

Impact of straw on pig and pen hygiene in partly slatted flooring systems

Torun Wallgren (✉ torun.wallgren@slu.se)

Sveriges Lantbruksuniversitet Veterinärmedicin och husdjursvetenskap <https://orcid.org/0000-0003-3205-2692>

Nils Lundeheim

Sveriges Lantbruksuniversitet Veterinärmedicin och husdjursvetenskap

Stefan Gunnarsson

Sveriges Lantbruksuniversitet Veterinärmedicin och husdjursvetenskap

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Abstract

Background: Straw is a beneficial enrichment material for pigs, shown to improve welfare and reduce abnormal behaviour such as tail biting. Straw has previously been identified as one of the means of how to raise pigs without tail docking, through improving natural exploratory behaviour. Straw has however been linked to poor pen hygiene, making farmers reluctant to use straw and has largely not been implemented in commercial farming. Straw is a beneficial enrichment material for pigs, shown to improve welfare and reduce abnormal behaviour such as tail biting. Straw has however been linked to poor pen hygiene, making farmers reluctant to use straw and has not been implemented in many commercial farming.

Results: This study investigates the impact of straw on pig and pen hygiene in partly slatted pens in three grower and four finishing pig batches on five commercial farms in Sweden which are providing straw daily. Each batch was divided into two treatments; Control: 50-600g straw/pen/day based on the farm normal straw ration; and Extra straw; (=doubled Control ration). The pens were scored based on cleanliness of the pigs, solid and slatted pen floor every second week. The pig and pen hygiene were mostly scored as clean in both treatments, overall around 1 % of the observations were considered dirty/soiled.

Conclusions: As very few pens or pigs were considered dirty, it was concluded that straw provision is possible without risking poor pig and pen hygiene. Few observations in this study were considered dirty regardless of amount of straw that was provided, and had likely to do with other factors in the production rather than straw ration. These results implicates that straw could be used in partly slatted pens in order to improve pig environment.

Background

Over 90% of EU pigs are tail docked to minimise tail biting which causes reduced welfare and production [1]. Although tail biting is a multifactorial, lack of long straw has been identified as the largest risk factor for tail biting [2]. Several studies have investigated the amount of straw needed to keep tail biting at an acceptable level on both research farms [3, 4] and in commercial settings [5, 6]. Actual implementation of straw has however largely not taken place and there are still lack of management routines on how to provide straw.

One reason why straw provision has not been implemented is the farmer opinion that straw may block the slatted flooring, manure handling system and stack mired straw in pens, disturbing the pen environment [7–9]. A survey among Swedish farmers using straw it was considered that blockage of slats and manure handling was the most common reason for not increasing straw rations although problems in the manure handling system were quite rarely reported [6]. Furthermore, in practice straw was not reported to be associated with increased need of manual cleaning [5] which has previously been proposed by e.g. Tuytens [10]. Previous studies show that pig hygiene was worse in straw-based compared to fully slatted systems [11]. However, fully slatted pens substantially reduce the possibility to provide straw on the floor since most straw will quickly pass through the slats and reduces the behavioural benefits for the pigs. Pigs in straw-based systems may purposely soil their lying area to enabling wallowing during hot conditions, which may impair pig hygiene [11] but may also be an indication of poor indoor environment.

There is lack of knowledge of how straw provision impact hygiene under commercial conditions. The aim of this study was to investigate the pig and pen hygiene in systems with partly slatted flooring in farms that are providing increased straw ration compare to standard level. The gained knowledge may be used for facilitating straw usage in commercial production in partly slatted flooring systems.

Methods

Animals and housing

The study was conducted in five commercial Swedish pig farms from November 2015 to June 2017. All pigs were progenies of crossbred sows (Landrace and Yorkshire sows; either Norwegian Landrace*Swedish Yorkshire or Norwegian Landrace*Topigs Large White, that were inseminated with Duroc (G1, G2, F2, F3, G5, F5) or Hampshire boars (F4). One batch each of growing pigs (10 to 30 kg) was investigated on three grower farms: one specialized piglet producing farm (G1), and two farrow-to-finish farms (G2, G4). One batch each of finishing pigs (30 kg – 120 kg) was investigated on four farrow-to finish farms (F2, F3, F4, F5). On F2 and F4 the same batch of pigs was observed in the grower finishing pig stable. The experiment started as the pigs moved in to the grower/finisher unit and finished as the pigs were moved from the grower unit to the first pig was sent to slaughter, respectively. Detailed information about farms and housing is found in Table 1.

