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POLISH FARMERS' PERCEPTION OF THE SAFETY, ERGONOMICS AND SOZOLOGY OF TRACTORS

Summary

The second edition of the Independent Farmers' Opinion Poll (IFOP 2018) resulted in a database of 600 subjective and reliable opinions used for the analysis of the ergonomics and safety of farm tractors. The poll was conducted in all regions of Poland and resulted in Polish farmers' opinions of several dozen parameters of tractors, which are basic machines on each farm. John Deere won the second edition of the Independent Farmers' Opinion Poll as users of these tractors considered them the most ergonomic and safest during long-term operation. Like in the first edition (650 questionnaires), the users were the most critical about the insufficient number of compartments in the tractor cab.
***Keywords**: ergonomics, safety, quality, farm tractors, IFOP system*

POSTRZEGANIE BEZPIECZEŃSTWA, ERGONOMII I SOZOLOGII CIĄGNIKÓW PRZEZ POLSKICH ROLNIKÓW

Streszczenie

Po zakończeniu II edycji Niezależnego Badania Opinii Rolników (NBOR 2018) otrzymano bazę 600 subiektywnych i rzetelnych opinii do analizy o ergonomii i bezpieczeństwie w użytkowaniu ciągników rolniczych. Badanie swym zasięgiem objęło cały kraj i pozwoliło poznać opinie polskich rolników o kilkudziesięciu parametrach podstawowej maszyny w każdym gospodarstwie. Zwycięzcą II edycji według użytkowników zostały ciągniki firmy John Deere, które uznano za najbardziej ergonomiczne i bezpieczne podczas wieloletniej eksploatacji. Podobnie jak w I edycji (650 ankiet) użytkownicy najwięcej zastrzeżeń mieli do niewystarczającej liczby schowków w kabinie ciągnika.
***Słowa kluczowe**: ergonomia, bhp, jakość, ciągniki rolnicze, system NBOR*

1. Introduction

Ergonomics is the science about relations between people and the environment. The term was first introduced by a group of English scholars in 1949. In consequence, the Ergonomics Research Society (ERS) was established. The starting point for ergonomics is the synthesis of medical sciences, psychology and technological knowledge. The aim of ergonomics is to optimise the efficiency and effectiveness of the relation between the human and machine [13].

Most agrotechnical treatments should take place at strictly specified dates. Failure to meet the essential conditions of cultivation, protection and fertilisation significantly decreases yield quality and quantity [1, 8]. Modern constructions, materials and technological solutions are used to manufacture farm vehicles and machinery [7]. As a result of natural ageing processes, parts are frequently worn and damaged, so they must be removed to prevent further wear and damage. According to the research conducted by Tomczyk [10, 11, 12], the most common causes of damage to machines are:

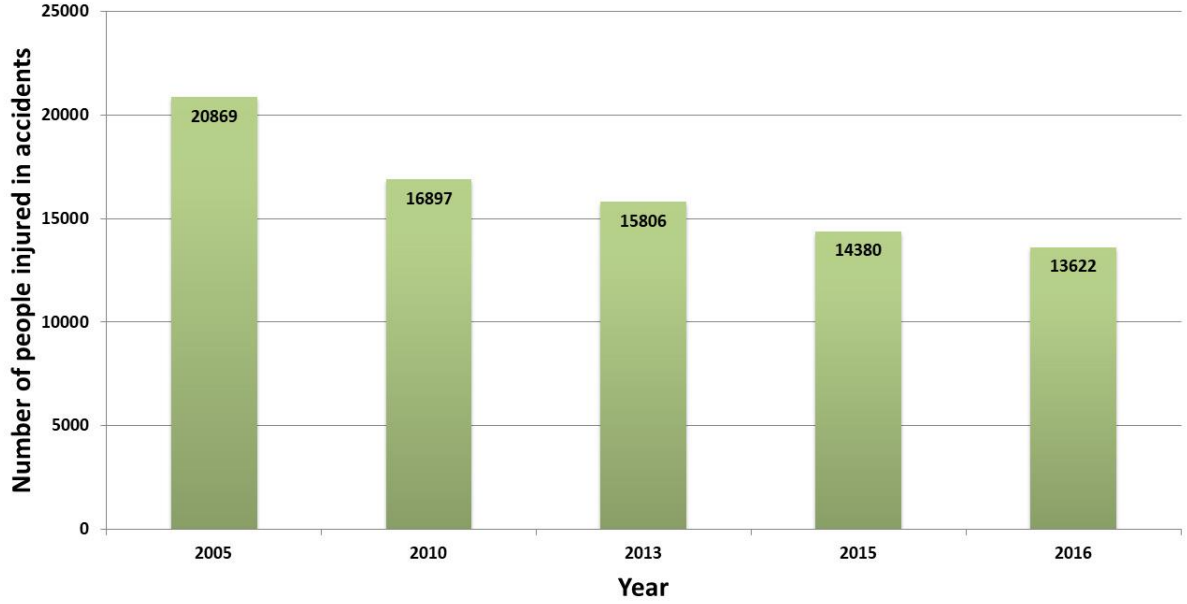
- ~20% - faulty construction and production technology,
- ~25% - insufficient maintenance and storage,
- ~15% - insufficient quality of repairs.

