Safe Habitus

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TECHNICAL NOTE 5

Germany

Responding to Priority Needs: Improving safety of tractors and machinery

Framework

Three central fields of action were identified within the German Priority Needs Register, identified in Technical note 3 (PA3).

Against this background, this practical report deals with the second category: tractors and agricultural machinery.

People working in the green sector encounter many machines on a daily basis, which can be very dangerous depending on their size, area of use and handling. This can also be deduced from the annual accident statistics compiled by the Social Insurance Institution for Agriculture, Forestry and Horticulture (SVLFG) in Germany. According to these statistics, vehicles, machines, tools and equipment account for almost a third of all accidents. Around 20 % of fatal accidents are caused by the use of chainsaws, primarily in felling work.

Accidents involving large agricultural machinery in particular can cause a great deal of damage and endanger not only the driver himself, but also road traffic and other road users. According to the German Insurance Association (GDV), 59 people were killed in accidents involving tractors across Germany in 2019. 618 people were seriously injured (Gesamtverband der Deutschen Versicherungswirtschaft e. V.). More than half of accidents occurred at a junction - out of town (56%) significantly more frequently than in urban areas (39%) or at an intersection (20%) (Borrack et al, 2023).

Nevertheless, tractors have become indispensable in agriculture, not least because of their multifunctional applications. A wide range of implements can be attached and operated via the front or rear PTO shaft. Tractors are also indispensable for harvesting in trailer operation. It is therefore obvious that the tractor, as the most frequently used machine in agriculture, is also associated with a correspondingly high accident rate.

In addition to the typical agricultural tractors with the corresponding attachments, there are numerous other vehicles and machines in agricultural operations. Farm loaders, forage harvesters/combine harvesters, trailers and hand-held power tools are also in the repertoire of an agricultural business and their use can result in a corresponding number of accidents (Agrarheute; 2023).

Due to the increase in part-time farms and the general reluctance to invest, it can be assumed that hardly any investment will be made in new and safe agricultural machinery and technology (Deutscher Bauernverband, 2023). The operation of old, technically unsafe machinery and equipment is therefore a general problem that occupational health and safety must address in this sector. Added to this is the import of tractors and machinery from non-EU countries that have a lower technical standard.

Germany

Location

Social Insurance for Agriculture, Forestry and Horticulture (SVLFG)
Weißensteinstraße 70-72
34131 Kassel
Germany

Contacts

Klaus Klugmann, (CoP administrator)
OSH-Prevention
Phone:
+49 561 785 – 13848 / +49 173 5398870
E-Mail:
klaus.klugmann@svlfg.de

Sarah Öztürk, (CoP facilitator)
International Relations
Phone:
+49 561 785 – 13514 / +49 171 5448063
E-Mail: sarah.oeztuerk@svlfg.de

More info

Internet: www.safehabitus.eu
www.SVLFG.de
YouTube: SVLFG - YouTube

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Accident Statistics in the field of Tractors and Agricultural Machinery

The accidents involving tractors shown below relate to reportable accidents at work within the SVLFG's group of insured persons. In addition, there are road traffic accidents in which other persons, usually not insured by SVLFG, are injured. A study by the insurance industry shows 1,941 accidents with personal injury in this area in 2019 (Gesamtverband der Deutschen Versicherungswirtschaft e. V., 2023). Compared to general road traffic, tractor accidents are comparatively rare but often have serious consequences. In 62% of road accidents, the tractor driver is the cause of the accident (Brockmann, 2023).

Table 1. Total accidents in comparison to tractor accidents in the agriculture sector

Key figures	2019	2020	2021	2022	2023	Average 2019-2023
Total reportable accidents	68,064	64,060	61,578	59,024	57,608	62,067
Total fatal accidents	132	113	125	117	125	122
Tractor reportable accidents	2,666	2,257	2,132	2,075	2,018	2,230
Tractor fatal accidents	16	16	12	21	17	16

As can be seen from Table 1, while on average only 3.6% of accidents in the last five years involved a tractor, 13.6% of all fatal accidents involved a tractor. Furthermore, although the number of accidents has fallen by around 30% during this period, the number of fatal accidents has not decreased.

