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ANALYSIS OF SAFETY AND CAUSES OF ACCIDENTS AT WORK IN AGRICULTURE IN POLAND

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Abstract: *The article analyzes the dynamics of accidents at work in agriculture in Poland in 2020–2021, taking into account factors influencing their occurrence and the effectiveness of preventive measures. Data comes from the Agricultural Social Insurance Fund, the Central Statistical Office and research by scientific institutes. It has been shown that the number of accidents decreased by over 50% in the period under review, but agriculture remains one of the most dangerous sectors of the economy. The main causes are technical defects of machines, lack of occupational health and safety training and work in inappropriate conditions. The conclusions indicate the need for further modernization of farms and intensification of training.*

Keywords: accidents, work in agriculture, prevention, work safety.

1. INTRODUCTION

Agriculture, as one of the basic branches of the national economy, plays a key role in ensuring food security, maintaining ecological balance and supporting sustainable development of rural areas. At the same time, it remains one of the most accident-prone sectors of professional activity, both in Poland and in other European Union member states. Accident statistics indicate that the number of incidents at work in agriculture remains at a relatively high level, despite technological progress, mechanization of field work and intensification of preventive measures carried out by institutions responsible for occupational safety (Pac, 2002; Pac, 2024a; Pac, 2024b). The characteristics of work in agriculture include a number of features that increase the risk of hazards: variability of weather conditions, physical intensity of work, multitasking, low saturation with safety procedures and frequent lack of technical and formal supervision. This situation is particularly visible in individual farms, which dominate the agrarian structure of Poland. In addition, work in agriculture is often performed by older people with a lower level of vocational education, which negatively affects compliance with occupational health and safety (OSH) rules. (Kowalski & Białkowska 2021; Centralny Instytut Ochrony Pracy – Państwowy Instytut Badawczy, 2023).

From a research perspective, it is important not only to capture the scale of the accident phenomenon, but also to identify its conditions, causal structure and socio-demographic determinants (Jędrasik-Jankowska, 2013; Jędrasik-Jankowska, 2003; Pac, 2006; Pac, 2018). A comprehensive analytical approach, combining empirical data with the assessment of organizational, technical and human factors, allows for a better understanding of the mechanisms leading to accident events and the formulation of effective prevention strategies. (Kordecka, 2008; Kordecka, 1997; Pac, 2022; Pac, 2023).

2. MATERIALS AND METHODS

The aim of the work is to conduct a multi-aspect analysis of the causes of accidents at work in the agricultural sector, taking into account the classification of risk factors, the characteristics of typical accident events and the presentation of statistical data illustrating the scale and dynamics of the phenomenon in 2020-2021. The analysis was based on available reports of the Central Statistical Office (GUS), the Agricultural Social Insurance Fund (KRUS) and scientific literature on work safety in agriculture in Poland.

The work includes a detailed analysis of data for 2020-2021 in the scope of:

- Structure of accidents by type of work performed;
- Structure of accidents by type of machinery and equipment;
- Causes of accidents by category (human, organizational, technical, other);
- Accidents by time of day;
- Accidents by day of the week;
- Accident rate and frequency of fatal accidents by voivodeship;
- Accident rate by province;
- Fatal accident rate by province.

3. RESULTS

The hazards occurring in the agricultural work environment are multifaceted and result from the impact of mechanical, biological, chemical and psychosocial factors (Matczak & Szpak 2022). The most frequently identified hazards include:

- Exposure to changing weather conditions – working in the open field implies the risk of overheating, hypothermia, dehydration and falls caused by reduced surface adhesion.
- Operating agricultural machinery and equipment – contact with moving parts of mechanisms is a significant source of injuries, especially in the context of improper technical condition or lack of protective covers.
- Hazards resulting from contact with farm animals – unpredictable behaviour of animals and errors in the organisation of work when handling them may result in bodily injuries of varying degrees of severity.
- Impact of chemical substances and biological factors – contact with mineral fertilizers, plant protection products, mycotoxins or organic aerosols increases the risk of poisoning, allergies and occupational diseases.