Polish farms are well-equipped with machinery and technological equipment, as evidenced by the drastic decline in purchases of new products. Simple machines, i.e. ploughs, harrows and cultivators are only a small fraction of farming machinery and equipment. The majority are technological devices with different constructions and operating parameters within the same group of machines and vehicles. The poor ergonomic quality of numerous, usually older types of vehicles and farming machinery influences farmers' working conditions and their safety [5, 6].

Damaged or worn components fundamentally affect work safety. Every year manufacturers of vehicles and farming machinery use more safeguards to improve ergonomics and work safety. This fact is evidenced by the number of people injured in accidents on farms (Fig. 1) [4].

However, the rate of accidents on farms is continuously and noticeably decreasing due to the positive actions taken by the Agricultural Social Insurance Fund, PZU Group (State Insurance Company) and other insurance companies and organisations. EU directives affect ergonomics and safety criteria. Directive 2006/42/EC significantly influenced both manufacturers and users because of new health and safety requirements. In spite of the growing awareness of the importance of occupational health and safety in agriculture, especially small and medium-sized farms find it difficult to implement safety measures, because they usually cannot bear additional costs to manage basic work activities. Obsolete farm vehicles and machinery are commonly used. This fact is also emphasised in reports of the European Agency for Safety and Health at Work (EU-OSHA), which analyses the causes of accidents [3, 9].

Consecutive editions of the National Safe Farm Competition and annual scientific conferences entitled 'Problems of Safety, Ergonomics and Ecology in the Use of Farming Machinery and Tractors', which are held at the Industrial Institute of Agricultural Engineering in Poznań, are very popular.



Source: the authors' compilation by [4] / Źródło: opracowanie własne wg [4]

Fig. 1. Accidents on Polish farms in recent years
Rys. 1. Wypadkowość w polskich gospodarstwach rolnych na przestrzeni ostatnich lat

The web portal Independent Farmers Opinion Poll (IFOP), which was developed and implemented at the Institute of Biosystems Engineering, Poznań University of Life Sciences two years ago, also participates in improvement of the safety of farming machinery and vehicles. It has a wide range, because it is supported by the web portal *top agrar* Poland.

2. Aim of study

The aim of the study was to provide farmers' reliable opinions about the ergonomics and safety of their tractors on the basis of data obtained from the electronic questionnaire survey available at www.nbor.pl. Farmers' long experience will allow us to present the features which they think should be improved as well as those that they are satisfied with. This analysis will help us determine the decision-making processes concerning the improvement of construction parameters of farm tractors.

3. Methodology and object of study

The first IFOP edition 2017, which evaluated the performance of farm tractors, lasted from March to September 2017. It provided a rich database of 650 farmers' opinions about the functioning, failures, ergonomics, safety and aesthetics of tractors [2]. After the success of the first edition with 39 detailed criteria, including 14 related to the subject and aim of the study, in October 2017 the researchers started collecting questionnaires for the second IFOP edition 2018, which was completed at the end of August this year. Due to the respondents' inquisitive and relevant comments the set of tractor assessment criteria was extended to 50 detailed criteria, where as many as 21 concerned ergonomics and safety. Thus, they became the largest group. Below is the list of these criteria.