Table 1

Information on participating farms, studied animals and straw provisions. Identical Farm number (within farm id) indicates that the farm produced both grower and finisher pigs. C indicates Control treatment and ES Extra Straw treatment (Wallgren et al. 2018).

Farm	Age category	No. pigs produced /year	No. of days in experiment	No. pigs in experiment	No. of pens		Pen Size (m ²)		No. of pigs / pen	Area/pig (m ²)	Mean straw length (range).cm	Straw ration. g/pen			Straw g/pig
					C	ES	Total	Slatted				C	ES	C	
G1	Growers	18 000	35	286	12	12	4.98	1.19	12	0.41	6.6(1-40.5)	100 (day 1-15)	200	500	8.3
												200 (day 16-24)	1000		16.7
												600(day 25-35)			50.0
G2	Growers	7000-7500	34	427	22	17	5.39	1.06	10-11	0.49-0.54	11.9 (7.5-88.5)	47	94		4.3-4.7
F2	Finishers		74	444	21	21	10.49	2.68	11	0.95	11.9 (7.5-88.5)	132	264		12
F3	Finishers	2300	70	195	11	9	9.7	1.8	11	0.88	10.4 (1-44)	100	200		9.1
G4	Growers	7500	43	360	12	12	4.01	1.08	12(9) ¹	0.33-0.45	5.3(1-31)	46	92		3.8-5.1 ¹
F4	Finishers		74	209	12	12	9.05	2.25	9	1.00	6.9(5.5-51.5)	110	220		12.2
F5	Finishers	10 000	68	408	20	20	10.49	2.68	10	0.95	8.4(1.5-44.5)	58	115		5.8
¹ In farm 4. three pigs per pen were removed after 5 weeks to comply with national legislation according to Swedish board of Agriculture regulations and gene (2017:25) on the holding of pigs in agriculture, case no. L 106															
² 2 weekends and one week															
³ 3 weekends															
⁴ 7 weekends															

The pigs had daily straw provision and supervision according to normal farm routines. All pens consisted of both solid and slatted flooring (Table 1). The pigs were mixed in pens with gilts and castrates and sorted by size; housing the heaviest and the lightest pigs together respectively. Intact litters was practiced when possible. This study was part of a larger study investigating the impact of increased straw ration on pig behaviour and prevalence of tail lesions (see [5]).

Experimental design and treatments

The studied pens was divided in two treatments per farm: Control (C), receiving the farm normal straw ration; and Extra Straw (ES), receiving a double C-ration (Table 1). The C-ration was determined and standardized before the experiment by measuring the daily straw ration provided by the herdsmen (Table 1). All pens of the same treatment were located in the same row of the stable unit, to ease for the animal caretaker. Except for straw ration, all pens in the stable unit were managed in the same way on farm level. Any exceptions from the straw provision routine were recorded by the caretaker (Table 2). If there was blockage in the slatted flooring, and more than 50% of the slatted area was no longer visible, the daily straw provision could be paused until blockage was cleared.

Table 2

Interruption in provision of daily straw, %. Identical Farm number indicates that the farm produces both grower and finisher pigs. C indicates Control treatment and ES Extra Straw treatment.

Grower Farm	C	ES	Finisher Farm	C	ES
G1	0	0			
G2	0	0	F2	11	11
			F3	1	6
G4	0	0	F4	6	6
			F5	0.3	0.08

Observations

The pig and pen hygiene was scored every second week, including the first and last week of the experiment by two observers (taking turns scoring C or ES treatment, no intra-observer reliability was measured) (Table 3). The recordings were conducted at least one hour after the daily cleaning and straw provision.

Table 3
Production length and number of observations specified per participating farm. Identical Farm number indicates that the farm produces both grower and finisher pigs. WIP indicates weeks in production.