Table 2. Average values of the top fifteen injury-activities on tractor accidents for the years 2019-2023

Activity of the injured person (Top 15)	Reportable accidents						
	2019	2020	2021	2022	2023	Average 2019-2023	Diff. 2023 to 2022
Get out, get off	1,162	952	917	974	927	986	-47 ↓
Steer, directing	374	352	329	270	286	322	16 ↑
Get in, get on	201	153	160	138	159	162	21 ↑
Couple, hitch up	128	134	109	95	87	111	-8 ↓
Uncouple, disconnect	84	76	64	63	69	71	6 ↑
Build, attach, assemble, convert, dismantle, install	89	76	57	55	50	65	-5 ↓
Jump on, out, down, over	79	57	71	60	53	64	-7 ↓
Repair	80	60	59	53	42	59	-11 ↓
Maintain	61	53	49	39	40	48	1 ↑
Open, close	39	44	34	47	38	40	-9 ↓
Walk, run	37	32	21	31	18	28	-13 ↓
Stand, get up	25	21	18	27	26	23	-1 ↓
Operate	30	23	21	19	22	23	3 ↑
Set up, adjust, fold	23	20	15	23	15	19	-8 ↓
Clean, care, maintain	15	22	12	15	13	15	-2 ↓

Table 3. Average values of the top ten injury-activities on tractor accidents for the years 2019-2023

Activity of the injured person (Top 10)	Reportable accidents						
	2019	2020	2021	2022	2023	Average 2019-2023	Diff. 2023 to 2022
Ascent (step)	1,253	1,002	995	1,008	956	1,043	-52 ↓
Three-point linkage (top link, lower link)	106	126	112	101	108	111	7 ↑
Tires, wheel	91	85	78	74	66	79	-8 ↓
With attachment	108	85	69	66	51	76	-15 ↓
With trailer	80	76	72	62	67	71	5 ↑
Door	60	59	53	44	38	51	-6 ↓
Other vehicle part and assemblies	57	45	50	28	32	42	4 ↑
With trailer attachment	40	46	55	38	28	41	-10 ↓
Cab, driver's cab	45	34	36	39	37	38	-2 ↓
Towing device (towing jaw, towing eye)	35	28	26	41	39	34	-2 ↓

As table 2 shows, a strikingly high number of accidents are associated with getting on and off the tractor. The accidents when getting on and off the tractor are related to the ascents (Table 3). At 41%, the injuries are predominantly to the lower extremities (ankle, foot, lower leg and knee) and can be severe with permanent consequences.

Table 4. Fatal accidents with tractors 2019-2023 and activity of the person

Activity of the injured person (Top 10)	Fatal accidents						
	2019	2020	2021	2022	2023	Average 2019-2023	Diff. 2023 to 2022
Steer, directing	8	7	5	13	9	8	-4 ↓
Walk, run)	1	0	1	3	0	1	-3 ↓
Get in, get on	1	0	1	1	2	1	1 ↑
Operate	0	3	0	1	0	1	-1 ↓
Uncouple, disconnect	0	1	0	0	3	1	3 ↑
Switch on, start up	2	0	1	0	0	1	0
Couple, attach	0	1	0	1	1	1	0
Set up, adjust, fold	0	0	1	1	0	0	-1↓
Jump on, out, down, over	1	1	0	0	0	0	0
Stand, get up	0	1	0	0	1	0	1 ↑
Monitor, supervise, instruct	1	0	0	0	1	0	1 ↑
Ride along	0	0	1	0	0	0	0
Get off, dismount	0	1	0	0	0	0	0
Hold, fix, open, close	1	0	0	0	0	0	0
Load, load up	0	0	1	0	0	0	0

As expected, according to table 4, fatal tractor accidents also occur mainly during or in connection with operation. As can be seen in accident investigations, safety belts, if available, are generally not used. In fatal accidents, well over half of those involved are aged 65 and over. As table 4 shows, being run over by an old tractor rolling away is a recurring accident pattern (walk, run/ get in, get on). These injuries often result from farmers' attempts to rescue a tractor rolling away from them.

