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Assessment of a v-form scraper in a horse barn with paddock boxes

In the survey at hand, the procedural costs for a v-form scraper are gathered. In the process, it is found that due to the reduced working time requirement the use of a v-form scraper saves € 78/horse/year. The mechanization of manure removal can reduce working time in horse keeping by almost 30 percent. However, using manure removal systems, the profitability is not the only crucial criteria. The behaviour of the horses plays an essential role, too. Moreover the horses' behaviour when first encountering the manure scraper is observed. The study reveals that the horses avoid contact with the scraper and thereby also shirk critical situations.

Keywords
Manure removal systems, working time requirement, horse behaviour

Abstract
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Personnel costs make up a significant part of the costs in a horse keeping establishment. The actual working time requirements vary due to the individual conditions. These are for example the walking distances that are covered daily in the working process of a stable, the number of animals and the degree of mechanization [1]. Due to the individual conditions in practice, it is difficult to do systematic comparisons. This is why information concerning the working time requirement for routine procedures in horse stables varies strongly [2; 3; 4].

Currently, different techniques for manure removal in horse stables are being offered on the market; however, they are not yet to be widely distributed. In the case of the v-form scraper, this may be caused by the missing knowledge about functioning, profitability and horse behaviour. Literature presents a procedural comparison of common manure removal techniques, based on model stables with 24 horse boxes, to answer to questions about manure removal mechanization. Since it is not possible to investigate v-form scrapers, target figures are used to calculate working economy data. In the concluding procedural comparison of different manure removal techniques, the v-form scraper does well in annual costs and places first concerning working time savings [5].

The survey at hand aims to contribute to an improved estimation of the procedure of "v-form scraper manure removal systems in horse stables". In a testing stable, the profitability of a v-form scraper is exemplarily being rated while the behaviour of the horses when first encountering the scraper is being observed and judged with regards to potential dangers for the animals.

Material and Method

Testing Stable

A pension horse stable with 34 boxes serves as the testing stable. One v-form scraper was installed for a row of 8 boxes 3.5 years ago. On the opposite side of the stable, in the second row of 8 boxes, another v-form scraper is added. The horses in this row are 7 warmbloods and one Icelandic horse aged between 7 and 19 years. As one of the horses is temporarily absent, it is being left out of the evaluation. The mentioned 8 boxes measure 3.4 m x 4.5 m, the corresponding paddocks measure 3.4 m x 5.5 m. The v-form scraper (Suevia Haiges GmbH) is being pulled through the running gear in the pad-

Fig. 1

Paddocks with v-form scraper in the pilot plant (Foto: J. Köhnke)

docks in a concrete U-Form by 2 cranks on a synthetic rope at a speed of 5 m/min (**Figure 1**). The running gear is concreted 10 cm deeper than the paddock and measures 2 m of width.

Working Time Acquisition

Manure is being removed in the boxes and their corresponding paddocks once a day. The working time requirement is being registered 3 times with a wheelbarrow and 3 times with the v-form scraper. For this purpose, the working process is divided according to the time-element-method into 8 working segments. These are: entering horse box, manure removal, cleaning paddock, leaving horse box, the way to the dunghill and back to the stable, transport from temporary storage facility to permanent dunghill including stacking (in the case of the v-form scraper manure removal), stacking of solid dung on dunghill (in the case of manure removal using a wheelbarrow). Both procedures are being timed with a chronograph.

When using a scraper to remove manure, the dung is being conveyed out of the box and onto the scraper running gear. In comparison to manure removal using a wheelbarrow, with this technique both transporting the wheelbarrow into the box as well as the immediate way to the dunghill are dropped. Instead, the dung is transported once a day from the temporary storage facility to the permanent dunghill via farm loader. With the measured times at hand, it is possible to define average data and compare both methods. A t-test serves to statistically secure the findings. Using operating specific information concerning wage, deduction and interest rates, the costs for both procedures can be estimated and compared. As a general condition, the overall amount of manure in the stable that is being evaluated has to be registered to make sure it answers to the dimension customary in practice of nine to twelve tons of recent dung per year and horse. For that purpose, the arising amount of dung per paddock-box is being estimated on three days, by putting the dung on silo foil and weighing it with a spring scale.

