

SOURCES OF ACCIDENTS RISK IN HARVESTING WORK

Summary

Most of activities in agriculture are performed with machines and equipment. In many farms, these objects do not meet basic safety standards. Therefore, it was conducted a survey on 180 farms, whose major purpose was to determine the most common category of accidents at harvest. Main categories include: inappropriate handling of machine and an assessment of the technical condition of appliances. Obtained results show that, most frequently occurring reasons of accidents related with machines are: missing protective covers, missing reflectors and lack of handrails. Among the most common accidents are the following: falls, hits by machine moving parts and hits by the vehicle in motion. It was found that farmers do not respect the principles of safety during handling of machine and do not participate in training courses and workshops of this subject. Therefore, farmers should perform all the activities with full responsibility and use machines in good condition.

Key words: harvest, machine failures, accidents on farms, work safety

ŹRÓDŁA ZAGROZEŃ WYPADKAMI PRZY PRACACH ŻNIWNYCH

Streszczenie

Większość prac w rolnictwie przeprowadza się z wykorzystaniem maszyn i urządzeń o znacznym stopniu skomplikowania. W wielu gospodarstwach rolnych obiekty te nie spełniają podstawowych norm bezpieczeństwa. Mając na uwadze wysoki wskaźnik wypadkowości z udziałem maszyn przeprowadzono badania ankietowe w 180 gospodarstwach rolnych. Głównym celem tych badań była charakterystyka najczęściej występujących kategorii wypadków podczas prac żniwnych oraz ocena stanu technicznego użytkowanego sprzętu. Rolnicy w przeważającej części wskazali na brak obowiązkowych osłon, niedobór odpowiednich poręczy oraz na niesprawne oświetlenie jako główne mankamenty użytkowanego sprzętu. Wśród najczęstszych wypadków z udziałem maszyn wymienia się: upadki osób z wysokości, pochwycenie kończyn operatora przez niezabezpieczone osłonami elementy ruchome maszyn oraz liczne uderzenia i skaleczenia z ich udziałem. Stwierdzono, że rolnicy nie przestrzegają zasad bezpieczeństwa podczas kontaktu z maszyną oraz nie uczestniczą w szkoleniach i warsztatach o tej tematyce. Systematyczne kontrole maszyn oraz odpowiednia wiedza rolników w znaczny sposób przyczynią się do poprawy bezpieczeństwa pracy na wsiach.

Słowa kluczowe: żniwa, usterki maszyn, wypadki w rolnictwie, bezpieczeństwo pracy

1. Introduction

The situation in Polish agriculture after 1989 began to change significantly. It was mainly the result of the transformation, which started a period of dynamic changes. The primary manifestations of that process were the following: an increase in cultivated land area, higher field work performance and more effective management of the financial capital. However, negative farming effects accompanying the positive aspects also appeared. They were the rush and stress, which very often contribute to an increased risk of an accident or body injuries at work [8, 17].

In 2005 in Poland there were 1,782 thousands farms, whereas in 2012 only 1,583 thousands farms of the land area over 1 ha. Year after year the amount of machinery used in agriculture has been growing, which is reflected in the growing number of tractors used in individual farming. In 2011 in Poland there were 1 471 thousands tractors and 152 thousands combine harvesters. Polish farmers had total of 198 thousands balers [10, 12].