Table 5. Age of persons injured in fatal accidents

Age of the injured person at the time of the accident	Fatal accidents						
	2019	2020	2021	2022	2023	Average 2019-2023	Diff. 2023 to 2022
Up to 18 years	1	0	2	0	0	1	0
19 to 25 years	1	0	0	1	2	1	1 ↑
26 to 30 years	1	0	0	1	0	0	- 1 ↓
31 to 35 years	1	0	0	0	0	0	0
36 to 40 years	0	0	1	0	0	0	0
41 to 45 years	0	1	0	0	1	0	1 ↑
46 to 50 years	3	2	1	1	0	1	-1 ↓
51 to 55 years	1	1	0	1	1	1	0
56 to 60 years	0	2	0	1	5	2	4 ↑
61 to 65 years	0	1	1	2	0	1	-2 ↓
66 to 70 years	2	5	0	3	1	2	-2 ↓
Over 70 years	6	4	7	11	7	7	-4 ↓

Table 5 clearly shows that older farmers are particularly at risk of being fatally injured in tractor accidents.

Table 6. Fatal accidents in connection with chainsaw use

Field of worl	Fatal accidents				
	2021	2022	2023	Average 2019-2023	Diff. 2023 to 2022
Falling work	20	24	23	22	-1 ↓
Wood processing	1	1	6	3	5 ↑
Cutting and transporting wood	2	1	3	2	2 ↑
Other forest and forestry work or similar	1	4	1	2	-3 ↓
Loading and transport work	2	2	0	1	-2 ↓
Travelling to or from the workplace or work site	0	0	2	1	2 ↑
Cultivation and maintenance work	0	1	1	1	0
Maintenance and repair work on buildings	1	0	0	0	0
Road construction	0	1	0	0	-1 ↓
Firewood preparation, such as sawing, chopping, splitting	0	1	0	0	-1 ↓

On average over the last five years, around 850 accidents per year have occurred in direct connection with chainsaws. If you add to this the accidents caused by chainsaw handling, the figure is much higher. This results in almost 2,500 accidents when direct and indirect causes of chainsaw work are considered together. According to Table 5, the falling and processing of trees is one of the activities with the highest accident risk. Almost 20 % of fatal accidents occur here (25 cases table 6 / 122 cases table 1). The special feature of working with a chainsaw, especially when working on trees or natural wood, is that in addition to the hazards posed by the chainsaw itself, there are also hazards caused by the effects of the work. For example, if tensions in the wood are not recognised and are suddenly released and the moving wood hits the chainsaw operator.

Critical Issues

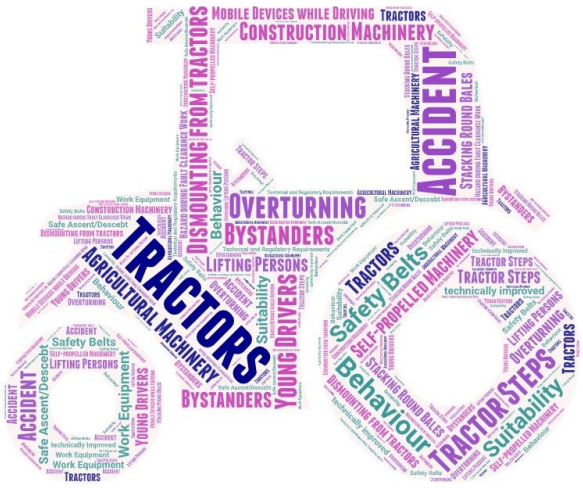

Figure 1. Tractor safety, Critical Issues and Challenges

Figure 1 illustrates critical issues and challenges relating to tractor safety, determined within the framework of the German Needs Register. As with all technical work equipment, the technical safety of the design is crucial for accident-free working with it. On the other hand, the operator must be able to use the device within the scope of the given technical freedom and must therefore be appropriately trained and qualified.

