecture for occupational safety governance (Republic of Zambia, 2010). In practice, however, the reach of this framework into smallholder livestock production, where the farmer is typically both the worker and the proprietor and where no formal employment relationship exists, remains limited. Where no employer bears a statutory duty to provide equipment, the cost of protection falls entirely on the farmer, and the governance structures that in a formal workplace would ensure the presence of safety policies and committees are frequently absent. The present study contributes to this literature by providing district-level, Zambian evidence on the availability and use of protective equipment and infrastructure among pig farmers, and by examining, through hypothesis testing, whether the governance structures that underpin safe working are evenly distributed across the veterinary camps of the district.

III. MATERIALS AND METHODS

The study adopted a mixed methods design, combining a quantitative survey with qualitative key informant interviews and focus group discussions, in order to evaluate both the extent of protective equipment availability and use and the reasons underlying the patterns observed. The study was conducted across all the veterinary camps of Chipata District in Eastern Province, Zambia, namely Chipata Central, Mnoro, Mtenguleni, Kanyanja, Chikando, Mwami, Kamlaza and Kaphinde, in order to obtain district-wide coverage.

The target population comprised registered pig farmers operating within the veterinary camps of the district, together with technical officers responsible for livestock extension and animal health. Applying Cochran's formula with a finite population correction to the registered farmer population yielded a sample of ninety-five farmers, which was distributed proportionately across the eight veterinary camps in line with each camp's share of the registered farmer population. Within each camp, farmers were selected by simple random sampling from the veterinary camp registration list, so that every registered farmer within a camp had an equal probability of selection. For the qualitative component, key informants were selected purposively on the basis of their institutional role, and focus group participants were selected purposively in consultation with camp-level extension staff to ensure a mix of farmers by gender, herd size and experience.

Quantitative data were collected using a structured questionnaire that recorded, among other variables, the protective equipment each farmer possessed, how consistently each item was used, and the safety infrastructure present on the farm. Because a farmer typically possesses several items of equipment at once, the availability of protective equipment and infrastructure was treated as a multiple response set. Qualitative data were collected using semi-structured interview and focus group guides that explored farmers' access to protective equipment and the barriers to its consistent use. Quantitative data were analysed in the Statistical Package for the Social Sciences, using multiple response analysis to summarise availability and use, and the chi-square test of independence to test for associations between veterinary camp and the availability of documented safety policies and safety committees. Qualitative data were analysed thematically in NVivo, with recurring themes coded and quantified by the number of coding references, and the results are presented as hierarchy and coding comparison charts.

The study was conducted in accordance with recognised ethical standards. Ethical clearance and permission were obtained from the relevant authorities before data collection, informed consent was obtained from all participants, and the anonymity and confidentiality of individual responses were maintained throughout.

IV. RESULTS AND FINDINGS

- *Availability of Personal Protective Equipment*

The possession of protective equipment was analysed as a multiple response set. Table 1 presents the availability of each item of protective equipment among the farmers who possessed at least one item.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jul997

Table 1 Availability of Personal Protective Equipment (Multiple Response)

$PPE Frequencies

		Responses N	Responses Percent	Percent of Cases
PPE[a]	PPE available: gloves	31	29.5%	64.6%
	PPE available: boots/closed shoes	27	25.7%	56.3%
	PPE available: mask/respirator	7	6.7%	14.6%
	PPE available: apron	18	17.1%	37.5%
	PPE available: overalls/protective clothing	22	21.0%	45.8%
Total		105	100.0%	218.8%

a. Dichotomy group tabulated at value 1.

Source: Field Data (2026), SPSS Output.

Table 1 shows that the possession of protective equipment was generally low and uneven. Gloves were the most commonly owned item, held by 64.6 per cent of the valid cases, followed by boots at 56.3 per cent, overalls at 45.8 per cent and aprons at 37.5 per cent. The mask or respirator was the least available item, held by only 14.6 per cent of cases. These percentages are based on the forty-eight farmers who possessed at least one item of protective equipment, which means that almost half of the full sample of ninety-five farmers possessed no protective equipment at all. The scarcity of masks is particularly significant given the prominence of biological and respiratory hazards in pig housing, since the mask is precisely the item most relevant to protecting against airborne dust, ammonia and infectious aerosols in confined conditions.