When analyzing the etiology of accidents in agriculture, the causal factors can be classified into four basic categories (Nowak, 2020; Kasa Rolniczego Ubezpieczenia Społecznego, 2023; Różański, 2023):

1. Technical factors:
   - deficiencies in the technical efficiency of machines and devices,
   - lack of mandatory protection of moving elements,
   - use of equipment not in accordance with its intended use or technical specification.
2. Organizational factors:
   - insufficient level of training in the field of occupational health and safety,
   - lack of operational procedures or their non-implementation,
   - improper planning and supervision of work processes.
3. Human (behavioral) factors:

- excessive physical and mental fatigue,
- reduced risk perception and routinization of professional behavior,
- undertaking work under the influence of psychoactive substances (alcohol, medicines, drugs).

4. Environmental factors:
   - unfavorable microclimatic conditions,
   - varied topography of the work area,
   - insufficient lighting of workstations.

The elements defining an accident at work are: suddenness, external cause, injury or death of the employee and connection with work. Sudden event – an event characterized by the employee's surprise, something unpredictable, unexpected, sudden. External cause – a cause outside the employee's body. Injury – damage to body tissues or human organs. Work-related – occurs when there is a temporal, local and functional connection of a given event with work. An accident at work is considered to be an event (Świder & Piotrowski 2021): 1) sudden; 2) caused by an external cause; 3) resulting in injury or death; 4) which occurred in connection with work:

- during or in connection with the employee performing ordinary activities or orders from superiors;
- during or in connection with the employee performing activities for the employer, even without an order;
- while the employee was at the employer's disposal on the way between the employer's registered office and the place of performing the duty resulting from the employment relationship.

The analysis and characteristics of accidents at work in agricultural activities in Poland are conducted by the Agricultural Social Insurance Fund (KRUS). At the beginning of KRUS's operation, over 60,000 accidents were reported to organizational units annually (in 1993 - 66,000) (Kobielski, 2005). In recent years, a significant decrease in the number of accidents has been noted. In 2021, 12,000 were recorded. i.e. over 80% less, and the accident rate understood as the number of accidents ending with the payment of one-off compensations per 1,000 insured persons decreased in this period from 24.6 to 8.4.

This paper provides a detailed analysis of the structure of accidents over two years (2020-2021). During this period, 9,770 accidents were recorded in 2020 and 11,267 accidents in 2021, respectively. One of the main analyses that allow for the characterization of the accidents in question is the structure presented in terms of the type of work performed. A summary of data on the structure of accidents in 2020-2021 by type of work performed is presented in Table 1 below.

Table 1. Structure of accidents in 2020-2021 by type of work performed

Type of work performed	**Number of accidents**		**Share in %**		**2021-2020**	**2021/2020 in %**
	2020	**2021**	**2020**	**2021**		
Moving without load (to and from a location)	1 573	2 058	16.1%	18.3%	485	130.8%
Manual transport work - walking with carrying in hands, on shoulders, etc.	1 163	1 523	11.9%	13.5%	360	131.0%
Transport of loads using wheelbarrows, trolleys, etc.	137	116	1.4%	1.0%	-21	84.7%
Mechanical transport of animals, agricultural products and means of production	188	182	1.9%	1.6%	-6	96.8%
Work at heights (trees, stacks, piles, attics, lofts, scaffolding, etc.)	732	787	7.5%	7.0%	55	107.5%
Work in excavations, tanks and depressions	16	6	0.2%	0.1%	-10	37.5%
Cleaning work in the farmyard	226	312	2.3%	2.7%	86	138.1%
Agricultural work at home	74	86	0.8%	0.8%	12	116.2%
Maintenance, renovation, construction and demolition of buildings	353	318	3.6%	2.8%	-35	90.1%