ES_1 – Access to cabin,
ES_2 – Visibility from driver's seat (front, sides),
ES_3 – Visibility from driver's seat (back),
ES_4 – Size of cabin,
ES_5 – Adjustability and size of driver's seat,
ES_6 – Shock absorption,
ES_7 – Noise in cabin,
ES_8 – Ventilation and heating efficiency,
ES_9 – Legibility of indicators,
ES_{10} – Comprehensibility of instruction manual,
ES_{11} – Number of compartments,
ES_{12} – External lights,
ES_{13} – Steering wheel adjustability,
ES_{14} – Layout of control levers,
ES_{15} – Operability of foot-controlled items,
ES_{16} – Operability of hand-controlled items,
ES_{17} – Information and warning graphics (layout and size of pictograms),
ES_{18} – Method of cover removal and opening,
ES_{19} – Anti-slip protection,
ES_{20} – Outside noise level,
ES_{21} – Tightness of hydraulic system.

Like in the previous edition, the farmers rated each criterion with a five-degree ordering scale, where:
1 – very low rating,
2 – low rating,
3 – average rating,
4 – high rating,
5 – very high rating.

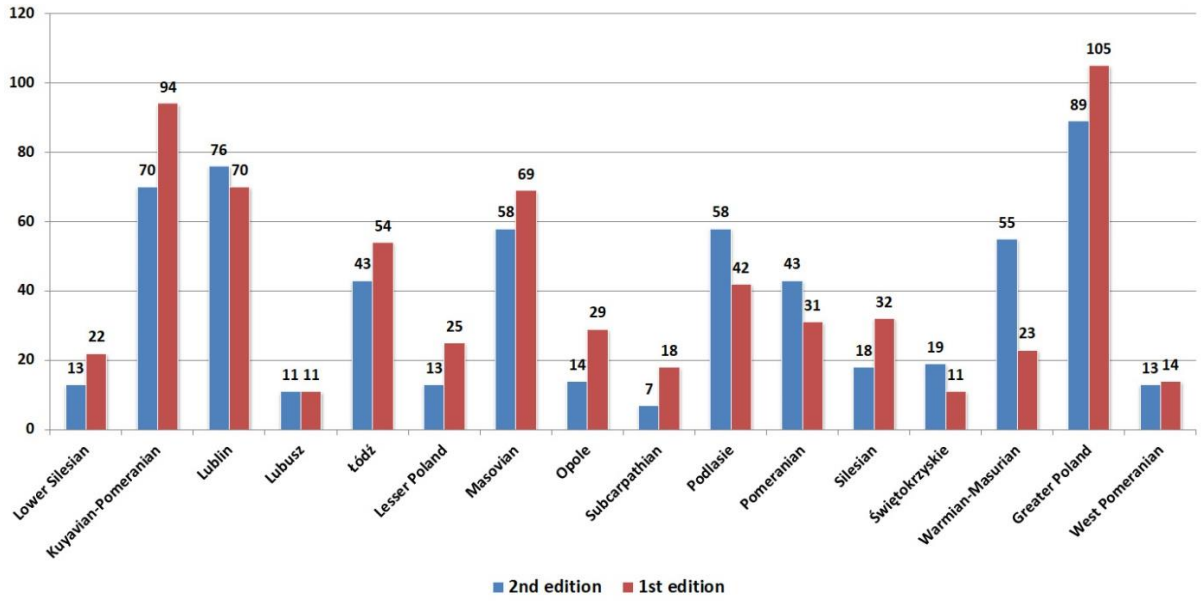
4. Results

Like in the first edition of the survey evaluating the quality of farm tractors, the final results included 8 brands. There were more than 30 brands of tractors in the survey, but only 8 of them met the requirement of a large random sample: Case IH, Deutz-Fahr, Fendt, John Deere, Massey Ferguson, New Holland, Ursus and Zetor. 600 questionnaires were collected during the second edition of the survey evaluating the quality of farm tractors. The most questionnaires were provided by farmers from Greater Poland Voivodeship. The following diagram (Fig. 2) shows the number of questionnaires collected from each voivodeship during the first and second edition of the survey.

The arithmetic mean was calculated for each brand and for the ergonomics and safety criterion so as to calculate the overall mean for the main criterion. The mean of the main criterion was multiplied by its weight, i.e. 13%. It resulted in the ergonomics and safety indicator I_{ES} (Table 1).

