

## EVALUATING OCCUPATIONAL HAZARDS AND PREVENTION STRATEGIES IN AGRICULTURE: CASE STUDY

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**Abstract:** This article explores the multifaceted issues of occupational hazards in agriculture, focusing on common causes, circumstances of accidents, and preventive measures. Agriculture is recognized as one of the most hazardous industries, second only to construction. The study delves into the reasons for the high incidence of accidents, which include a tolerance for risky behaviors, poor engagement, lack of proper risk assessment, and inadequate safety regulations. By analyzing data from the International Labour Organization and other relevant sources, the research identifies the primary risks faced by agricultural workers, such as mechanical, chemical, biological hazards, and accidents involving animals and machinery. The findings highlight the necessity of comprehensive safety education, technological improvements, and legal regulations to mitigate these risks. The goal is to provide a thorough understanding of the current safety landscape in agriculture and to propose actionable strategies to enhance occupational safety and health.

**Keywords:** Agricultural Safety, Occupational Hazards, Risk Management, Prevention Strategies, Safety Regulations

### 1. INTRODUCTION

The International Labour Organization annually reports on occupational diseases among agricultural workers and workplace accidents (Bakirci, 2011). According to these data, 1.3 billion people work in the agricultural sector, with 170,000 fatalities each year due to workplace accidents and occupational diseases (Yalcin et al., 2016). Agriculture is a crucial sector in the economy, not only providing food but also playing a vital role in shaping the economy by offering employment opportunities for millions of people, environmental conservation, and ensuring sustainable social development. However, the bucolic imagery often associated with farming belies the stark reality of the occupational risks involved. Safety in agriculture is not merely a concern; it is an imperative that necessitates urgent and sustained attention. The industry is inherently hazardous, with a prevalence of risks ranging from the use of heavy machinery to exposure to chemicals and extreme weather conditions. Agricultural workers are often in close contact with powerful equipment, while tasks such as lifting, repetitive motions, and working with animals add to the physical strain. The World Health Organization has highlighted that

such workers are at higher risk for fatal and non-fatal injuries, occupational diseases, and respiratory issues compared to other sectors.

Statistics from the International Labour Organization (ILO) reveal a sobering trend: the agricultural sector has one of the highest rates of workplace fatalities, injuries, and illnesses worldwide. These accidents stem from a variety of factors, including but not limited to machinery rollovers, falls from heights, incidents involving livestock, and acute exposure to pesticides and other chemicals. Chronic outcomes are also prevalent, including musculoskeletal disorders from repetitive tasks, hearing loss from constant exposure to loud noises, and respiratory conditions from inhalation of dusts and molds. Unfortunately, currently, especially in small individual farms, agricultural machinery and equipment are several decades old. Consequently, the highest risk of fatal injuries among men is associated with agricultural machinery and tractors (Ciez, 2005; Murphy and Buckmaster, 2003). The reasons behind the high number of accidents in agriculture primarily include the use of inadequate safety measures and training, lack of appropriate personal protective equipment, a high tolerance for risky behaviors, low employee engagement, inadequate risk assessment at workstations, absence of regulations on safety and hygiene in individual agriculture, haste, stress, inadequate personal protective gear, performing equipment repairs without proper qualifications, and insufficient preventive measures (Murphy et al., 2010). The need for a robust safety framework in agriculture is clear. It must prioritize the dissemination of knowledge about the risks and the implementation of comprehensive safety protocols. Understanding these occupational hazards and diseases is the first step towards mitigating their impact. The following sections will delve deeper into the specific hazards present in agriculture, analyze the root causes of accidents and occupational diseases, and evaluate the effectiveness of current prevention strategies, with the ultimate goal of proposing new solutions to enhance the safety and well-being of agricultural workers.

Suggestions regarding risk reduction in such accident-prone sectors as agriculture are invaluable aids in managing industrial activities, including the automotive industry (Mazur, 2018; Ulewicz, 2018), heavy machinery production (Borkowski et al., 2012; Krynke et al., 2022), protection against toxic substances (Radzymińska-Lenarcik et al., 2018), and the energy sector (Mołczan et al., 2022). Risk reductions can be achieved through the application of enhanced structural materials, both steel-based (Ulewicz et al., 2013; Ulewicz et al., 2014) and special alloys (Szczotok, 2023), as well as plastics (Kuciel et al., 2019). Improving material properties significantly influences applied technologies (Szataniak et al., 2014; Guzik et al., 2023), enabling the enhancement of welds (Radek et al., 2018) and interacting kinematic pairs (Kalinowski, 2023), thereby increasing machine reliability. Additionally, one should not overlook passive protective measures, including the use of appropriate warning and protective coatings (Radek and Dwornicka, 2020; Jasiński et al., 2022; Radek, 2023) and continuously provided R&D (Pietraszek et al., 2020).