Operation and use of agricultural machinery and equipment (including aggregation and adjustment, work in the field, orchard and meadow)	1 142	1 326	11.7%	11.7%	184	116.1%
Overhaul and repair of machinery and agricultural equipment	555	639	5.7%	5.7%	84	115.1%
Timber harvesting and processing (preparation of fuel, building material, etc.)	874	877	8.9%	7.8%	3	100.3%
Preparing pet food (steaming, grinding, etc.)	161	189	1.6%	1.7%	28	117.4%
Animal care (feeding, milking, zoohygienic treatments, driving away, etc.)	1 956	2 166	16.1%	1.7%	210	110.7%
Manual work on the farm, including the use of simple tools (rakes, hoes, forks, knives, secateurs, etc.)	269	294	16.1%	18.3%	25	109.3%
Processing of agricultural products (fruit, vegetables, meat, milk, cereals, etc.)	38	41	16.1%	18.3%	3	107.9%
Dealing with official matters, purchasing means of production, etc.)	49	53	16.1%	18.3%	4	108.2%
Other	264	294	16.1%	18.3%	30	111.4%
Total	**9 770**	**11 267**	**100,0%**	**100.0%**	**1 497**	**115.3%**

Source: Own study based on data from the Agricultural Social Insurance Fund

Analyzing the data in Table 1, it can be seen that most accidents occurred during work related to animal handling, e.g. feeding, milking, zoohygienic procedures, driving, etc. (1956 and 2166 accidents, i.e. 20.0% and 19.2%, respectively), moving around the farm without a load (1573 and 2058 accidents, i.e. 16.1% and 18.3%, respectively) and manual transport work (1163 and 1523 accidents, i.e. 11.9% and 13.5%, respectively).

When analyzing accident events in the analyzed period of 2020-2021, attention should also be paid to the size and structure of the number of accidents involving machines and devices used in agricultural activities (Table 2).

Table 2. Structure of accidents in 2020-2021 by type of machinery and equipment

Type of machines/devices	Number of accidents		Share in %		2021-2020	2021/2020 in %
	2020	2021	2020	2021		
Agricultural tractors	784	939	20.6%	22.2%	155	119.8%
Means of transport (passenger cars, motorcycles, bicycles, public transport, etc.)	131	148	3.4%	3.5%	17	113.0%
Means of transport (trailers, horse-drawn carts, delivery vans, etc.)	528	508	13.9%	12.0%	-20	96.2%
Cultivation machines and tools (harrows, ploughs, cultivators, etc.)	119	170	3.1%	4.0%	51	142.9%
Machines and equipment for sowing, planting, fertilizing and irrigation, including:	156	177	4.0%	4.2%	21	113.5%
grain seeders	32	34	0.8%	0.8%	2	106.3%
potato planters	17	24	0.4%	0.6%	7	141.2%
manure spreader	58	72	1.5%	1.7%	14	124.1%
fertilizer spreader	21	30	0.6%	0.7%	9	142.9%
other machines and devices for sowing, planting, fertilizing and irrigation	28	17	0.7%	0.4%	-11	60.7%
Machines and tools for plant care (for field, vegetable and fruit production, etc.)	70	77	1.8%	1.8%	7	110.0%
Machines and devices for plant protection (including dressing) and disinfection (e.g. sprayers, dressing machines, etc.)	52	50	1.4%	1.1%	-2	96.2%
Machines and equipment for harvesting crops, including:	302	361	7.9%	8.5%	59	119.5%

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combine harvesters	116	131	3.1%	3.1%	15	112.9%
combines and other machines for root harvesting	55	78	1.4%	1.8%	23	141.8%
machines for harvesting hay, straw and green fodder	118	129	3.1%	3.0%	11	109.3%
other machines and equipment for harvesting crops	13	23	0.3%	0.5%	10	176.9%
Threshing machines and equipment, dryers and auxiliary equipment	15	37	0.4%	0.9%	22	246.7%
Machines and devices for cleaning and sorting crops and fruits	22	23	0.6%	0.5%	1	104.5%
Machines and equipment for feed processing (grinding machines, mixers, etc.)	67	79	1.8%	1.9%	12	117.9%
Machines and equipment for animal breeding and husbandry (for feeding, removing manure, caring for animals, etc.)	93	100	2.4%	2.4%	7	107.5%
Machines and equipment for timber harvesting and processing:	742	759	19.5%	17.9%	17	102.3%
circular saws	402	382	10.5%	9.0%	-20	95.0%
Chainsaws	235	259	6.2%	6.1%	24	110.2%
other equipment for obtaining and processing wood	105	118	2.8%	2.8%	13	112.4%
Other machines, devices and tools, including:	731	810	19.2%	19.1%	79	110.8%
hand power tools	265	298	7.0%	7.0%	33	112.5%
other machines, devices and tools	466	512	12.2%	12.1%	46	109.9%
Total	**3 812**	**4 238**	**100.0%**	**100.0%**	**426**	**111.2%**