The ordering of the items in Table 1 is itself instructive. The items most commonly owned, namely gloves and boots, are those that are comparatively inexpensive, durable, locally available and compatible with the physical demands of daily farm tasks, whereas the least owned item, the mask, is costlier to replace, less locally available and widely perceived as impractical for sustained wear during strenuous work. This gradient suggests that farmers acquire protective equipment in an order dictated by cost and practicality rather than by the severity of the hazard against which each item protects. The consequence is that the item most relevant to the biological and respiratory hazards that dominate pig keeping is precisely the item least likely to be owned, so that the pattern of availability leaves farmers least protected against the hazards that are most prevalent.

- *Utilisation of Personal Protective Equipment*

Ownership of an item does not guarantee its use. Table 2 presents, for the three principal items, how consistently owners actually used them.

Table 2 Utilisation of PPE Among Owners (Multiple Response, Consistent Use)

$Use Frequencies

		Responses N	Responses Percent	Percent of Cases
Use[a]	PPE utilisation: how often gloves are used (owners only)	11	52.4%	84.6%
	PPE utilisation: how often boots are used (owners only)	8	38.1%	61.5%
	PPE utilisation: how often mask is used (owners only)	2	9.5%	15.4%
Total		21	100.0%	161.5%

a. Dichotomy group tabulated at value 3.

Source: Field Data (2026), SPSS Output.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jul997

Table 2 reveals a further shortfall between availability and use. Among the thirty-one farmers who owned gloves, only eleven used them consistently, and among the twenty-seven who owned boots, only eight did so. For masks, only two of the seven owners used them consistently. Expressed against the full sample of ninety-five farmers, this means that gloves were consistently used by roughly one in eight farmers, boots by fewer than one in ten, and masks by only about one in fifty. The gap between the availability figures in Table 1 and the utilisation figures in Table 2 is the central finding of this study. It demonstrates that simply providing protective equipment is not sufficient, because a substantial proportion of farmers who own equipment do not use it consistently, whether because of discomfort, the slowing of work, or the perception that the risk does not warrant the inconvenience.

➢ *Farm Safety Infrastructure*

The availability of supporting infrastructure was also analysed as a multiple response set, presented in Table 3.

Table 3 Availability of Farm Safety Infrastructure (Multiple Response)

		Responses		Percent of Cases
		N	Percent	
infrastructure[a]	Infrastructure: designated injection/restraint area	23	12.0%	37.7%
	Infrastructure: adequate pen ventilation	33	17.2%	54.1%
	Infrastructure: running water for handwashing	30	15.6%	49.2%
	Infrastructure: first aid kit on farm	24	12.5%	39.3%
	Infrastructure: safe needle disposal system	13	6.8%	21.3%
	Infrastructure: secure fencing/pen structures	41	21.4%	67.2%
	Infrastructure: waste/manure disposal system	28	14.6%	45.9%
Total		192	100.0%	314.8%

a. Dichotomy group tabulated at value 1.

Source: Field Data (2026), SPSS Output.

Table 3 shows that secure fencing was the most commonly available item of infrastructure, present in 67.2 per cent of cases, followed by adequate ventilation at 54.1 per cent and running water for handwashing at 49.2 per cent. More safety-specific facilities were much less common, with first aid kits present in only 39.3 per cent of cases, designated injection or restraint areas in 37.7 per cent, and safe needle disposal systems in only 21.3 per cent of cases. The relative abundance of fencing, which serves production as much as safety, alongside the scarcity of dedicated safety facilities such as needle disposal systems, suggests that farmers invest first in infrastructure that protects their animals and their output, and only secondarily, if at all, in infrastructure that protects their own health. This reinforces the conclusion that occupational health and safety is not yet treated as a priority in farm-level investment decisions.

➢ *Camp-Level Differences in Safety Governance*

Two null hypotheses were tested using the chi-square test of independence, in order to establish whether the availability of key elements of occupational health and safety governance differed significantly across the veterinary camps. The camp of the respondent was cross-tabulated against, first, whether the farm or camp had a documented safety policy and, second, whether it had a workplace safety and health committee.

- *H01: There is No Association between Veterinary Camp and having a Documented Safety Policy.*

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jul997

Table 4 Chi-Square Test of Veterinary Camp by Documented Safety Policy

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	38.010[a]	7	.000	.000
Likelihood Ratio	41.681	7	.000	.000
Fisher's Exact Test	37.955			.000
N of Valid Cases	95			

a. 4 cells (25.0%) have expected count less than 5. The minimum expected count is 4.26.