## **2. LEGAL FRAMEWORK FOR OCCUPATIONAL SAFETY AND HEALTH (OSH) IN AGRICULTURE**

The primary aim of all legal frameworks is to ensure safe working conditions in agriculture and to minimize the risk of accidents, occupational diseases, as well as other health hazards for farmers and agricultural workers.

The legal responsibility concerning safety and occupational hygiene in agriculture should be differentiated between individuals working on their own farms (self-employment) and individuals working under an employment contract (farmers as employers-entrepreneurs). One of the most significant directives in the EU aimed at ensuring the health and safety of workers is the Framework Directive 89/391/EEC, encompassing all employed individuals. Directive 89/391 obliges all employers to conduct risk assessments, document risks, and inform employees about accident prevention and work-related illnesses. However, in the EU, 89.5% of all agricultural holdings are family farms without employees (self-employment), and EU legislative directives are mandatory only for employees, thus not encompassing individual farmers (Jakob et al., 2021). In the European Union, attention has been drawn to the protection of self-employed workers for some time (Recommendation No. 2003/134/EC of February 18, 2003). Individual farmers operate under this form of activity. Unfortunately, concerning agriculture, the issue of occupational health and safety has not been precisely regulated. As Musiał (2006) points out, these recommendations do not have legal regulation (normative) in individual farms. Therefore, in Poland as well as in other EU countries, there is no legal regulation regarding occupational health and safety in individual agriculture, nor is there supervision to ensure compliance of working conditions with occupational health and safety requirements (Report: Safety and health in agriculture). Consequently, family farms are not covered by EU directives. However, self-employed farmers and their families may be subject to national legislation. The legal conditions regarding occupational health and safety in agriculture vary across EU countries. In Denmark and Sweden, legislation only partially applies to self-employed farmers. Farmers in these countries are required to comply with regulations concerning the use of machinery and hazardous chemicals. However, in Finland, Lithuania, and North Macedonia, laws apply solely to employed agricultural workers and not to self-employed farmers. In Denmark, Finland, Montenegro, North Macedonia, and Slovenia, there are no inspections conducted regarding occupational health and safety in farms where self-employed farmers work (Jakob et al., 2021). Similar approaches are observed in Poland (Kowalski, 2022). Individuals employed in agriculture in Poland under an employment relationship are subject to the Labor Code (Kowalski, 2022). Unfortunately, these regulations do not cover individuals working on their own account or performing work under a different basis than an employment contract (Meller, 2006). Farmers are not subject to the Labor Code, hence there is no possibility of enforcing occupational health and safety regulations by the State Labor Inspectorate.

### **3. OCCUPATIONAL HAZARDS IN AGRICULTURE**

In agriculture, there are numerous occupational hazards associated with the nature of work and the environment in which farmers and agricultural workers operate. These hazards include mechanical, chemical, and dust-related risks, biological threats, as well as dangers associated with animals, exposure to noise, and risks related to electricity and machinery.

*Biological Hazards.* Biological hazards include bacteria, viruses, fungi, and other bioaerosols that workers are exposed to during activities such as handling soil, plants, and animals. As stated by Woolhouse and Gowtage-Sequeria (2005), approximately 75% of emerging and re-emerging pathogens are capable of causing infectious diseases in animals (zoonotic pathogens), which means they can be transmitted from animals to

humans (e.g., *Toxoplasma gondii*, *Cryptosporidium parvum*). Preventive measures include vaccination, biosecurity practices, and personal hygiene.

*Animal-related Hazards.* According to the Agricultural Social Insurance Fund, in 2022, the majority of accidents (20.2%) occurred during tasks related to animal handling (KRUS, 2023) Working with livestock involves risks of injuries from kicks, bites, and being pinned or trampled. Effective control measures include proper animal handling training, use of barriers, and understanding of animal behavior to anticipate and prevent incidents (Langley and Morrow, 2010).

*Noise Exposure.* In most agricultural farms, noise measurements are not conducted, likely due to low awareness of the risks associated with noise exposure (Olszewski and Lachowska, 2020). As stated by Solecki (2007), individual farmers are exposed to an average noise exposure of 90.2 dB(A) during an eight-hour workday. The author noted that farmers are significantly exposed to noise during fieldwork. International scientific studies indicate a high prevalence of hearing loss among farmers (Plakke and Dare, 1992). According to Challinor et al. (2000), two-thirds of over 6,000 farmers surveyed in Australia showed signs of hearing impairment caused by noise. Chronic exposure to noise from machinery, can result in permanent hearing loss, a common but preventable occupational illness in agriculture. The use of hearing protection devices and the implementation of engineering controls to reduce noise levels at the source are critical preventive strategies.