Farm	WIP	Number of scorings
G1	5	4
G2	5	3
G5	3	4
F2	13	7
F3	9	5
F4	11	7
F5	10	6

Pig hygiene

Pig hygiene was scored according to the Welfare Quality® protocol applied to growing and finishing pigs manure on the body (Welfare Quality 2009). All pigs were individually assessed for manure on the body, on the side that was visible towards the observer according to a three point scale; 1 if a maximum of 20% of the pig was covered in manure; 2: >20–50% of manure coverage; 3: >50 of manure coverage.

Pen hygiene

The solid and slatted floor of the pen were each divided in to four separate parts (Fig. 1). The solid floor part was considered dirty when at least 50% of the area was covered by faeces, mired straw or was wet. The slatted floor area was considered as blocked, when the slats was covered and no space between the slats was visible for at least 50% of the assessed area. For each part assessed as dirty/blocked, the pen was scored with one point. Subsequently the scores were added to receive the final hygiene score of the solid and slatted area respectively. A pen could have a maximum of four points (all parts \geq 50% dirty/blocked) and a minimum of 0 points (all parts < 50% dirty/blocked) per solid/slatted area.

Statistical analysis

All data was recorded in Microsoft Excel 2016 and analysed through SAS 9.4 (SAS Institute Inc., Cary, NC, USA). The descriptive statistics were calculated through means and frequencies on both farm and age category (grower/finisher) level. Pig and pen hygiene data was ordinal and data had repeated measurements on pen level.

Pig hygiene

The low variability made analysis of variance on age level impossible. To enable analysis the data was rearranged into binomial traits; hygiene score 1 (i.e. maximum 20% soiled body surface) were considered clean while pigs with score 2–3 (> 20% soiled body surface) were considered dirty. Data was then analysed using Fisher's exact test, investigating impact of Treatment (C or ES) on Pig hygiene on pig level for each Farm and observation occasion separately.

Pen hygiene

The low variability made analysis of variance on age level impossible. To enable analysis of variation, the data was rearranged into binomial traits on the solid/slatted floor separately. Pens with the score 0 (no soiling/blockage of the floor) were considered clean while pens with score 1–4 (soiling/blockage of 25–100% of the Solid/Slatted area) were considered dirty. Data was then analysed using Fisher's exact test, investigating the impact of Treatment (C or ES) on pen hygiene on pen level for each Farm and observation occasion separately.

Correlation between Pig and Pen hygiene

Spearman rank correlation was used to investigate the correlation between pig hygiene and solid/slatted floor hygiene. Pig hygiene was converted into a mean score per pen instead of the initial pig level value. Solid and slatted hygiene was kept as the initial values ranging from 0–4 for each occasion. Thus, the correlations were estimated based on pen level scores, for each scoring occasion, both on Farm and Treatment level.

Methods

Animals and housing

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Observations

The pig and pen hygiene was scored every second week, including the first and last week of the experiment by two observers (taking turns scoring C or ES treatment, no intra-observer reliability was measured) (Table 3). The recordings were conducted at least one hour after the daily cleaning and straw provision.

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Results

Pig hygiene

Grower level

In grower pens, 99.4% of the observed pigs were scored 1 (ranging from 1-2 in C and 1-3 in ES treatment); 99.1% in C and 99.5% in ES treatment. On farm G1 scores ranged from 1-2 in both treatments, on farm G2 scores ranged from 1-2 in C treatment and 1-3 in ES treatment, on G4 all pigs were scored 1 at all occasions. In total, 0.8% of the observations on G1 and 1.1% on G2 were considered dirty.

No significant treatment effect on pig hygiene was found on any farm on grower level (Table 4).

Finishing pig level

In finisher pens, 97.1% of the pigs observed were scored 1 (ranging from 1-3), 96.7% in C and 97.4% in ES treatment. On F2, F4 and F5 scores ranged from 1-3 in both treatments. On F3 scores ranged from 1-3 in C and 1-2 in ES treatment. In total, 0.9% of the observations on F2, 0.8% on F3, 8.1% on F4 and 3.4% on F5 were considered dirty.