Source: Own study based on data from the Agricultural Social Insurance Fund

Among all accident events recorded in the period under review, the high rate of accidents involving machinery and equipment used in agricultural activities is noteworthy. In 2020, the share of accidents in question was 39.0% (3,812 accidents) and in 2021 37.6% (4,238 accidents). Most of them occurred while operating agricultural tractors (20.6% and 22.2%, respectively), other machinery and equipment (19.2% and 19.1%, respectively) and various types of machinery for obtaining and processing wood (19.5% and 17.9%, respectively). With the participation of machinery and equipment, the most common events were from the following groups:

- ✓ catching, hitting by moving parts of machinery and equipment - 1,398 accidents, constituting 32.7% of all accidents involving agricultural machinery and equipment;
- ✓ falling of persons - 1,187 accidents, i.e. 27.8%; - other events (other events causing damage to health) – 531, i.e. 14.1%.

Available KRUS publications and studies on accidents in agricultural activities in the period under review also allow for characterizing the causes of accidents. The causes of accidents in 2020-2021 by category are presented in Table 3.

Table 3. Causes of accidents in 2020-2021 by category

Category of causes	**Number of accidents**		**Participation (%)**		**2021-2020**	**2021/2020 (%)**
	2020	**2021**	**2020**	**2021**		
Human:	**5 653**	**6 346**	**57.9%**	**56.3%**	**693**	**112.3%**
– improper conduct of the farmer	1 993	2 301	20.4%	20.4%	308	115.5%
– improper use of machines, devices and tools	1 220	1 441	12.5%	12.8%	221	118.1%
– the psychophysical condition of the farmer, which does not ensure safe performance of work	467	576	4.8%	5.1%	109	123.3%
– failure to use work safety and security devices	1 217	1 340	12.5%	11.9%	123	110.1%
– inappropriate behavior of the farmer	756	688	7.7%	6.1%	-68	91.0%
Organizational	**1 031**	**1 046**	**10.6%**	**9.3%**	**15**	**101.5%**

Technical:	**2 317**	**3 016**	**23,7%**	**26,8%**	**699**	**130,2%**
– improper condition of machines, devices and tools	356	394	3.6%	3.5%	38	110.7%
– improper condition of building structures	385	463	3.9%	4.1%	78	120.3%
– improper condition of the yard, communication routes, maneuvering areas, etc. on the farm	1 213	1 790	12.4%	15.9%	577	147.6%
– improper technical condition of ladders, platforms, scaffolding and other auxiliary equipment used on the farm	265	250	2.7%	2.2%	-15	94.3%
– improper condition of communication routes (roads, pavements, etc.) and construction facilities outside the farm	70	94	0.7%	0.8%	24	134.3%
– other technical irregularities	28	25	0.4%	0.3%	-3	89.3%
Other causes	**769**	**859**	**7.8%**	**7.6%**	**90**	**111.7%**
Total	**9 770**	**11 267**	**100.0%**	**100.0%**	**1 497**	**115.3%**

Source: Own study based on data from the Agricultural Social Insurance Fund

- The majority of accidents were caused by human causes – (5653 and 6346, respectively, i.e. 57.9% and 56.3% of all accidents analyzed in the reporting period. The largest share among them is occupied by:
- improper conduct of the farmer (1993 and 2301 accidents, respectively, i.e. 20.4% and 20.4%)
- improper use of machines, devices and tools (1220 and 1441 accidents, respectively, i.e. 12.5% and 12.8%)
- failure to use work protection and safety devices (1217 and 1340 accidents, respectively, i.e. 12.5% and 11.9%)