*Risks Associated with Electricity and Machinery.* Agricultural settings often involve exposure to electrical hazards, including overhead power lines and electrically powered equipment. Electrocutions occur when equipment or workers come into contact with energized lines. Additionally, machinery with inadequate guarding or faulty electrical systems can lead to accidents. The most common causes of electric shock are insulation failure, connection defects, human errors, mismatch between networks and permissible powers, as well as unfamiliarity with instructions (Stefański and Strawiński, 2008, Woźny 2020; Kielesińska, 2018). Regular electrical safety inspections, proper training on electrical hazards, and lockout/tagout procedures can significantly minimize these risks.

Hurrying through work tasks and frustration due to breakdowns can mentally burden the farmer and may lead to accidents. Accidents are not always a result of human error, often, the machine's condition is a contributing factor. Poorly maintained machinery tends to malfunction, posing a hazard (Cecchini et al., 2013; Skowron-Grabowska, and Sobociński, 2018). Fenollosa-Ribera and Guadalajara-Olmeda (2007) demonstrated that the risk of accidents increases with the age of tractors. The array of occupational hazards in agriculture is extensive and multifaceted. Addressing these requires a scientifically grounded approach that involves risk assessment, the application of engineering controls, personal protective equipment, education, and a culture of safety to prevent accidents and ill health.

#### **4. ANALYSIS OF THE MOST FREQUENT CAUSES OF ACCIDENTS IN AGRICULTURE**

In Poland's individual farms, several thousand accidents occur each year. According to the Agricultural Social Insurance Fund, in 2022, there were 11,649 reported accidents, which was 439 (3.6%) fewer than in 2021, despite a decrease of insured individuals by 3.8%. The accident rate in individual agriculture decreased from 8.4 in 2021 to 8.0 in 2022. The majority of accidents (49.2%) were incidents involving falls of the injured individuals.

Other significant categories of accidents included impacts, crush injuries, and animal bites (12.8% of accidents), followed by entrapment or impact by moving machine parts and equipment (12.1% of accidents), and other incidents (8.8% of accidents). Fatal accidents constituted 0.51% (45 individuals) of all accidents in 2022, with a frequency of 4.1 per 100,000 insured individuals (KRUS, 2023).

The main reasons behind the high number of accidents in agriculture primarily include a high tolerance for risky behaviors, low employee engagement, inadequate risk assessment in workstations, lack of regulations concerning occupational health and safety in individual agriculture, haste, stress, lack of personal protective equipment, performing equipment repairs without appropriate qualifications, and insufficient preventive measures (Murphy et al., 2010).

Accidents in agriculture caused by human factors involve improper farmer behavior, incorrect handling of farm animals, improper use of ladders or platforms during work performed at heights. This category also encompasses improper use of machinery, equipment, and tools, including improper handling of tools and work items, incorrect mounting and dismounting from agricultural machinery, trailers etc., improper operation and use of agricultural machinery and equipment (Molina-Guzmán and Ríos-Osorio, 2020). This group also includes the absence or incorrect use of personal protective equipment, protective and work clothing, as well as the absence of safety devices.

According to Tiwari et al. (2002) and Suutarinen (2004), 'human error' is one of the main causes of accidents in agriculture. Many authors consider 'human error' to encompass execution errors arising from attention or memory disturbances, mistakes and violations (Alper and Karsh, 2009; Salmon et al., 2010). Mayrhofer et al. (2014) state that half of the accidents in agriculture occur during machinery operation. Of these, two-thirds are a result of haste, fatigue, and stress during individual tasks at work (Rautiainen et al., 2004). Accidents in agriculture caused by technical factors include improper farmyard conditions, inadequate conditions of traffic lanes, and maneuvering areas on the farm (Rautiainen et al., 2004). This category also encompasses inadequate technical conditions of building structures (e.g., structural defects in buildings). Additionally, this group includes the inadequate condition of machinery, equipment, and tools (e.g., lack or improper fitting of guards and protections for moving parts of agricultural machinery and equipment) (Cecchini et al., 2013). The quality of machinery and equipment used in farms significantly impacts work safety. Studies conducted in the USA indicated that machines were the leading cause of accidents (Myers, 2005). Accidents in agriculture caused by organizational factors encompass improper work organization (e.g., lack of operating instructions for feeding wagons). This group also includes a lack of personal protective equipment and improper selection thereof. Inadequate passages and approaches (e.g., during cow milking) (Lindahl et al., 2012), improper placement and storage of work items (e.g., hay). Improper positioning of equipment in the workplace (e.g., drinking troughs for animals) (Lindahl et al., 2013). Improper handling of material factors (e.g., improper repairs and inadequate maintenance). In family farms, accidents often occur during self-repairs using non-specialist materials and equipment.