Significant treatment effect on pig hygiene was found at three occasions on two of the farms. On F4, the highest straw ratio (ES) had cleaner pigs on occasion 4 ($P < 0.05$). On F5, lowest straw rations (ES) pigs were cleaner on occasion 6 ($P < 0.001$) while C pigs were cleaner on occasion 10 ($P < 0.001$) (Table 4).

Pen hygiene

Solid floor area

Grower level. 91.6 % of the C and 96.3% of the ES observations were scored 0 (Table 4). The mean score ranged from 0.0-0.2 on farm level. On Farm G1, G2 and G4, no significant effect of treatment was found on Solid floor hygiene (Table 5).

Finishing pig level. 89.4% of the C and 92.0% of the ES observations were scored 0 (Table 4). The mean score was from 0.0-0.4 between the farms. F3 and F2 had no effect of treatment (Table 5). F4, i.e. one of the highest straw rations, C pens were cleaner compared to ES pens on occasion 4 ($P < 0.001$), 8 ($P < 0.01$) and 11 ($P < 0.01$). On Farm F5, i.e. the lowest straw ration, C pens were cleaner compared with ES pens on occasion 8 ($P < 0.001$).

Slatted floor area

Grower pig level. 85.4 % of the C and 90.7% of the ES observations were scored 0 (Table 4). On G2, i.e. the lowest straw ration, the score ranged from 0-4 in C Treatment and 0-2 in ES Treatment. On G2, ES pens were cleaner compared to C pens on occasion 3 ($P < 0.001$), but no treatment effects were seen on farms G1 or G4 (Table 5).

Finishing pig level. 92.5% of the observations in C and 98.4% of the observations in ES were scored 0 (Table 4). The hygiene score ranged between 0-2 on F2, 0-1 on F3, 0-4 on F4 and 0-3 on F5. No treatment effect was found on F2, F3 and F5 (Table 5). On F4, C pens were cleaner than ES on occasion 8 ($P < 0.05$) and 11 ($P < 0.01$).

Correlation between Pig and Pen Hygiene

Grower pig level. On Farm level, correlations were found on farm G2, where solid hygiene was positively correlated with pig hygiene ($P < 0.05$) and slatted hygiene ($P < 0.001$) (Table 6).

On Treatment level solid and slatted hygiene was fully correlated on farm G1 on WIP (weeks in production) 5 ($P < 0.0001$) (Table 7). In C treatment on G2 Pig hygiene was positively correlated with slatted hygiene ($P < 0.005$) and fully correlated with solid hygiene ($P > 0.001$) and solid and slatted hygiene was positively correlated ($P < 0.05$) on WIP 5. In the ES treatment Solid and slatted hygiene was positively correlated in WIP 5 ($P < 0.05$).

Finishing pig level. On Farm level, correlations were found on farms F2, F3 and F4 (Table 6). On F2 pig and solid hygiene was positively correlated on WIP 5 ($P < 0.05$) and solid and slatted hygiene on WIP 13 ($P < 0.001$). On F4 positive correlations were found between solid and slatted hygiene on WIP 8 ($P < 0.05$), 10 ($P < 0.05$) and 11 ($P > 0.05$). On F5 positive correlations were found between solid and slatted hygiene on WIP 2 ($P > 0.001$) and WIP 6 ($P > 0.001$).

On Treatment level, effects were found on F2, F4 and F5 but not F3. On F2 pig hygiene was positively correlated with slatted hygiene on WIP 5 ($P < 0.01$) WIP 13 ($P < 0.05$) in C treatment (Table 7). In ES treatment solid and slatted hygiene was fully correlated ($P < 0.001$) on F2. On F3 solid and slatted hygiene was positively correlated in WIP 11 ($P < 0.01$) in C treatment. On F5 solid and slatted hygiene was positively correlated in WIP 2 ($P < 0.01$) and WIP 6 ($P < 0.01$) in C treatment.

Discussion

Our study did not indicate that pen provided with straw had poor hygiene since the absolute majority of observations were (>90%) were clean. This experiment was conducted to gain further knowledge on straw impact on pig and pen hygiene in order to facilitate straw usage in commercial pig production as the compatibility of straw into current production systems, with slatted floors and mechanic manure handling, has been questioned [9, 10].