Separating from the above data technical causes (2317 and 3016 accidents, respectively, i.e. 23.7% and 26.8%), the largest share is occupied by:

- improper condition of the yard, communication routes, maneuvering areas, etc. (1,213 and 1,790 accidents, i.e. 12.4% and 15.9%, respectively);
- improper condition of buildings (385 and 463 accidents, i.e. 3.9% and 4.1%, respectively);
- improper condition of machines, devices and tools (356 and 394 accidents, i.e. 3.6% and 3.5%, respectively).

An additional, noteworthy factor in the structure of accidents conducted by KRUS is the breakdown of accidents by time of day and day of the week. Table 4 presents the number of accidents by time of day in 2020-2021.

Table 4. Accidents by time of day in 2020 - 2021

	Number of accidents		**Share in %**	
Time of day	**2020**	**2021**	**2020**	**2021**
in the morning (06:01 to 12:00)	3 492	4 027	35.7%	35.7%
in the afternoon (12:01 to 18:00)	4 864	5 546	49.8%	49.2%
evening (18:01 to 24:00)	1 191	1 417	12.2%	12.6%
at night (00:01 to 06:00)	223	277	2.3%	2.5%
Total	**9 770**	**11 267**	**100.0%**	**100.0%**

Source: Own study based on data from the Agricultural Social Insurance Fund

Below is a summary of the number of accidents on farms by day of the week in 2020-2021 (Table 5).

Table 5. Accidents by day of the week in 2020-2021

	Number of accidents		**Share in %**	
Day of the week	**2020**	**2021**	**2020**	**2021**
Monday	1 634	1 853	16.7%	16.4%
Tuesday	1 380	1 605	14.1%	14.2%
Wednesday	1 414	1 676	14.5%	14.9%

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Thursday	1 426	1 664	14.6%	14.8%
Friday	1 489	1 678	15.2%	14.9%
Saturday	1 650	1 867	16.9%	16.6%
Sunday	777	924	8.0%	8.2%
Total	**9 770**	**11 267**	**100.0%**	**100.0%**

Source: Own study based on data from the Agricultural Social Insurance Fund

Data analysis allows us to draw attention to the days that stand out in terms of the increased number of accidents - Monday (16.7% and 16.4%, respectively) and Saturday (16.9% and 16.6%, respectively). The majority of accidents are recorded in the morning and afternoon (from 6:01 to 18:00).

For many years, the Agricultural Social Insurance Fund has observed a large variation in the accident rate between individual provinces. Data on the accident rate and data on the frequency of fatal accidents in 2021, divided by province, are presented in Table 6.

Table 6. Accident rate and frequency of fatal accidents in 2021 by voivodeship

Voivodeship	**Accident rate**	**Fatal accident rate**
	2021	
dolnośląskie	7.2	5.0
kujawsko-pomorskie	10.7	8.1
lubelskie	9.2	3.4
lubuskie	6.8	0.0
łódzkie	8.7	2.2
małopolskie	5.9	2.2
mazowieckie	8.3	4.2
opolskie	4.8	0.0
podkarpackie	7.7	1.2
podlaskie	10.8	6.2
pomorskie	8.6	13.1
śląskie	4.8	0.0
świętokrzyskie	7.8	31
warmińsko-mazurskie	9.4	2.5
wielkopolskie	10.2	6.3
zachodniopomorskie	5.7	0.0

Source: Own study based on data from the Agricultural Social Insurance Fund

The highest accident rate was recorded in the following provinces: Podlaskie (10.8), Kujawsko-Pomorskie (10.7), Wielkopolskie (10.2) and Warmińsko-Mazurskie (9.4), and the lowest in the Opolskie and Śląskie provinces (4.8). The large variation in the accident rate between provinces results from, among others, the profile of agricultural production, differences in terrain, disproportions in their infrastructure, as well as from the different economic situation of farms. Chart no. 1 presents the accident rate in 2021 divided by province.