## **5. PREVENTIVE MEASURES AND ACCIDENT PREVENTION IN AGRICULTURE**

Preventing accidents in agriculture requires a focus on proper employee training, the implementation of safety procedures, regular maintenance of machinery and equipment, monitoring working conditions, and raising awareness of the risks associated with the

tasks being performed. Understanding the etiology of accidents in agriculture is a complex endeavor that involves dissecting various contributory factors. The first step before developing a program to prevent accidents in agriculture should be to analyze accidents and potentially hazardous incidents that have already occurred. Agricultural accidents can be caused by both external and internal factors. Scientific scrutiny has shown that these factors are often interrelated, leading to a range of incidents from minor injuries to fatalities.

*Role of education and training.* Education and training play a crucial role in preventing accidents in agriculture. Adequate preparation and training of farmers and agricultural workers can significantly reduce the risk of accidents by helping them understand potential hazards associated with their work. Training on safe use of machinery, proper farming techniques related to crop cultivation and harvesting, animal husbandry, and the use of chemical substances can mitigate the risk of accidents in agriculture (Legault and Murphy 2006).

*Technological advancements and their impact on safety.* Technological advancements play a crucial role in improving the safety of agricultural work. Modern agricultural machinery is equipped with advanced safety systems, reducing the risk of accidents and injuries. Modern farming technologies enable the reduction of pesticide usage, thereby reducing the risk of exposing farmers to harmful chemicals (Khan et al., 2021). Despite the numerous benefits that technological advancements bring to the safety of work in agriculture, there are also risks associated with the adoption of new technologies. The lack of proper training for farmers in operating and safely using new equipment and systems can increase the risk of accidents.

Best practices for accident prevention

*Human Factors and Behavioral Risks.* Human error remains a predominant factor in agricultural accidents. Studies have highlighted that a significant proportion of accidents occur due to the operator's failure to adhere to safety protocols or due to a lack of risk perception (McLaughlin and Mayhorn 2011). A report by the European Agency for Safety and Health at Work has pointed out that insufficient training and failure to recognize hazards contribute to a substantial number of incidents. The implementation of comprehensive training programs and behavioral adjustments, supported by a body of research emphasizing human factors engineering, can mitigate these risks.

*Equipment and Machinery Misuse.* Agricultural machinery, if misused, becomes a conduit for severe accidents. Data from the Polish Central Statistical Office (GUS, 2022) indicates that machinery-related incidents are among the leading causes of agricultural injuries. These often stem from the use of outdated equipment lacking modern safety features, or from bypassing built-in safety mechanisms. According to Mayrhofer et al. (2014), half of the accidents in agriculture occur during machine operation, with two-thirds of them being the result of haste, fatigue, and stress (Rautiainen et al., 2004). The application of ergonomic principles in the design and operation of agricultural machinery can reduce misuse and consequently decrease the accident rate.

*Environmental Conditions.* Agriculture is subject to the whims of nature, which in turn affects the safety conditions. The farmer performs their work not only within livestock buildings and crop storage facilities but also in outdoor areas such as fields, pastures, and yards. Wet or icy conditions can lead to slips, trips, and falls, a common type of accident as per the Agricultural Social Insurance Fund (KRUS, 2023). Environmental ergonomics

suggests modifications such as proper drainage systems, anti-slip flooring, and the use of adaptive clothing to combat these natural adversities.

*Maintenance Issues.* Neglect in maintenance can turn agricultural tools and machinery into hazards. Poland, the Agricultural Social Insurance Fund (KRUS, 2023) has reported that a significant number of accidents are due to equipment failures, which proper maintenance could have prevented. Predictive maintenance, a concept derived from reliability engineering, could be a pivotal strategy in identifying and rectifying potential equipment failures before they result in accidents (Kogler et al., 2015).

*Chemical Handling.* The misuse of agricultural chemicals not only poses a risk of acute poisoning but also long-term health effects (Abhilash and Singh, 2008). In Poland, regulations have tightened around the use of such chemicals, but compliance varies. The integration of chemical safety management systems and the promotion of less hazardous substitutes as recommended by the International Programme on Chemical Safety can lead to a reduction in chemical-related incidents (Becking and Bing-Heng, 1998).