The effect of the straw amount on pig behaviour could be found in Wallgren et al [5]. Whenever there was a Treatment effect on pig hygiene, ES treatment resulted in cleaner pigs, compared C treatment. The effect on pen hygiene was more variable although most pens were considered clean and implies that straw has different effects on different farms. Increased straw rations might help differentiating between lying and dunging areas, leading to less soiling of

the lying area, on farms where straw provision lower. On farms with larger C rations, negative effect was mainly seen on the slatted floor possibly indicating that if larger amounts of straw do end up on the slats it might not pass through the slats and hence reducing slatted floor hygiene. However, it should be noted that the overall hygiene scores were very good on all farms, suggesting a satisfactory pen hygiene for all treatments.

The scoring of pig and pen hygiene was conducted at least 1 hour after the daily supervision, when pens were cleaned and provided with straw, which might have affected the results. However, as reported from the same experiment [5], the treatment had no effect on manual cleaning. It could be argued that the pig hygiene is a more long term effect of the pen hygiene as pigs will get soiled lying in a soiled pen. The pig hygiene will thus sustain also if the pen has been temporarily cleaned. Therefore, the cleanliness of the pigs supports the conclusion that the pen hygiene was good. On few occasions, positive correlations were found between solid floor hygiene and pig hygiene, indicating that pigs needed to lie down on a dirty solid area. Correlations between slatted floor hygiene and pig hygiene were less common. Significant correlations between solid and slatted floor pen hygiene were more common, although only found on few occasions. The equivocal results are probably dependant on the low variability and relative cleanliness of the pens, where the possible poor hygiene on the slatted floor is not enough to change the behaviour of the pig to soil also the solid floor and vice versa. Dirty pigs could also be as result of wallowing, i.e. the covering of the body in mud-like substances [12]. The behavioural background of wallowing is not fully understood but is thought to be part of e.g. thermoregulation, grooming, sexual and social behaviour [12]. Wallowing in excreta, the only type of wallowing offered here, has however been advocated as an abnormal behaviour and suggested to happen only when there is no other suitable wallowing substrate available[13, 14]. Further, wallowing in excreta would only serve as thermoregulatory as pigs normally would avoid lying in excreta [13, 14]. Wallowing in excreta is thus rather an indicator of improper environment and not primarily a hygiene issue.

This study was done on commercial farms, and daily straw provision and reporting was performed by the herdsmen. The low variability in the data made sophisticated modelling of the effect of increased straw difficult, while the descriptive data and simple tests still has great value describing the practicalities of using straw in partly slatted pens. Studies conducted on-farm differ compared to studies conducted on research farms where research is the main activity. The accuracy of studies made in commercial settings may therefore be discussed in terms of e.g. self-reporting and consistency of applied treatment. In order to increase the reliability the experiment was conducted in several farms. Conducting the experiment in commercial setting aimed to increase the applicability of the results. Daily straw provisions to pigs in partly slatted pens did not result in poor pig or pen hygiene.

Conclusions

The amount of straw provided had no effect on the hygiene scoring of the pen floor (solid or slatted) or pen hygiene. It could therefore be concluded that it is possible to provide pigs with straw without risking large problems with hygiene. Pens with presence of poorer hygiene were commonly not affected by the amount of straw provided, why hygiene issues was probably related to other management issues rather than the provision of straw.

Abbreviations

C- Control

ES- Extra Straw

Declarations

Ethics approval and consent to participate

The study comprised only behavioural observations of privately owned commercial pigs and the treatment aimed to improve animal welfare. Due to the low severity of the treatment of the animals (increased straw ration) and usage of privately owned animals this experiment did not require approval by an ethical committee for animal experiments due to Swedish National legislation [SJVFS 2019:9 2 kap. 18 §]. All participation was voluntary and accepted through verbal consent and withdrawal from the experiment could be done at any point in time if the farmer wanted to according to SJVFS 2019:9 2 kap. 17 §.

Consent for publication

Not applicable

Availability of data and materials

The datasets used and analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors contributions

Study design: SG, TW. Data collection: TW. Data analysis: NL, TW. Writing the manuscript: SG, NL, TW. Funding application: SG. All authors read and approved the manuscript.