Source: Field Data (2026), SPSS Output.

As shown in Table 4, the Pearson chi-square value was 38.010 with seven degrees of freedom and a p value of .000, which is well below the conventional significance threshold of 0.05. The likelihood ratio and Fisher's exact test both returned the same highly significant result, with an exact significance of .000, confirming the finding even though four cells had expected counts below five. The null hypothesis is therefore rejected, and it is concluded that there is a statistically significant association between the veterinary camp and the availability of a documented safety policy. In practical terms, the better-resourced camps, notably Chipata Central, Mwami, Kanyanja and Chikando, were considerably more likely to have documented safety policies than the smaller and more remote camps such as Kamlaza, Kaphinde, Mnoro and Mtenguleni.

- *H02: There is No Association between Veterinary Camp and having a Workplace Safety and Health Committee.*

Table 5 Chi-Square Test of Veterinary Camp by Workplace Safety Committee

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	33.811[a]	7	.000	.000
Likelihood Ratio	36.854	7	.000	.000
Fisher's Exact Test	33.523			.000
N of Valid Cases	95			

a. 5 cells (31.3%) have expected count less than 5. The minimum expected count is 4.07.

Source: Field Data (2026), SPSS Output.

Table 5 shows a similarly significant result for the second hypothesis. The Pearson chi-square value was 33.811 with seven degrees of freedom and a p value of .000, again supported by the likelihood ratio and Fisher's exact test at an exact significance of .000. The null hypothesis is therefore rejected, and it is concluded that there is a statistically significant association between the veterinary camp and the existence of a workplace safety and health committee. As with safety policies, the presence of safety committees was concentrated in the larger and better-served camps. Taken together, the two hypothesis tests demonstrate that occupational health and safety governance in Chipata District is unevenly distributed across the veterinary camps, and that farmers in the smaller and more remote camps are systematically less likely to be supported by the formal structures that underpin safe working.

➢ *Qualitative Findings*

The qualitative data obtained from the key informant interviews and focus group discussions were analysed thematically in NVivo, in order to explain the patterns observed in the quantitative results and, in particular, the gap between the availability and the use of protective equipment. The coding produced six themes, whose relative prominence, measured by the number of coding references, is displayed in the hierarchy chart in Figure 1. The hierarchy chart, or tree map, sizes each theme by the number of coding references attached to it, so that the larger rectangles represent the barriers most frequently raised by participants.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jul997

