LANDTECHNIK 71(6), 2016, 210–220

DOI:10.15150/lt.2016.3143

LANDTECHNIK
AGRICULTURAL ENGINEERING

Effects of perforated rubber mats in the lying and walking area of pregnant sows on claws and joints

Christina Jais, Peter Oppermann, Josef Schwanfelder, Miriam Abriel

In a group pen for pregnant sows the floor was covered with perforated rubber mats in the lying and in the walking area. In a reference pen the lying area had hole-perforated concrete elements and the walking area conventional concrete slatted floor. The experiment lasted from November 2011 to June 2014 and included 6 trial runs. To detect the effects of the rubber mats, claws and joints of the sows were evaluated regularly. The sows were stabled in their second pregnancy and passed, depending on their lifespan and their entry into the trial, up to six pregnancies in the experiment. For evaluation of the recorded traits of claws, joints and lameness of the sows, data of 630 pregnancies of 199 sows could be used. The results of the evaluation of the claws showed that the claws of the sows on rubber floor were significantly longer than those of the sows on concrete floor. The traits wall horn abrasion and horn wall cracks were rated significantly worse on concrete floor. No differences were found in the evaluation of lameness.

Keywords:
Rubber mats, pigs, claw health, claw length, claw growth, joints, lameness

Problems with their legs and claws are often reasons for the culling of sows. Previous studies have shown that occurring lameness and the condition of the claws are mainly influenced by the age and the weight of the animals (Meyer 2013). But also the type of the floor has an influence on healthiness and prevalence of lameness. In a study with fattening pigs, it was found that the fewest claw problems occurred in straw bedding. A little more in plastic-concrete combined floors and the most claw problems like bruises, pressure marks, ball lesions and cracks occurred with only slatted concrete floor (Rähse 2006). Other studies showed, that sows which were kept on rubber mats were significantly less lame and had lower wall horn abrasions than sows on concrete floors (Baumann and Pflanz 2014, Calderón Díaz et al. 2014, Falke et al. 2015). However, it has also been shown that the abrasion of the claws on rubber mats is significantly reduced (Calderón Díaz et al. 2014, Jais et al. 2013a).

After previous experiments at the Bavarian State Research Center for Agriculture, in which only the lying area of the pregnant sows was provided with rubber mats and in which no improvement of the claw and joint healthiness with the exception of lateral wall horn abrasions was found (Jais et al. 2013a, Jais et al. 2013b, Jais et al. 2012), now the effect of softer surfaces in the walking area should be tested.

received 20 June 2016 | accepted 22 September 2016| published 1 December 2016

Experimental procedure

In the experimental barn of the Bavarian State Research Center for Agriculture, the floor of a group pen for pregnant sows with a size of 120 m² was equipped with slatted rubber mats in the walking and in the lying area (Figure 1). In the same stable, there was an identical reference pen of which the walking area was equipped with conventional slatted concrete floor and the lying area with hole-perforated concrete floor (Figure 2).

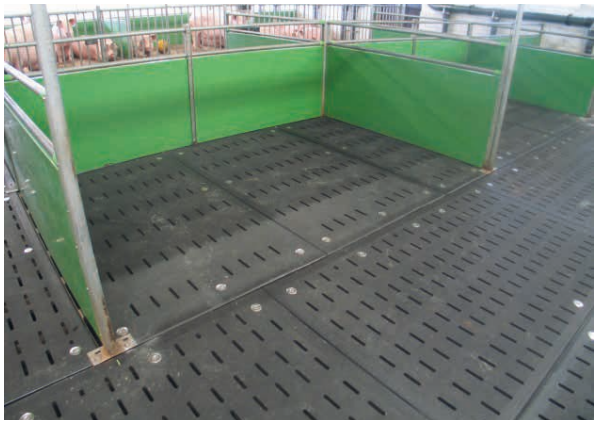


Figure 1: Lying and walking area with rubber mats in the trial pen (Photo: Bayer. LfL)

Figure 2: Lying area with hole-perforated concrete floor and walking area with conventional slatted concrete floor in the reference pen (Photo: Bayer. LfL)

In an additional outdoor area, concrete floor was installed in both pens. Between 46 and a maximum of 58 sows were stabled in each pen. The space per sow was between 2.1 and 2.6 m² depending on the number of animals. The design of the pens with a feeding station, lying and walking area inside and the outdoor area is shown in Figure 3.