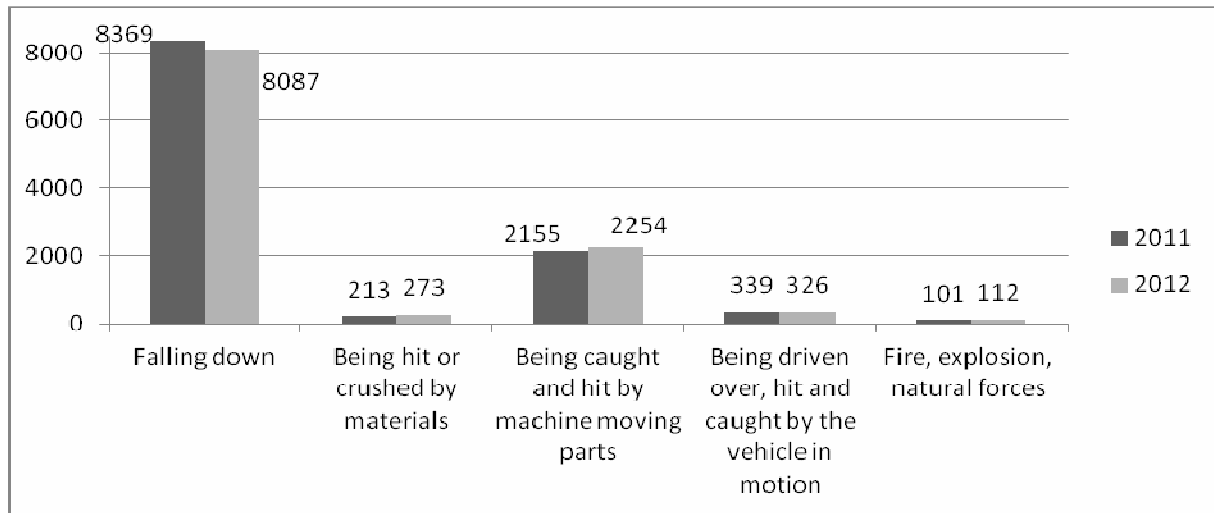
Appropriate use of each agricultural machine reduces the potential risk of an accident at work. An accident is defined here as such an event which was caused by external circumstances, was related to work and caused injury [3]. These criteria also apply to an accident at work in agriculture [2, 8]. A person working on the farm during the work-

ing day undertakes numerous different jobs that often require different skills. It is accompanied by a large variation of adverse factors. All this leads to the fact that agriculture/farming involves a relatively high number of accidents compared to other sectors of the industry. The frequency rate of accidents in agriculture is over twice as high as in other sectors of employment [5, 14]. One of the most dangerous period for health of farmers is harvesting. Figure 1 shows the most common risks associated directly with the process of harvesting.

Falling down of people involved in agricultural work are the most common events which occurred in the country between years 2011 and 2012. This tendency can mainly be related to the lack of consideration and caution when working at heights and to the lack of required security for the applied devices or machines. Frequently farmers were caught and hit by machine moving parts. In 2011 there were 101 accidents related to fire, explosion and natural forces.

2. Purpose and research methodology

The variety of work and activities in agriculture and a wide range of applied machines and equipment make it hard to directly assess the risk connected with the farming profession. Therefore it is necessary to identify and analyse risks concerning individual farming tasks and activities.



Source: KRUS press report on accidents at work and occupational diseases of farmers in 2012

Fig. 1. The number of accidents in agriculture related to the operation of machines in 2011 and 2012

For this purpose, a survey was carried out directly on farms. Farmers as the main group of respondents comprised 90% of the analysed population; the remaining 10% were members of the farmer's family. The study was carried out during the harvesting season in 2012 in the province of Lower Silesia and Łódź. In total, based on a random sample, data from 180 farms were obtained. A questionnaire used in this case as the primary measurement tool provided abundant data to perform a statistical analysis and draw useful conclusions.

The main objective of this article is to analyze the risks in agriculture, including works connected with collection of cereals. Recognition of these risks at work will help to identify ways of protection against these threats, which may contribute to the improvement of safety in farming. Moreover, the article discusses the most likely accidents at selected harvesting activities and specific ways to reduce the risk.

3. Collection of grain by combine harvester

The specificity of this process includes the collection of the entire mass remaining in the field, i.e. the grain and straw. Obtaining wheat grain already separated from the straw is made in one-step procedure using a combine harvester, in which successive steps (cutting, threshing and cleaning) allow to leave in the field the seed-free straw exclusively. Those combine harvesters are powered by a diesel engine. The remaining straw is collected in the form of bales obtained during treatment. Additional procedures in harvesting cereals are loading operations and transporting the collected materials [1].

Another activity associated with grain collection is the collection of cereal straw. In order to use it as bedding and feed for animals the straw is pressed or formed into bales. The following bales can be distinguished here: small rectangular bales (weighing about 10 kg), large rectangular bales (ca. 200 kg) and a large-scale roll bales (ca. 400 kg). Compressed straw is loaded on vehicles the design of which depends on the weight of bales. Loading and unloading of small bales is carried out manually; large-size ballots require the use of tractor-mounted loaders or telescopic loaders [14].