The overall mean of all ratings of ergonomics and safety was 3.97. Only three brands did not exceeded this limit.

The study also involved calculations for individual detailed criteria. The results are shown in the diagram below (Fig. 3).



Source: the authors' compilation / Źródło: opracowanie własne

Fig. 2. The respondents' activity in individual voivodeships during the first and second edition of the IFOP project [number of votes]

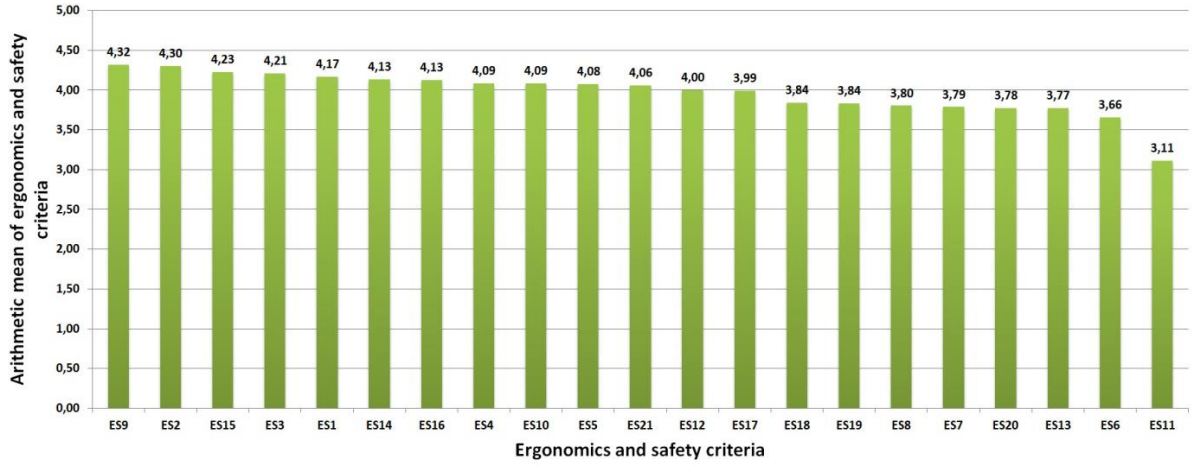
Rys. 2. Aktywność oceniających według województw podczas I i II edycji projektu NBOR [liczba oddanych głosów]

Table 1. The ergonomics and safety indicator I_{ES} of 8 brands of tractors

Tab. 1. Wyniki obliczeń wskaźnika EB dla 8 ocenianych marek ciągników

	John Deere	**New Holland**	**Massey Ferguson**	**Case IH**	**Fendt**	**Deutz-Fahr**	**Zetor**	**Ursus**
ES_1	4.32	4.30	4.40	4.25	3.91	4.06	4.01	4.00
ES_2	4.34	4.49	4.33	4.36	3.91	4.42	4.18	4.04
ES_3	4.34	4.38	4.19	4.39	4.13	4.13	4.13	3.88
ES_4	4.06	4.05	4.26	4.06	3.88	3.58	4.36	4.09
ES_5	4.30	4.30	4.48	4.19	4.41	4.16	3.76	3.33
ES_6	4.06	3.97	3.74	3.92	4.06	3.48	3.29	2.81
ES_7	4.39	4.11	4.07	4.03	3.97	3.90	3.32	2.63
ES_8	4.36	4.26	4.12	4.00	3.88	3.48	3.64	2.58
ES_9	4.53	4.54	4.45	4.28	4.28	4.32	4.17	3.93
ES_{10}	4.37	4.20	4.10	3.83	4.00	3.94	4.08	3.93
ES_{11}	3.42	3.26	3.26	2.89	3.38	3.29	3.03	2.63
ES_{12}	4.14	4.20	4.24	4.06	3.88	4.16	4.03	3.25
ES_{13}	4.39	4.12	4.00	4.03	4.19	3.97	2.76	2.56
ES_{14}	4.50	4.33	4.52	4.42	4.63	4.03	3.73	3.33
ES_{15}	4.52	4.32	4.50	4.39	4.56	4.10	3.96	3.81
ES_{16}	4.43	4.25	4.40	4.19	4.50	3.97	3.82	3.68
ES_{17}	4.32	4.21	4.26	4.17	4.22	4.00	3.68	3.47
ES_{18}	4.12	4.07	3.88	4.00	3.94	3.90	3.43	3.37
ES_{19}	4.23	4.01	4.02	4.14	3.81	3.97	3.49	3.18
ES_{20}	4.19	4.08	3.79	3.72	3.78	3.97	3.43	3.11
ES_{21}	4.50	4.30	4.24	4.28	4.16	4.13	3.96	3.60
MEAN	**4.28**	**4.18**	**4.16**	**4.08**	**4.07**	**3.95**	**3.73**	**3.39**
W_{ES}	**0.56**	**0.54**	**0.54**	**0.53**	**0.53**	**0.51**	**0.48**	**0.44**