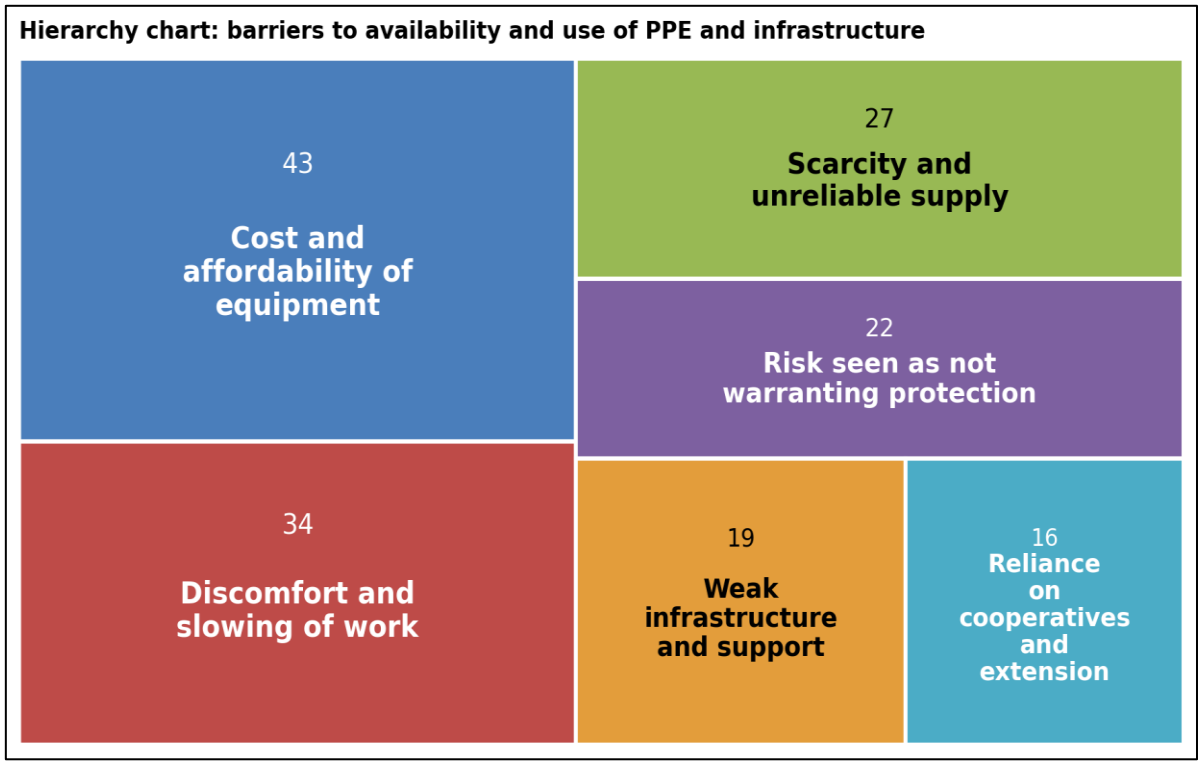

Fig 1 NVivo Hierarchy Chart of Barriers to the Availability and Use of PPE and Infrastructure
Source: NVivo Thematic Analysis of Field Data (2026)

As Figure 1 shows, the theme of cost and affordability of equipment attracted the greatest number of coding references, at forty-three, confirming that the price of protective equipment was the single most frequently cited barrier to both acquiring and consistently using it. The theme of discomfort and the slowing of work was the next most prominent, with thirty-four references, followed by the scarcity and unreliable supply of equipment at twenty-seven references, the perception that the risk did not warrant protection at twenty-two references, weak infrastructure and support at nineteen references, and reliance on cooperatives and extension at sixteen references. The coding comparison chart in Figure 2 presents the same themes ranked by number of coding references, allowing their relative weight to be compared directly.