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Tables

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Farm	Age category	No. pigs produced /year	No. of days in experiment	No. pigs in experiment	No. of pens		Pen Size (m ²)		No. of pigs / pen	Area/pig (m ²)	Mean straw length (range).cm	Straw ration. g/pen			Straw g/pig
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F2	Finishers		74	444	21	21	10.49	2.68	11	0.95	11.9 (7.5-88.5)	132	264		12
F3	Finishers	2300	70	195	11	9	9.7	1.8	11	0.88	10.4 (1-44)	100	200		9.1
G4	Growers	7500	43	360	12	12	4.01	1.08	12(9) ¹	0.33-0.45	5.3(1-31)	46	92		3.8-5.1 ¹
F4	Finishers		74	209	12	12	9.05	2.25	9	1.00	6.9(5.5-51.5)	110	220		12.2
F5	Finishers	10 000	68	408	20	20	10.49	2.68	10	0.95	8.4(1.5-44.5)	58	115		5.8

¹In farm 4. three pigs per pen were removed after 5 weeks to comply with national legislation according to Swedish board of Agriculture regulations and general advice (SJVFS 2017:25) on the holding of pigs in agriculture, case no. L 106

²2 weekends and one week

³3 weekends

⁴7 weekends

Table 2. Interruption in provision of daily straw, %. Identical Farm number indicates that the farm produces both grower and finisher pigs. C indicates Control treatment and ES Extra Straw treatment.

Grower Farm	C	ES	Finisher Farm	C	ES
G1	0	0			
G2	0	0	F2	11	11
			F3	1	6
G4	0	0	F4	6	6
			F5	0.3	0.08

Table 3. Production length and number of observations specified per participating farm. Identical Farm number indicates that the farm produces both grower and finisher pigs. WIP indicates weeks in production.

Farm	WIP	Number of scorings
G1	5	4
G2	5	3
G5	3	4
F2	13	7
F3	9	5
F4	11	7
F5	10	6

Table 4. Descriptive statistics of pen hygiene scoring for both grower and finishing pigs. C indicates Control treatment and ES Extra Straw treatment. Identical Farm number indicates that the farm produces both grower and finisher pigs.

Farm	Treatment	Slatted Hygiene score							Solid Hygiene score							Pig Hygiene score					
		n	0	1	2	3	4	mean	n	0	1	2	3	4	mean	n	1	2	3	n	mean
Growers																					
	C	164	140	12	8	3	1	0.25	156	150	13	1	0	0	0.09	1823	1807	16	0	164	1.01
	ES	164	142	7	7	0	0	0.13	156	150	4	2	0	0	0.05	1743	1735	6	2	161	1.01
G1		96	94	2	0	0	0	0.02	96	85	11	0	0	0	0.11	1149	1140	9	0	96	1.01
G2		128	93	16	15	3	1	0.46	128	121	4	3	0	0	0.08	1350	1335	13	2	133	1.01
G4		96	95	1	0	0	0	0.01	96	94	2	0	0	0	0.02	1067	1067	0	0	96	1.00
G1	C	48	48	0	0	0	0	0.00	48	39	9	0	0	0	0.19	573	567	6	0	48	1.01
G1	ES	48	46	2	0	0	0	0.04	48	46	2	0	0	0	0.04	576	573	3	0	48	1.01
G2	C	68	45	11	8	3	1	0.59	68	65	2	1	0	0	0.06	721	711	10	0	68	1.01
G2	ES	60	48	5	7	0	0	0.32	60	56	2	2	0	0	0.10	629	624	3	2	65	1.01
G4	C	48	47	1	0	0	0	0.02	48	46	2	0	0	0	0.04	529	529	0	0	48	1.00
G4	ES	48	48	0	0	0	0	0.00	48	48	0	0	0	0	0.00	538	538	0	0	48	1.01
Finishers																					
	C	373	346	23	4	0	0	0.08	373	332	35	3	1	2	0.14	3842	3716	95	31	377	1.04
	ES	352	289	41	15	5	2	0.27	352	325	22	3	1	1	0.10	4104	3998	89	17	357	1.04
F2		233	229	3	1	0	0	0.02	233	225	8	0	0	0	0.03	3019	2993	24	2	236	1.01
F3		95	90	5	0	0	0	0.05	95	81	13	1	0	0	0.16	1044	1036	6	2	95	1.01
F4		159	98	41	14	4	2	0.56	159	125	25	4	2	3	0.32	1407	1293	86	28	159	1.10
F5		238	218	15	4	1	0	0.11	238	226	11	1	0	0	0.05	2476	2392	68	16	244	1.04
F2	C	126	123	2	1	0	0	0.03	126	120	6	0	0	0	0.05	1380	1367	12	1	127	1.01
F2	ES	107	106	1	0	0	0	0.01	107	105	2	0	0	0	0.02	1639	1626	12	1	109	1.01
F3	C	51	49	2	0	0	0	0.04	51	41	9	1	0	0	0.22	559	553	4	2	51	1.01
F3	ES	44	41	3	0	0	0	0.07	44	40	4	0	0	0	0.09	482	480	2	0	44	1.00
F4	C	79	65	13	1	0	0	0.19	79	66	9	1	1	2	0.28	695	631	45	19	79	1.12
F4	ES	80	33	28	13	4	2	0.93	80	59	16	3	1	1	0.36	712	662	41	9	80	1.08
F5	C	117	109	6	2	0	0	0.09	117	105	11	1	0	0	0.11	1205	1162	34	9	120	1.04
F5	ES	121	109	9	2	1	0	1.13	121	121	0	0	0	0	0.00	1271	1230	34	7	124	1.04