The results of the analysis have shown that the main reasons for accidents on farms are the following: wrong

methods of doing some work, lack of caution, routine, haste, fatigue, poor work organization, ignoring the risks involved, poor technical condition of machinery and equipment as well as the difficult financial situation of households [4]. The most important factor influencing the possibility of an accident is the lack of farmers' awareness of the risks associated with the performance of a particular job. Noteworthy is the fact that people working in agriculture are rarely involved in the training on health and safety at work, which concerns both individual farmers and agricultural enterprises employees [9].

Analyzing the risks related to the harvesting of cereals, each of the above steps is a potential source of an accident or injury. Among the most common events is catching the farmer's limb by the moving parts of a machine lacking the required safety guards. The potential elements that can harm the operator include driving components such as gears and crimson-wedge header elements (reel, auger-finger feed, inclined conveyor). Two main causes of such events are taken into consideration:

- cleaning working items without switching off the drive. This situation happens very often when sets of working elements get blocked by excess material.
- making some adjustments and minor repairs when the drive is in the working mode.

Repairing the harvest combine often involves cuts caused by the body contact with the sharp edges.

Carelessness and rush are usually the main reasons for accidental hitting against machine components. Due to the large dimensions of the machine and the operator's position at height, frequent accidents are connected with people who accompany the farmer in the machine, are not involved in harvesting and fall out of the machine [3]. Among the more significant threats, the possibility of self-ignition of the vehicle should be indicated, as the work in air temperatures of about 30°C influences the engine area temperature exceeding 100°C, thus creating a risk of fire as well as a possibility of being hit by high pressure fluid stream. The harvester is a complex machine built up of a large number of moving mechanisms. Therefore, the operator may be hit by rotating parts of the vehicle. Loud noise and vibration are also integral parts of the operator's work. Due to spending long hours at one workplace without a properly noise-screened cabin, the operator is exposed to the average noise level ex-

ceeding the acceptable norm of 85 dB, often reaching up to 100 dB, which results in hearing defects. One of the integral elements of the farmer's work as a combine operator is exposure to dust from the field, which adversely affects the human respiratory system [9, 15]. The cutterbar assembly has a relatively hazardous cutting element. A direct contact with it can lead to cuts and wounds, and even amputation of limbs if the strip is in motion [3]. The operator's position on the combine requires a fixed ladder. It may cause two risks:

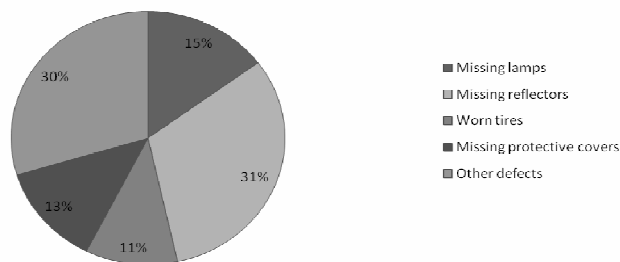
- the operator's falling down from the ladder when entering or leaving the cabin (about 12% of all accidents involving harvesters);
- falling down from the ladder of other people standing on the ladder while the combine is moving.

The latter case in particular may have dangerous consequences, when the person who has fallen down the ladder is driven over by the vehicle. The combine operator should therefore pay attention to all the people who are close to the combine. Standing on the entrance ladder should not be accepted [7]. It is also vital to keep the combine in good working condition. The maintenance mainly involves the machine elements which are exposed to straw and grain dust. Bearings are such an element that can be damaged when not maintained (lubricated) properly, which increases the risk of fire. Another source of fire at harvesting work is a defective electrical system of the combine. To reduce the risk of fire, electrical connections and battery terminals should be checked regularly and the engine and exhaust systems should be regularly cleaned from dust. It is necessary to provide the combine with the hand fire-fighting equipment. It is recommended to equip the combine with at least two fire extinguishers containing 2 kg of extinguishing agent [4, 6].

Selective checking on farms during the harvest shows many irregularities in the use of combine harvesters. This is often due to ignorance and lack of awareness in terms of working environment for farmers and the potential negative consequences of improperly performed work. The research shows that only 43% of farmers participate in trainings and workshops organized by the Agricultural Advisory Centres aiming at improvement of safety on farms.