Technical aspects

Current, technically complex tractor combinations, which are correspondingly powerful and also reach higher travelling speeds, must be further developed to prevent accidents. The safety of attachments, especially for lifting such as front loaders, must also be further developed to address design safety issues. Another topic is the import of tractors from outside the EU, for example from India. These tractors have a reduced level of basic technical equipment and are only suitable to a limited extent for safe working in local fields of application. Older tractors, which are generally also operated by older farmers, are also prone to accidents as the technical safety of these tractors does not meet today's requirements.

Some important safety issues with substandard, imported, or old tractors are:

- Mounting and dismounting from the tractor (The last step to the ground is particularly accident-prone).
- Poor ergonomics (generally with old/cheap tractors) with new tractors this also affects the design of the safety belt,
- Attachment and use of front loaders without technical safety limitations (lifting of persons, round bales handling),
- Poor all-round visibility, especially when operating with trailers and attachments,
- Constructive safety deficiencies in older tractors and imported 'cheap' tractors (the Indian Solis 26 small tractor is the best-selling tractor in Germany in 2022 and 2023, especially because of its cheap price, it is purchased as a replacement by farm loaders in part-time farms).

Operator behaviour and handling
The safe handling of technical devices depends largely on the operator's expertise. Within the scope of application specified by the manufacturer, the qualification of the operator is decisive for safety. The role of training is therefore just as important as the ability to recognise unsafe conditions and react appropriately with a situation-related risk assessment. This is particularly important for work equipment with a high degree of technical freedom, such as chainsaws, where safety depends largely on operator behaviour and less on the device itself.
Some important operator-dependent safety issues are:

- Descend forwards and, out of necessity, jump from the last step to the ground,
- a lack of awareness of technical operating limits and travelling speeds,
- No use of the seat belt,
- Use of mobile phones while driving. (Accumulation of unexplained accidents such as lane departures indicate that. Traffic observations support this assumption),
- Starting (older) tractors from the ground to activate the PTO shaft (driver is driven over when gear is engaged),
- Due to the high actuation force of the handbrake on older tractors, they can roll away and the driver is run over when trying to jump on,
- Improper use of the chainsaw due to lack of qualification.

Potential Solutions

The accident patterns resulting from accidents and the associated issues must be taken into account in the further development of EU regulations. The risks with importing low-cost tractors should also be taken into account. In this context, Regulation (EU) No. 167/2013 on the approval and market surveillance of agricultural and forestry vehicles should be adapted in the following points:

- Technical intrinsic safety of ascents,
- Installation of ergonomic restraint systems for the driver (e.g. ELR belt systems),
- Visual or audible warning system for belt non-use (required by machinery regulation (EU) 2023/1230 valid from 2027),
- Improved ergonomic specifications, e.g. for the operation of actuators or whole-body vibration (values date back to the 1980s),
- Hazardous area monitoring with automatic person detection.

Technical measures are also recommended in the following areas:

- Retrofitting of old tractors in the areas of ascent and immobiliser,
- Intelligent hands-free system as standard equipment on tractors,
- Define and specify tractor front loader interface in terms of safety (handling round bales, lifting people)

The following areas are important in terms of safety behaviour during handling and operation:

- Driver safety training with defined requirement areas (basics, trailer operation during harvesting, narrow-track tractors, farm loaders, attachments),

- Proof of qualification for the safe handling of chainsaws (no defined training courses, but the verification of manual skills).

Figure 2. Examples to promote awareness of safe handling of tractors, for example wearing a seatbelt: tractor translated caption: fasten your seatbelt, listen to your lifesaver! Bubble> do not forget to fasten your seatbelt! Farm loader translated caption: “cow wisdom”, bubble> pun in German with the word "schnallt" (=fasten), which means something like "when will he finally get it"

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