Table 5. Impact of treatment on pig and pen hygiene scores. The table displays where Treatment had an effect on hygiene. For the full table, see Appendix I. Identical Farm number indicates that the farm produces both grower and finisher pigs. WIP indicates Weeks in Production.

Farm	Treatment	WIP	Slatted Hygiene		p-value	Solid Hygiene		p-value	Pig Hygiene		p-value		
			Clean	Not Clean		Clean	Not Clean		Clean	Not Clean			
G2	C	3	14	10		24	0		253	0			
	ES		20	0	0.0009	20	0	N.E.	217	0	N.E.		
F4	C	4	12	0		12	0		103	6			
	ES		12	0	N.E.	0	12	0.0001	108	0	0.0291		
	C	8	10	2		12	0		80	23			
	ES		4	8	0.0361	5	7	0.0046	93	13	0.0670		
	C		10	4	8		9	3		93	10		
	ES			12	0	0.0013	12	0	0.2174	94	12	0.8227	
	C			11	9	2		10	1		77	18	
	ES				2	10	0.0033	3	9	0.0028	92	15	0.4461
F5	C	6	16	4		19	1		180	21			
	ES		20	0	0.1060	20	0	1.000	202	4	0.0003		
	C	8	18	1		19	0		177	11			
	ES		20	0	0.4872	11	9	0.0012	202	5	0.1234		
	C		10	16	4		16	4		213	4		
	ES			20	0	0.1060	18	2	0.6614	179	25	0.0001	

Solid and slatted floor area was scored on a 5 graded scale, 0 indicating no soiling/blocking. For each score above 0, 25% of the Solid/Slatted floor was considered soiled/blocked. Pig hygiene was scored on a 3 graded scale, 1-3. Score 1 indicate maximum of 20% soiled body surface, score 2; maximum 50% soiled body surface, score 3; more than 50% soiled body surface. Soiling of body surface was scored on one of the pig sides according to Welfare Quality (2009). N.E.: non estimable.

Table 6. Correlation between pig hygiene, slatted and solid pen hygiene on farm level. The table displays where there was a significant correlation between traits. For the full table, see Appendix I Identical Farm number indicates that the farm produces both grower and finisher pigs. WIP indicates Weeks in Production.

Farm	WIP	Pig Hygiene*Slatted Hygiene	Pig Hygiene*Solid Hygiene	Solid Hygiene*Slatted Hygiene
G2	5	0.11	0.29*	0.44**
F2	5	-0.10	0.30*	-0.04
	13	-0.08	-0.28	0.46**
F4	8	-0.08	-0.09	0.41*
	10	-0.11	0.15	0.39*
	11	-0.01	0.14	0.49*
F5	2	0.29	-0.05	0.55***
	6	-0.11	0.12	0.48**

*Indicates a p-value between 0.01-0.05

**Indicates a p-value between 0.001-0.01

***Indicates a p-value <0.001

N.E.: non estimable

Table 7. Correlation between pig hygiene, slatted and solid pen hygiene per farm level on treatment level. The table displays where there was a significant correlation between traits. For the full Table, se Appendix I. Identical Farm number indicates that the farm produces both grower and finisher pigs. WIP indicates Weeks in Production.