Therefore sufficient education of farmers is vital in order to effectively reduce the risk of accidents while using agricultural machinery.

The information has also been collected on the number of farms where safety regulations are adhered to when working in agriculture at least to the extent determined by the respondents. For 134 people providing answers, in 58% the response was positive, which means that all the works on the farm are carried out with the utmost care and consideration, as shown in Figure 2.



Source: own study

Fig. 2. The most common defects of agricultural equipment (including equipment for harvesting cereals) in 2011

It is true that in recent years the number of new machines has increased, but still many combines used in Poland are old and worn, and thus they fail to meet the required standard [2]. The main defects of the equipment used to harvest grain (mainly harvesters) are similar to those of most agricultural machines and include:

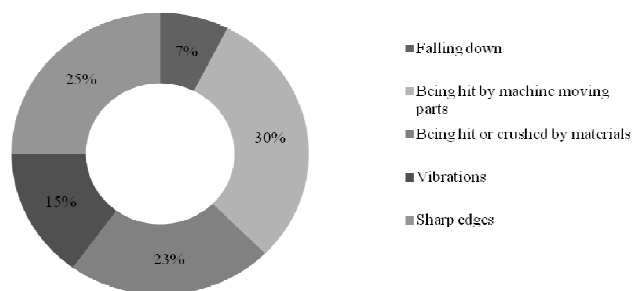
- unsecured moving parts of mechanisms,
- improper labeling when moving on public roads,
- damaged components and light-elements,
- inefficient (excessively worn) tires [5].

The structure of the defects mentioned above is shown in Figure 2, where the majority of cases refer to the none of the sufficient lighting equipment (31%) and protective covers (15%) in a large number of agricultural machines. In addition 11% of all defects concerned a poor condition of tires.

4. Straw pressing

For straw harvesting baling presses are very often used. In the popular press a straw is followed by pick-up and reel. These elements are often clogged, so it is necessary to clean them. Sometimes farmers are trying to remove the excess of straw without disconnecting the drive operating mechanisms. As with the harvesters, the greatest threat in pressing straw is catching a worker by moving parts of the machine. Because the presses are aggregated with agricultural tractors, during compression there are also risks specific to operating a farm tractor [14].

There are several types of presses with different dimensions and mode of action. However, in each of them there is a large number of moving parts (drive systems, pickup, pressing and binding mechanisms). Another threat typical of presses is exposure to sharp edges, especially of the parts of the binder what is shown in Figure 3. Based on results, the most part of questioned farmers were hit by machine moving parts and injured by sharp edges. About 15% farmers fell down from the vehicle and in a few percent of the cases recorded a severe vibration in the workplace.



Source: own study

Fig. 3. Percentage of accidents in agriculture related to pressing straw in 2011

Balers are in the group of machines with an average share of the total number of accidents, but the severity of accidents involving presses is relatively high [3]. It's unacceptable to use the shaft without guards or with broken screens - there is a high risk of the worker's garment being caught by a rotating shaft and thus winding up a limb, which usually ends in serious injury. A little bit safer group of machines are balers because they do not have a binding mechanism, and the mechanism design reduces the risk of capturing the sheaving operator. In the case of these presses

there is, however, an increased risk of crushing the worker as the bale weight is greater than the square balers [3]. While pressing the straw there is a high risk of fire, so it is vital to ensure a good condition of the tractor's electrical system and the presence of fire-fighting equipment.

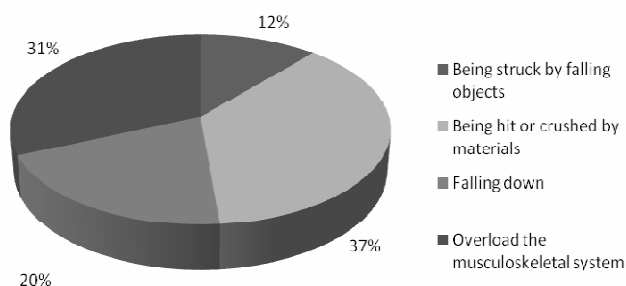
5. Transport of grain and straw

Generally on Polish farms, tractors are used as main transportation means in 70-90% of all transportation work. In the west Europe this indicator is about 2-10%. There are many reasons of dangerous situation caused by agricultural vehicles on Polish roads. First of all is dangerous and outdated inertia brake system used in towed machines and trailers. Second issue concerns a limited velocity of agricultural tractor-trailers which reaches a speed of units (25-45 km·h⁻¹). Sometimes technical condition of these vehicles is poor. In this group of risks may be mentioned a leakages from outdated farm tractor's power hydraulic circuits [11, 13].