*Lack of Safety Culture.* Agricultural work often takes place in a cultural context where safety is not always the primary concern. The main cause of accidents on farms is human errors, such as improper behavior (Becking and Bing-Heng, 1998). Promoting a safety culture through behavioral change theories like the Health Belief Model may influence workers' attitudes and behaviors towards safety (Guerin and Sleet, 2020). While statistical data specific to Poland is not provided in the current context, it can be inferred from European Union statistics that the patterns observed in Poland likely mirror those seen across other EU countries, where agricultural accidents account for a significant portion of occupational injuries. The use of such data helps in developing targeted interventions for the agricultural sector.

## **6. CASE STUDY: OCCUPATIONAL HEALTH AND SAFETY ANALYSIS ON A SELECTED FARM**

Conducting a safety and hygiene analysis on a farm is an essential step in ensuring safe working conditions for farmers and promoting good agricultural practices.

In the farm in Trzebin, a comprehensive analysis was conducted on a farm that encapsulates the broader occupational health and safety risks inherent in agricultural operations. This case study delves into the various hazards identified, explores the underlying causes of potential accidents, and discusses the preventive actions that were or could be implemented to mitigate these risks.

### **Risk of Accidents and Their Causes**

The farm in question presented several mechanical hazards, typified by exposed moving parts on machinery. Such hazards pose a significant risk for entanglement and amputation. The lack of protective shielding on power take-off shafts and other machinery components was noted as a primary safety oversight.

Operational practices also contributed to the risk landscape. The use of damaged equipment, such as a mower with a compromised safety skirt, and improper load distribution on trailers, were observed. These conditions not only increase the likelihood of accidents through mechanical failure or loss of vehicle control but also suggest a broader trend of insufficient maintenance protocols.

Moreover, the farm's approach to equipment repair was identified as a concern. The inadequate securing of machinery during repair procedures could lead to unintentional movement, risking injury to individuals performing maintenance tasks.

One of the biggest hazards on the analyzed farm is noise. The conducted research revealed that only during the cleaning of the combine with compressed air, the permissible noise standards (85 dB) were not exceeded. The farmer did not use individual noise protection in the form of earmuffs while working with machinery. The results of the noise research on specific workstations in the analyzed farm are presented in Table 1.

Despite the evident risks, preventive measures had been sparingly adopted on the farm. The study identified several areas for intervention that could significantly reduce the risk of accidents. These include the integration of machine guarding, which is a fundamental safety measure that could be readily implemented.

Training and awareness programs were recognized as vital in altering the current practices. Educating farm workers on the correct use of machinery, load distribution principles, and the importance of routine maintenance can transform the safety culture on the farm.

Table 1

Results of the noise measurement in the analyzed farm.

Workstations	Measurement results
Grain combine harvester	93,4 dB
Tractor C-360	93,3 dB
Tractor C-360 with engine hood not installed	93,7 dB
Grain blower	89,0 dB
Chainsaw	107,5 dB
Air compressor – cleaning the combine harvester	75,1 dB
Hammer mill	89,7 dB
Table saw	91,3 dB

Further, establishing a systematic safety inspection routine would ensure that machinery is consistently maintained and that any necessary repairs are carried out with due regard for safety, including the proper securing of equipment.

The findings from this farm are not isolated incidents but are reflective of widespread issues within the agricultural industry. The scientific literature corroborates that mechanical hazards and lax safety practices are leading contributors to agricultural accidents. Implementing a rigorous safety management system, informed by agronomic ergonomics and safety engineering, could serve as a model for reducing accident rates not just in Trzebina but across the agricultural sector.

## 6. CONCLUSION

There are several areas in the Trzebin farm that require immediate repair actions to minimize accident risks and improve work safety. The main hazard is the lack of protective shielding on power take-off shafts and other machinery components. Currently, there is a need for immediate securing of agricultural machinery by covering moving parts (such as drive belts, gearwheels, universal telescopic shafts) in a way that ensures their safe operation. Additionally, there is a necessity to begin renewing the machinery fleet, as the risk of injuries and accidents increases with their age. Also, appropriate safeguards need to be purchased for repaired and maintained machinery.

Noise is a significant health issue for the farmer in the analyzed farm; hence, there is a need to use personal protective equipment at workstations where the noise level exceeds permissible standards.



The farmer is not aware of hazards that could lead to injuries or accidents (mechanical, chemical, biological hazards) on the farm. Therefore, they should undergo appropriate training in equipment operation and safe usage to minimize accident risks.

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