Behaviour Observation

The horse's behaviour is being documented with video tapings. Subject to the evaluation is the time period during the scraping procedure from installing it until 5 days after the first use. During the scraping, the animals can move freely. They know their box-neighbours as well as the scraper alley that has already been part of their paddock even before the installation of the scraper. The video tapings occur continually during the daily 15 minute dung removal procedure and include both the clearing and the returning process. When evaluating, the occurrence of several behavioural ways in the three different phases of scraper position (scraper in front of paddock, scraper in paddock, scraper after paddock) are being counted according to the scan-sampling-method. In this process, behaviour like remote reconnaissance, near reconnaissance, flight and fear behaviour, mixed types of behaviour [6] as well as direct contact with the scraper are being observed.

Results and Discussion

Working Time Registration

The v-form scraper dung removal with 618.5 cmin per horse and day shows a working time advantage of 29 % in comparison to dung removal with a wheelbarrow with 875 cmin per horse and day (**Table 1**). This means an annual working time saving of 15.6 working hours per horse or calculating for 8 boxes more than 20 minutes a day. Most of the time is being saved in the

Table 1

Working time requirement for manure removal in the testing stable

Arbeitsteilvorgang ***Working segment***	**Schubkarre** ***Wheelbarrow***	**Standardabweichung** ***Standard deviation***	**Schieber** ***Scraper***	**Standardabweichung** ***Standard deviation***	**Ersparnis** ***Savings***
Box Betreten/*Entering horse box* [cmin]	57	13	33	10	24
Box Misten/*Manure removal* [cmin]	315	38	398	33	-83
Paddock Reinigen/*Cleaning paddock* [cmin]	277	97	123	57	154
Box Verlassen/*Leaving horse box* [cmin]	58	27	27	10	31
Hinweg zur Dunglage *Way to dunghill* [cmin]	75	12	-	-	75
Rückweg Dunglage zum Stall *Way back to stable* [cmin]	68	12	-	-	68
Misttransport Zwischen- zum Endlager inkl. Stapeln *Transport from temporary storage facility to permanent dunghill incl. stacking* [cmin]	-	-	37,5	-	-37,5
Stapeln des Mistes auf der Dunglage *Stacking of solid dung on dunghill* [cmin]	25	-	-	-	25
Summe je Box und Tag *Sum per box and day* [cmin]	875	-	618,5	-	256,5
Summe je 8 Boxen und Jahr ***Sum per 8 boxes and year [h]***	**425,8**	**-**	**301,0**	**-**	**124,8**

Table 2

Operating costs for the v-form scraper

	Schubkarre *Wheelbarrow*	Schieber *Scraper*
Lohnkosten/*Labour costs*		
Lohn inkl. Lohnnebenkosten (13 €/Jahr)/*Wage incl. non-wage labour costs (13 €/a)*	5.535 €	3.913 €
Fixe Maschinen- und Anlagenkosten/*Overhead expenses for machine and facility*		
Faltschieber (Nutzungsdauer 15 Jahre; Zinssatz 5 %) *Annual overhead expenses (Deduction 15 years; interest rate 5 %)*	-	471 €
Schieberbahn (Nutzungsdauer 25 Jahre; Zinssatz 5 %) *Annual overhead expenses for subsoil (Deduction 25 years; interest rate 5 %)*	-	408 €
Variable Maschinenkosten/*Variable machine costs*		
Strom (0,22 €/kWh)/*Electricity costs (0,22 €/kWh)*	-	8 €
Reparatur und Wartung (2 % des Investitionsbedarfs) *Maintainance costs (2 % of investment costs)*	-	103 €
Variable Kosten Hoflader/*Variable costs for farm loader*	8 €	13 €
Arbeitserledigungskosten für 8 Pferde/*Operating costs for 8 horses*	5.543 €	4.916 €
Kosten je Pferd/*Annual costs per horse*	693 €	615 €