Farm	WIP	Control			Extra Straw		
		Pig Hygiene Slatted Hygiene	Pig Hygiene Solid Hygiene	Solid Hygiene Slatted Hygiene	Pig Hygiene Slatted Hygiene	Pig Hygiene Solid Hygiene	Solid Hygiene Slatted Hygiene
G1	5	N.E.	-0.38	N.E.	N.E.	N.E.	1.00***
G2	5	0.40*	1.00***	0.40*	-0.25	-0.11	0.60*
F2	5	-0.11	0.65**	-0.073	N.E.	N.E.	N.E.
	13	-0.09	0.55*	-0.05	-0.07	-0.07	1.00***
F4	11	0.36	0.34	0.67*	0.05	0.43	0.06
F5	2	0.32	-0.08	0.51*	N.E.	N.E.	N.E.
	6	-0.21	-0.03	0.46*	N.E.	N.E.	N.E.

*Indicates a p-value between 0.01-0.05
 **Indicates a p-value between 0.001-0.01
 ***Indicates a p-value <0.001
 N.E.: non estimable

Figures

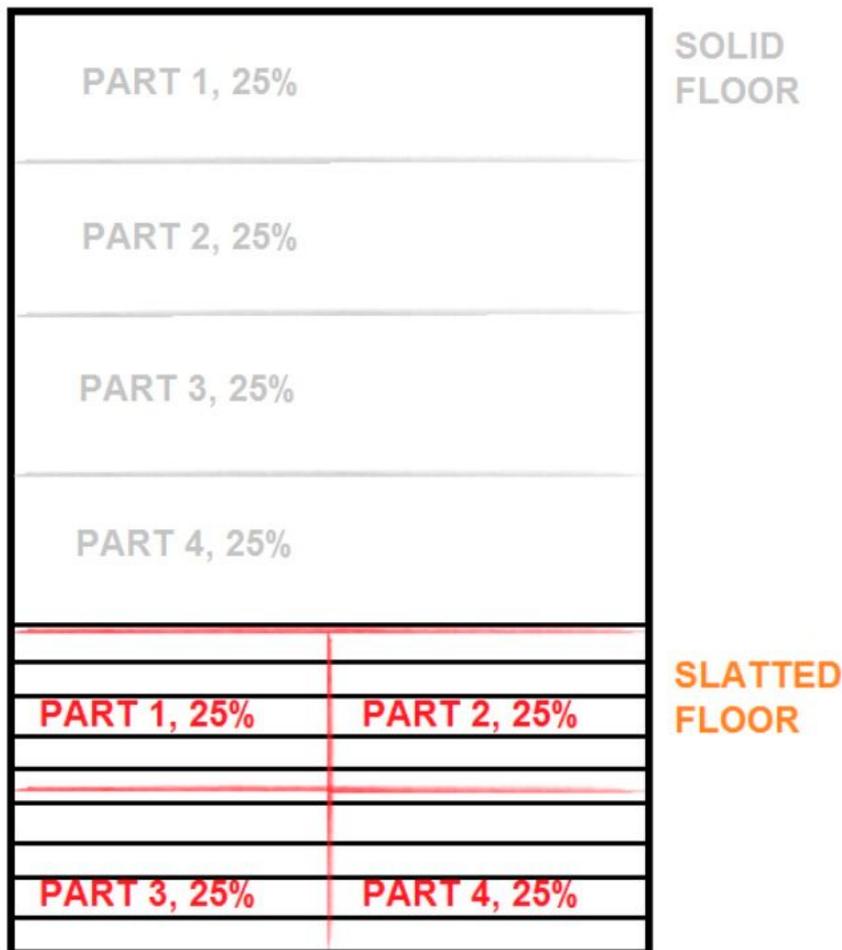


Figure 1