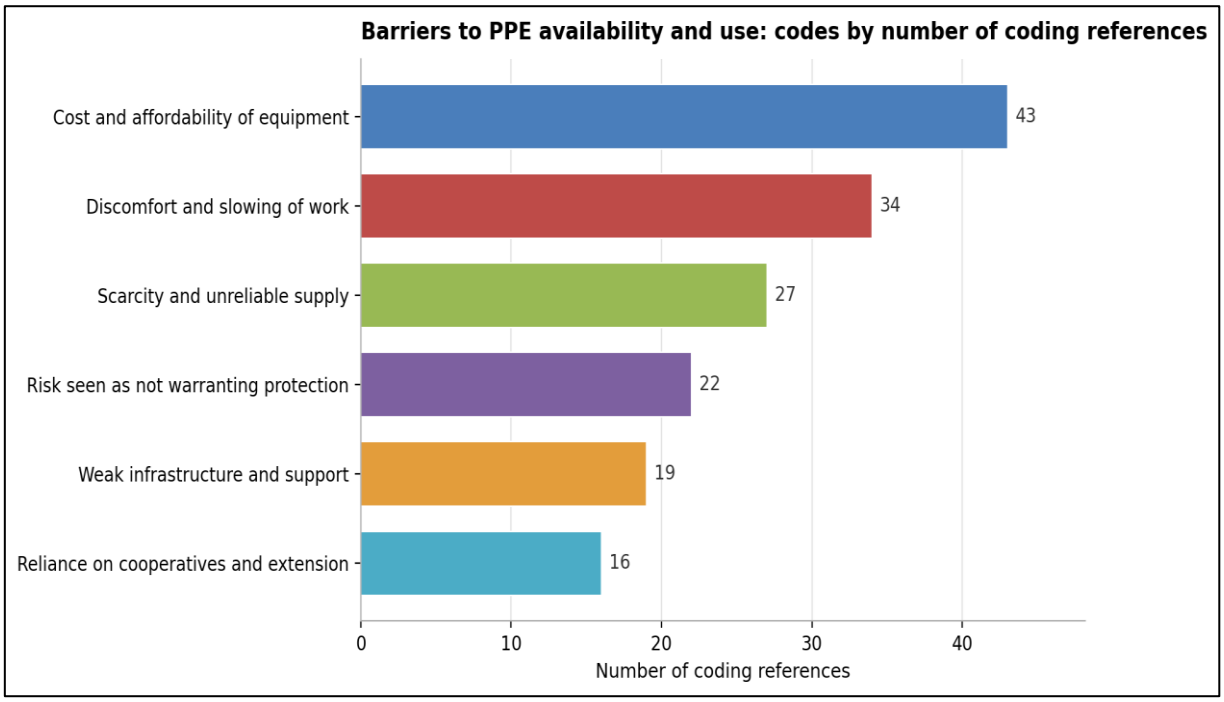

Fig 2 NVivo Chart of Barriers Compared by Number of Coding References
Source: NVivo Thematic Analysis of Field Data (2026)

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jul997

- *Cost and Affordability.*

Participants consistently identified the cost of protective equipment as the principal barrier to its acquisition and use, explaining that items had to be bought from town at prices that were difficult to justify against the modest returns of smallholder pig keeping. This theme accounts directly for the low availability figures in Table 1 and for the finding that almost half of the sample possessed no equipment at all. As one farmer explained:

"If the gloves and boots could come through our cooperative at a fair price, many of us would use them. The problem is not that we refuse, it is that we cannot afford to buy them from town every time."

— Focus group participant, Chipata Central veterinary camp

- *Discomfort and the Slowing of Work.*

The second theme explains the gap between availability and use documented in Table 2. Farmers who owned equipment frequently described it as uncomfortable or as slowing down their work, and this was especially the case for masks, which were both the least owned and the least used item. A veterinary officer observed:

"Even the farmer who has gloves will take them off when the work becomes difficult, because they say the gloves make them slow. The mask they almost never wear, they say they cannot breathe well in it while cleaning the pens."

— Key informant, district veterinary office

- *Scarcity, Risk Perception and Weak Support.*

The remaining themes reinforced this picture. Participants spoke of the difficulty of obtaining equipment locally and of the unreliability of supply, of a perception among some farmers that the risks of the work did not warrant the inconvenience of protection, and of the general weakness of the infrastructure and institutional support available to them. Running through these accounts, however, was a constructive thread, namely the reliance that farmers placed on cooperatives and extension staff, whom they identified as the most credible and accessible channels through which affordable equipment and practical guidance might be delivered.

V. DISCUSSION

The findings of this study establish that personal protective equipment is scarce and unevenly available among pig farmers in Chipata District, that its consistent use lags well behind its availability, and that farm safety infrastructure is underdeveloped and weighted towards production rather than protection. These findings are consistent with the international literature, which has repeatedly documented low availability and use of protective equipment among smallholder and resource-constrained farmers (Drouard et al., 2023), and they extend that literature by providing district-level Zambian evidence from the pig farming sub-sector, which has hitherto been almost entirely absent from the record.

The central contribution of the study lies in its clear demonstration of the gap between the availability and the use of protective equipment. The finding that only eleven of the thirty-one glove owners, and only two of the seven mask owners, used their equipment consistently mirrors the pattern observed among dairy farmworkers in Colorado, where the use of respiratory protection remained low even after a specific biological threat had been recognised, largely because of the practical discomfort of the equipment and gaps in its distribution (Marshall et al., 2024). The qualitative findings of the present study confirm that the same mechanisms are at work in Chipata District, where cost, discomfort and the slowing of work were the dominant barriers to consistent use. This convergence of evidence across very different settings suggests that the availability-to-use gap is a general feature of protective equipment adoption among farmers, and that interventions which focus solely on provision, without addressing the comfort, appropriateness and reliability of supply of equipment, are unlikely to secure consistent protection.

The finding that farm safety infrastructure is weighted towards production-oriented facilities, such as fencing, rather than dedicated safety provisions, such as safe needle disposal systems, is consistent with the wider evidence that smallholder pig farms in Southern and East Africa suffer from pervasive weaknesses in biosecurity and farm-level protection (Simbizi, Moerane and Gummow, 2025); (Fasina et al., 2024). Because many of the same measures protect both the farmer and the herd, the underinvestment in safety infrastructure documented here represents a missed opportunity to improve occupational protection and disease control together.