working element of "cleaning paddock", since one can muck out directly onto the scraper alley instead of into the wheelbarrow inside the box. When using a wheelbarrow for manure removal, the deflection to the dunghill and back arise after every box and are omitted with v-form scraper dung removal. Furthermore, the working steps of "entering horse box" and "leaving horse box" can be done a lot faster when one does not have to work with a wheelbarrow. In the case of scraper manure removal, the dung transport with a farm loader from the temporary storage facility to the permanent dunghill including stacking is an additional working element, while in the case of manure removal using a wheelbarrow the dung is stacked on the dunghill every two days with the farm loader. As the working time that is required for this is not being registered, the corresponding data is being provided by the operating manager and transferred from eight boxes to one. The survey was able to estimate daily manure amounts of 28 ± 11 kg per horse. Therefore, the annual manure amount of 10.2 tons per horse is within the usual. It can be assumed that this is valid according to the dung removal expense and that the findings from the representative testing stable are fundamentally relevant in practice.

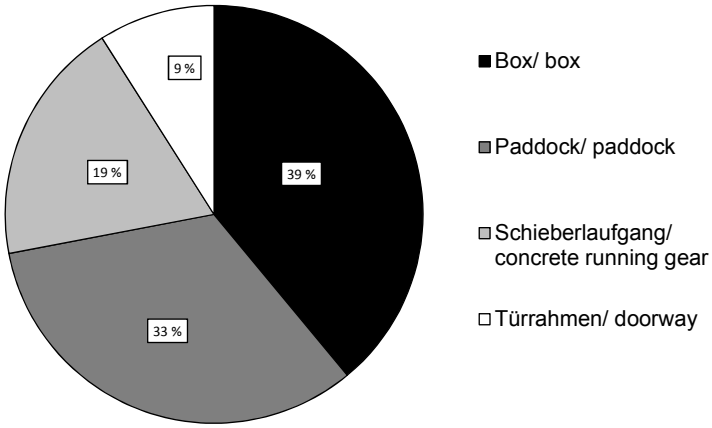
Profitability Calculation

The overall costs for removing dung in the paddock-boxes in the testing stable consist of working costs, fix costs for depreciation and interest rates for v-form scrapers including the concreted scraper alley as well as varying costs for v-form scrapers and farm loader altogether (**Table 2**). When using the v-form scraper, the working time requirement decreases by roundabout 125 working hours a year to a figure of 301 working hours a year. The wage rate is based on € 13 including non-wage labour costs. The power requirement adds up to 36 kWh a year. The power price is at € 0,22 each kWh. The maintenance costs are being calculated with 2 % of the original purchase price. The fix costs for the farm loader that is being used in both procedures is being left out, the varying costs are fixed at € 5,48 per hour. The investment demand for the v-form scraper is € 5143 (excluding sales tax and fitting). Opposing the average investment demand for turf pavers, an increased demand of € 6281 (12,70 €/m²) is fixed for the concreted scraper alley (overall 76 m²) [3]. The overall costs for employing the v-form scraper make up roundabout € 615 per horse and year and thereby undercut the costs of conventional wheelbarrow dung removal by € 78 per horse and year. It is important to consider the v-form scraper's capacity that is significantly bigger and is not fully made use of in the testing stable with 8 boxes. When projecting the costs to a reference of 24 horses to make the outcome comparable to literature data, the scraper cost shares per horse are reduced and the cost advantage compared with wheelbarrow manure removal increases to € 125 per horse and year. Employing a v-form scraper results in overall costs of roundabout € 567 per horse and year for dung removal in boxes and paddocks.

Animal Behaviour

When horses encounter the scraper, they first show scouting behaviour. During the observed time span, the horses do not stay by the scraper in the scraper alley 81 % of the time (**Figure 2**). **Figure 3** shows the whereabouts "box" and "scraper alley". The horses meet the scraper with caution, approach it curiously, but tend to keep their distance. The v-form scrapers slow driving speed allows the horses to watch the scraper, approach it and draw back from it. Near reconnaissance with sniffing, following the scraper or snorting can frequently be

Fig. 2



Whereabouts of the horses during the scraper operation

observed. This serves the purpose of learning how to get rid of their fear of an unknown object [7]. In addition, several ways of behaving like motion, food intake and resting are observed. One time, a horse crosses over the v-form scraper thus establishing direct contact. During the time of observation, the scraper and the rope are both only touched once. **Figure 4** gives an overview of the frequencies of the observed types of behaviour.