Source: the authors' compilation / Źródło: opracowanie własne

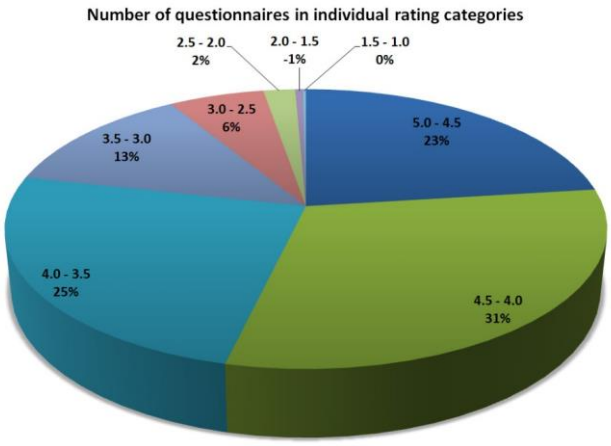


Source: the authors' compilation / Źródło: opracowanie własne

Fig. 3. The mean ratings of 21 ergonomics and safety criteria
Rys. 3. Średnie dla 21 kryteriów z grupy Ergonomia i bezpieczeństwo

The tractor manufacturers were mostly criticised for the insufficient number of compartments for food, documents, electrical equipment in the cabin and external storage spaces (for tools). The mean value of indicator ES_{11} from 600 opinions was only 3.11. The respondents rated the legibility of indicators highest ES_9 =4.32.

The rating scale 1-5 and verbal equivalents:
5.0 ~ 4.5 – excellent,
4.5 ~ 4.0 – distinctive,
4.0 ~ 3.5 – favourable,
3.5 ~ 3.0 – moderate,
3.0 ~ 2.5 – intermediate,
2.5 ~ 2.0 – unfavourable,
2.0 ~ 1.5 – critical,
1.5 ~ 1.0 – bad,
gave the final result presented in Fig. 4 below.



Source: the authors' compilation / Źródło: opracowanie własne

Fig. 4. The annual results of the IFOP project
Rys. 4. Podsumowanie wyników rocznych badań projektu NBOR

As much as 79% of the respondents rated the ergonomics and safety of their tractors as favourable, distinctive and excellent, which indicated their good and high satisfaction in this category.

5. Summary and conclusions

According to the Statistical Yearbook of Agriculture, there are about 1.5 million farm tractors registered in Poland, i.e. about 1 tractor per farm. Such high saturation of agriculture with mechanised equipment may indicate that there is a large group of people exposed to factors harmful to health and life. Due to the high technological and qualitative diversity of equipment working on Polish farms we can assume that it is necessary to conduct surveys concerning the ergonomics, safety and general quality of farming machinery. The final results may be helpful for future clients and producers in various decision-making processes.

The analysis of the results of the 1st and 2nd IFOP edition concerning farm tractors showed that the mean value of the ergonomics and safety criteria improved slightly from 3.90 to 3.97. The respondents were satisfied to see that the set of criteria had been extended from 14 to 21.

The farmers' involvement both in the first and second edition of the project confirmed the authors' view that independent opinions and subsequent rankings were valuable sources of information. In the future, respondents will have a chance to make additional comments, as some of them wished to do so. These comments are usually the most valuable part of data obtained in the survey. At present, there are active modules for the evaluation of combine harvesters and loader mowers at nbor.pl. The third edition of assessment of farm tractors has begun.

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