The hypothesis tests revealed a statistically significant and previously undocumented spatial inequality in occupational health and safety governance across the veterinary camps of the district. The concentration of documented safety policies and safety committees in the larger, better-resourced camps means that farmers in the smaller and more remote camps are systematically less well supported by the formal structures that underpin safe working. This finding echoes the observation that the practical reach of Zambia's occupational health and safety framework into smallholder and informal farming remains limited (Republic of Zambia, 2010), and it has direct implications for the targeting of interventions, since it identifies the specific camps in which governance is weakest and support is most needed. The finding also parallels evidence from the Zambian health sector, where the availability of protective equipment was found to vary meaningfully even within the formal system (Mayimbo et al., 2023), underlining that uneven access to protection is a persistent challenge across Zambian workplaces.

The pattern of protective equipment adoption observed in this study can be understood as the product of a rational, if health-adverse, calculation on the part of farmers

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jul997

operating under severe resource constraints. Faced with equipment that is costly to acquire, uncomfortable to wear and slow to work in, and with hazards whose consequences are often delayed and uncertain, farmers frequently conclude that the immediate burden of protection outweighs its deferred benefit. This calculation is reinforced by the normalisation of risk that characterises much of smallholder livestock keeping, in which bites, scratches and contact with sick animals come to be regarded as an ordinary and unavoidable part of the work. The qualitative theme in which the risk was seen as not warranting protection captures this normalisation directly, and it helps to explain why even farmers who possess equipment do not always use it. Any intervention that seeks to raise consistent protective equipment use must therefore address not only the cost and comfort of equipment but also the perception of risk that underlies farmers' decisions.

The prominence in the qualitative findings of reliance on cooperatives and extension staff offers a constructive route forward. Farmers identified these existing structures as the most credible and accessible channels through which affordable equipment and practical guidance might be delivered, a finding that aligns with the broader evidence that veterinary and extension services represent the natural conduit for safety messaging and biosecurity support in smallholder systems (Abigaba et al., 2022). Delivering protective equipment through cooperatives would not only reduce cost through bulk procurement but would also reach women farmers, who are often underserved by conventional extension, and would embed protection within a trusted social institution rather than leaving it to individual purchase. The convergence of the quantitative evidence on low availability and use, the qualitative evidence on the barriers of cost and comfort, and the institutional evidence on the trusted role of cooperatives points clearly towards an integrated intervention that combines subsidised, locally available equipment with practical training and stronger camp-level governance.

VI. CONCLUSION AND RECOMMENDATIONS

This study set out to evaluate the availability and use of personal protective equipment and supporting infrastructure among pig farmers in Chipata District. It concludes that protective equipment is scarce and unevenly available, that almost half of farmers possess no equipment at all, and that the consistent use of equipment lags substantially behind its availability, so that only a small minority of farmers are consistently protected. It further concludes that farm safety infrastructure is underdeveloped and prioritises production over protection, and that occupational health and safety governance is spatially unequal across the veterinary camps. The overarching conclusion is that the mere provision of protective equipment is a necessary but not a sufficient condition for protection, and that provision must be accompanied by measures that address the cost, discomfort and inconvenience that currently deter consistent use.

Arising from these conclusions, several recommendations are made. First, because cost was found to be the principal barrier to protective equipment use, it is recommended that protective equipment be made available to farmers at subsidised prices through farming cooperatives, which farmers identified as a trusted and accessible channel, and that bulk procurement be used to reduce unit costs and improve the reliability of supply. Second, because discomfort and the slowing of work were found to deter consistent use, it is recommended that the provision of equipment be accompanied by practical, demonstrative training on why and how protective equipment should be used, delivered through the veterinary camp structure and integrated into routine agricultural extension. Third, because occupational health and safety governance was found to be spatially unequal, it is recommended that the establishment of farm and camp-level safety policies and committees be actively supported, with particular attention to the smaller and more remote camps where these structures are currently weakest. Finally, it is recommended that the availability of dedicated safety infrastructure, and especially of safe needle disposal systems, be promoted, given that these facilities were found to be the least available yet are directly relevant to protecting farmers from injury and infection.

By evaluating both the availability and the use of protective equipment, and by documenting the spatial inequality in safety governance across the veterinary camps, this study provides an evidence base on which extension planners, cooperatives, veterinary services and occupational health authorities can act to strengthen the protection of pig farmers in Chipata District and in comparable smallholder settings elsewhere in Zambia.

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