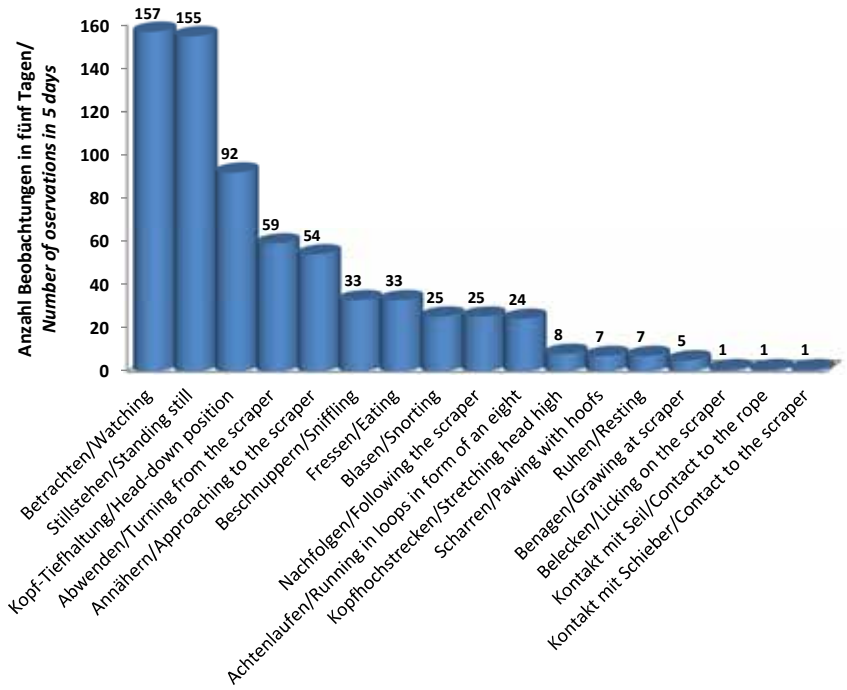
Additional Aspects Relevant for Practice

In addition to the findings of the survey at hand, other aspects that can be relevant for horse keeping practice can be observed. There have not yet been any surveys concerning the strain and stress on the working person. This aspect can play an important role considering the heavy physical occupation espacially in larger establishments. Furthermore, the frost resistance of a v-form scraper is being controversially discussed in practice. The studied establishment provides experience in that area, as there a v-form scraper has been installed in another row of boxes for 3.5 years. It proceeds to run without disruption during the winter months with frost. Moreover, with a v-form scraper in horse keeping less problems can be expected concerning the freezing of the system because in comparison with cattle keeping, the manure texture is drier. In the field of cattle keeping in regions with prolonged frost duration, the functional reliability is usually improved by conducting the guide rail of the scraper's middle block and the pulling rope a few centimetres deeper inside the ground. This conducting is also conceivable in the horse keeping sector if needed. In the testing stable however, there is no necessity. The keeping form of "box with paddock" will presumably gain more relevance in the future, as it allows the horses – opposing mere box keeping – more motion, social contacts, light and fresh air. According to the findings of the survey at hand, the v-form scraper in pension horse keeping displays a profitable technique for mechanization of the manure removal in single boxes with paddock.

Fig. 3

Whereabouts during scraper operation: box (left), scraper alley (right) (Foto: J. Köhnke)

Fig. 4



Horse behaviour during scraper operation

Conclusions

A v-form scraper that has proven reliable in cattle keeping can also take over the manure transport in horse keeping. The scraper alley is part of the horse paddock. In the testing stable with 8 paddock-boxes, the annual working time requirement for manure disposal in boxes and paddocks is reduced from 426 to 301 working hours. At a wage rate of 13 € per working hour, a financial advantage of € 78 per horse and year is being generated in the testing stable. In the case of larger establishments with more than 8 boxes, which thereby can exploit the v-form scraper's capacity better, an even more favourable result is expected. The horses behave calm and show exploration behaviour which corresponds with their normal behaviour during the scraper operation. For security reasons, the v-form scraper systems should generally be monitored during the operation.

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