Many of the risks are also caused at the last stage of the harvest of grain from fields - during transport. Frequently it is not only the movement of the load that generates a risk, but the defective preparation process before transporting. Transport of grain and straw is carried out with the use of aggregate trailers with agricultural tractors. Preparation of the trailer before usage involves checking its condition and attaching it to the tractor [11]. The latter activity generates the risk of injuries due to crushing the hand. Another possible injury is crushing the worker's feet with the trailer drawbar falling down from the trailer if not hooked properly due to the lack of a required attaching spring [3, 6].

Both the loading and unloading of grain is normally automatic, but it is necessary to be careful during these activities. It should be noted that grain pouring can generate a huge amount of dust. If the trailer is unloaded inside a building it is necessary to use the respiratory system protective equipment [5]. Grain transport on public roads can be done only if the sides of the trailer are secured against accidental opening and after covering the grain with a tarpaulin or cloth, which prevents the seeds from spilling while being transported. The proper condition of the braking system of trailers is of the utmost importance, the lack of brakes on the trailer leads to an intense push by the tractor trailer at braking [5, 6].

Figure 4 shows a percentage distribution of accidents of transportation during harvesting work. Based on the research, 37% farmers were hit or crushed by materials and 31% them were stuck by falling objects. The least percentage of accidents concerned: falling down and overload the musculoskeletal system.



Source: own study

Fig. 4. Percentage distribution of accidents in transport during harvesting work

Activities related to loading and transport of straw are more labor-consuming and often require the use of additional hardware. Small bales are usually loaded manually on the trailer and laid there. A worker's movement on straw is connected with difficulty in maintaining balance, which creates a risk of falling from the trailer (trailer's loading height may reach 4 m). The collapse from the trailer may also be due to sliding off the straw or the driver not signaling the start of the vehicle's movement [3, 11]. Regarding the above reasons, while loading the straw, it is necessary to exercise caution and use ladders enabling safe descent from the loaded trailer. Each start of the tractor's movement should be signal.

Large bales are loaded on special trailers with the use of mobile loaders or loaders mounted on tractors. Working near such loads is hazardous because there is a risk of crushing the worker by the bale. Straw loading with a loader carries the risk of the loader falling over due to the loss of balance while raising the load too high [6, 10]. Moreover the risk of contact of the loader boom with obstacles increases. It can be particularly dangerous when the boom accidentally meets the power lines. It must be ensured that during the loading and unloading work the engine of the vehicle is switched off, and if transport vehicles are set on a hill, they should be secured from sliding down [6].

Transport of straw on a public road carries a risk of bales falling onto the road, which could cause a traffic hazard. It is therefore appropriate to secure the load. The negative habit observed in the transport of straw is taking passengers on a loaded trailer. Apart from the risk of the people falling down from the height, the passengers are exposed to being hit by the objects in the road (e.g. branches of trees). It should be noticed that the highly loaded trailers are less stable, and the transported straw can easily slide off. When driving, avoid situations which cause the loss of aggregate stability [3]. The maximum height of cargo transported by an agricultural trailer is 4 meters, and the maximum width - 2.5 meters. A convenient way to protect bales from falling out of the trailer is to use special belts preventing movement [5, 6].

6. Summary

In the described activities related to the collection of cereals the main threat, which is directly related to the use of machines is catching and pulling the worker by moving parts because most machines have a powerful drive system with a large amount of gears that can be a source of rapture. Analyzing the described cases, a conclusion may be drawn that accidents involving machinery are generally caused by two reasons:

- poor condition of the machine (no guards on moving parts, worn tires and defective lighting, faulty articulated telescopic shafts),
- workers' inappropriate behavior in contact with machines: technical troubleshooting (removal of blocking material) and adjustments performed without switching off the machine drive.