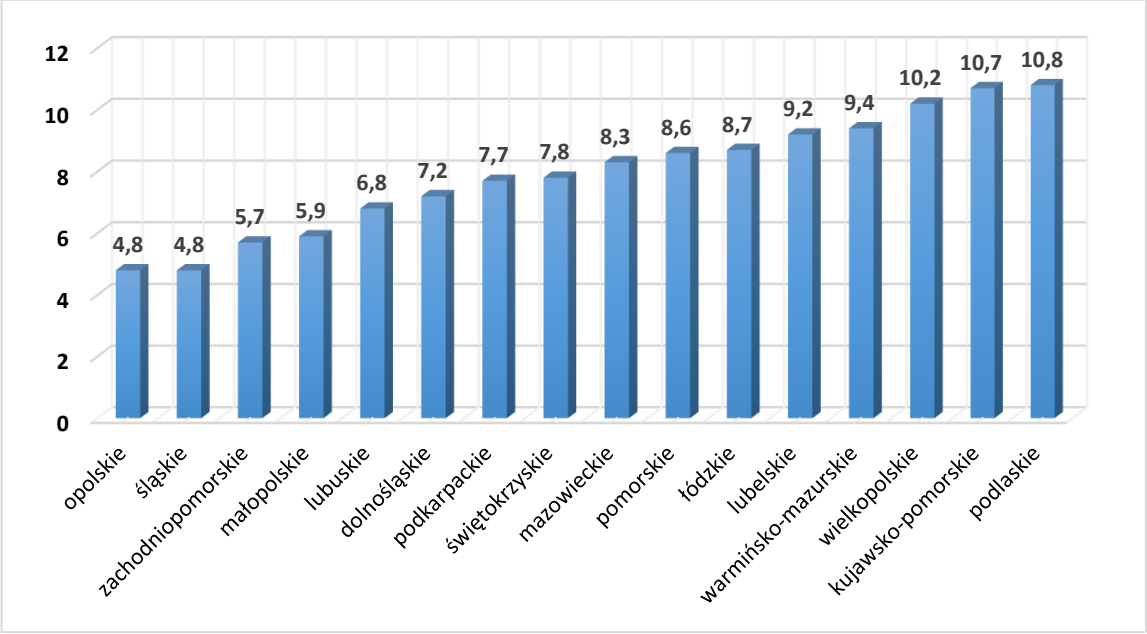

Figure 1. Accident rate in 2021 by province

Source: Own study based on data from the Agricultural Social Insurance Fund

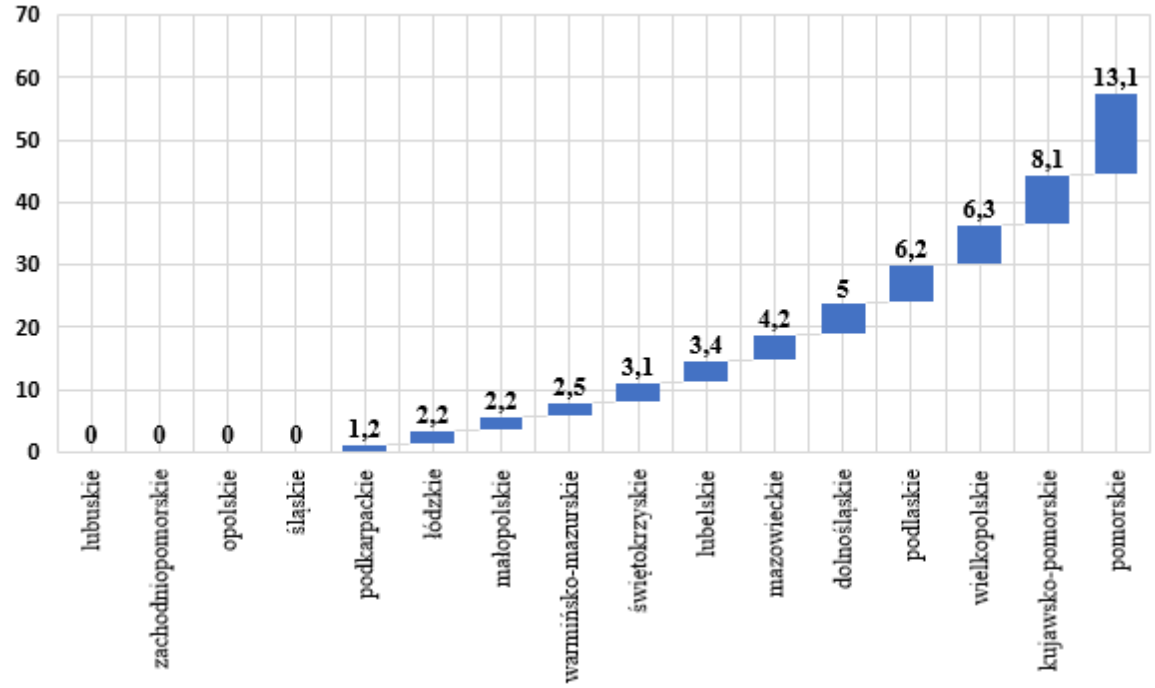

Figure 2. Fatal accident rate in 2021 by province

Source: Own study based on data from the Agricultural Social Insurance Fund

Fatal accidents accounted for 0.5% of all accidents resulting in the payment of benefits in 2021. Their frequency was 4 per 100,000 insured persons. The highest frequency of fatal accidents was recorded in the Pomeranian Voivodeship (13.1) and Kuyavian-Pomeranian Voivodeship (8.1), and the lowest in the Podkarpackie Voivodeship (1.2). On the other hand, no fatal accidents were recorded in the West Pomeranian, Silesian, Opole and Lubuskie Voivodeships in 2021. Data on the accident frequency rate are presented in Chart 2.

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4. CONCLUSIONS

Among all recorded accidents, there is a high rate of accidents involving machinery and equipment used in agricultural activities. Most of them occurred while operating agricultural tractors, other machinery and equipment, and various types of machinery for obtaining and processing wood.

Most accidents occur due to human causes. The most common human errors include:

- ✓ improper conduct of the farmer,
- ✓ improper use of machinery, equipment and tools,
- ✓ failure to use protective clothing at work and safety devices.

However, technical causes should also be taken into account, in which the highest share is held by:

- ✓ improper condition of the yard, communication routes, maneuvering areas, etc.,
- ✓ improper condition of building structures,
- ✓ improper condition of machinery, equipment and tools.