The most common defects of agricultural machinery based on the research are mainly lack of protective covers, lack of lighting and worn tires. However, negative phenomenon during transport are harvesting vibration and overload the musculoskeletal system. In many cases in terms of lack of caution and awareness agricultural machin-

ery mentioned falls from height, which often caused injury. High level of security in harvesting could be achieved only by raising the awareness of farmers to normal operation and modernization of the available machines.

7. References

- [1] Banasiak J.: Agrotechnologia. Wyd. Naukowe PWN, Warszawa, 1999.
- [2] Biuro Prewencji i Rehabilitacji KRUS.: Ochrona zdrowia i życia w gospodarstwie rolnym. Warszawa, 2006.
- [3] Bridger R.S.: Introduction to ergonomics. Third Edition, CRC Press Taylor and Francis Group, Parkway, New York, 2009, s. 639.
- [4] Cież J., Łuczycza D., Szewczyk A.: Zagrożenie wypadkowe w gospodarstwach rolnych – materiały szkoleniowe CIOP, Warszawa, 1999.
- [5] Główny Inspektorat Pracy.: BHP w rolnictwie – materiały informacyjne, Warszawa, 2008.
- [6] Ministerstwo Rolnictwa i Rozwoju Wsi.: Bezpieczeństwo i higiena pracy w rolnictwie – przegląd dorobku i rekomendacje dla polityki w tym zakresie, Warszawa, 2008.
- [7] Jaworski H.: Dziesięć lat dobrowolnej atestacji wyrobów na "znak bezpieczeństwa KRUS" w aspekcie zapobiegania zagrożeniom wypadkowym w rolnictwie indywidualnym. W: Chemiczne zagrożenia w rolnictwie - stan aktualny i perspektywy. Praca zbiorowa pod red. Nazimek T., Solecki L. 38 seria wyd. Monografie Instytutu Medycyny Wsi, Lublin, 2006, s. 403.
- [8] Kobielski W.: Wypadki przy pracy i choroby zawodowe rolników tendencje zmian. *Więś i Rolnictwo*, 2005, nr 4 (129), s. 3-4.
- [9] Mandes A., Waszkiewicz Cz.: Analiza wypadkowości w polskim rolnictwie. *Technika Rolnicza, Ogrodnicza, Leśna* nr 4, 2011, s. 1-2.
- [10] Pawlak J.: Kombajny do zbioru zbóż i roślin okopowych w rolnictwie polskim. *Problemy Inżynierii Rolniczej*, 2012, z. 4 (78), s. 46-48.
- [11] Pawlak J.: Zasady bezpieczeństwa w transporcie rolniczym. Materiały instruktażowe OIP Zielona Góra, Warszawa, 2006.
- [12] Pawlak J.: Zakupy ciągników rolniczych w Polsce w ujęciu regionalnym. *Problemy Inżynierii Rolniczej*, 2012, z. 3 (77), s. 35-44.
- [13] Pawłowski T., Dubowski A.: Nowa generacja środków transportu rolniczego jako efektywny sposób poprawy bezpieczeństwa transportu krajowego i międzynarodowego w Polsce. Przemysłowy Instytut Maszyn Rolniczych w Poznaniu, Materiały konferencyjne, Poznań, 2011.
- [14] Puślecki D.: Zjawisko wypadkowości w rolnictwie. *Roczniki Naukowe Stowarzyszenia Ekonomistów Rolnictwa Agrobiznesu*, Poznań, 2006, tom VIII, zeszyt 4, s. 291-296.
- [15] Rączkowski B.: Szkolenie wstępne, instruktaż stanowiskowy – typowe zagrożenia dla pracy w rolnictwie: młynarz, rolnik – hodowla zwierząt, rolnik – uprawa roślin, traktorzysta. Wyd. ODDK, Gdańsk, 2005.
- [16] Solecki L.: Zagrożenia fizyczne w rolnictwie. Wyd. Instytutu Medycyny Wsi, Lublin, 1999, s. 57-65.
- [17] <http://isap.sejm.gov.pl/DetailsServlet?id=WDU19910070024>.