Data analysis allows us to draw attention to the days that stand out in terms of the increased number of accidents - Monday and Saturday. It is probable that the increased number of accidents on Mondays is related to the farmer's Sunday rest.

In trying to develop and implement preventive principles for preventing accidents on farms, based on these studies, the most reasonable would be to first train farmers and workers working on farms in the principles of safe use of machinery and equipment, the need to use work protection and safety devices, as well as maintaining the infrastructure on the farm in proper condition. This would limit the negative social effects of such accidents, which in particular include:

- ✓ death as a result of injuries suffered,
- ✓ permanent damage to health (disability) that makes it difficult or impossible to run a farm,
- ✓ temporary inability to run a farm,
- ✓ increased public expenditure on health services,
- ✓ increased expenditure and pension and disability contributions,
- ✓ an increase in the number of people with a disability certificate.

Increasing expenditure on education and preventive measures, their effective development and implementation of the developed solutions would be an economically and socially beneficial action for both the Podkarpackie Province and the entire country.

The constant need to incur labor costs translated into the number of accidents recorded in agricultural activities in the province. Accidents on farms registered by the Agricultural Social Insurance Fund in Poland amounted to: 9,770 accidents in 2020 (2020) and 11,267 accidents (2021), respectively. Analyzing the data in terms of the type of work performed, it can be seen that most accidents occur during work related to animal handling, e.g. feeding, milking, zoohygienic procedures, driving, etc., as well as moving around the farm without a load and manual transport work.

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