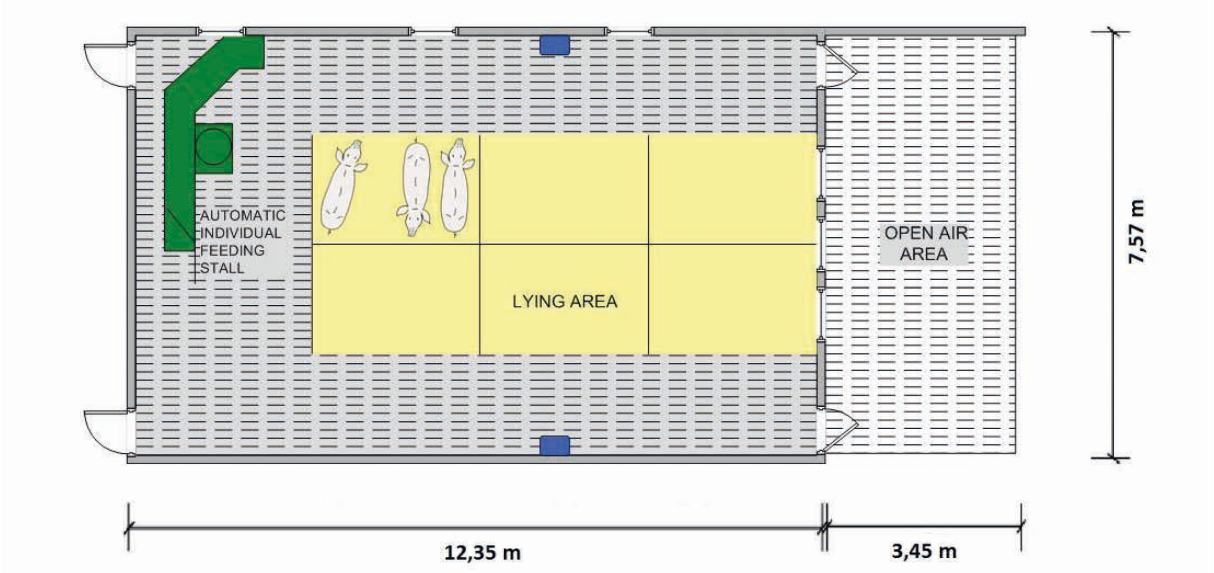


Figure 3: Set-up of the trial and the reference pen

The experiment lasted from November 2011 to June 2014 and included 6 trial runs. The rubber mats came from the company Gummiwerk KRAIBURG Elastik GmbH & Co. KG. They had a degree of perforation of 3–4% in the lying area and of about 8% in the walking area. The slots were between 8 cm and 20 cm long and only 1.5 cm wide. Thus, the slot width of the rubber mats was smaller than that of the concrete floor which was 2.0 cm. Likewise, the degree of perforation of the concrete floor in the walking area was about twice as high as that of the rubber mats.

A total of 92 sows with 319 pregnancies were stabled in the pen with rubber mats and 107 sows with 311 pregnancies in the pen with concrete floor. The sows were included in the experiment in their 2nd pregnancy and passed, depending on their lifetime and the time of entry into the experiment, up to six trial runs. In order to be able to assess a long-term effect of the floor design, animals which had been stabled into the pen with rubber mats in their first trial run, were also kept in this pen during all subsequent pregnancies, also sows held on concrete floor in the first trial run were furthermore stabled into the pen with concrete floor.

At the end of the 4th week of pregnancy, the sows were taken directly from the service area into the group pens of the gestation unit. The trial and control pen should always be filled with approximately the same number of sows. Culled sows were replaced by newly introduced sows in the second pregnancy. An identical stocking density of the pens could be essentially realized, with the exception of trial run 3.

Data collection

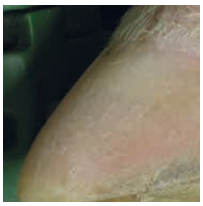
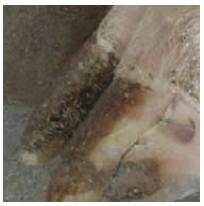
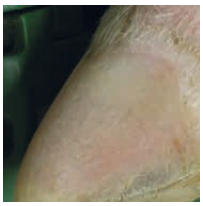
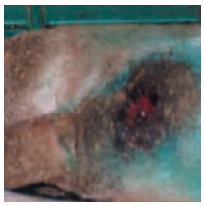
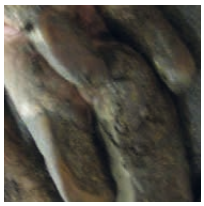
The focus of the investigation was the effect of the rubber mats on the healthiness of claws and legs of the sows. For this purpose, the claws and the joints of the sows were evaluated at two dates per production cycle: the first was in the gestation area, about one week after stabling and after the end of the ranking fights and the second date was at the end of pregnancy, one week after farrowing in the farrowing stable.

The length of the left and right outer claw (front wall) of the two hind limbs was measured once per production cycle about one week after farrowing in the farrowing stable with a sliding caliper (Figure 4).

Figure 4: Evaluation of the claw length (Photo: Bayer. LfL)

The condition of the claws of the back limbs was assessed at two times, too. The balls, wall horn injuries, wall horn abrasions, skin lesions above the claw, the length ratio of the inner claw and the outer claw, and the length of the dew claw were evaluated in a 4-step scheme (score 1 = no findings up to score 4 = severe pathological changes) (Table 1). Likewise, the condition of the fetlock joints and ankle joints was scored into four classes. The detailed scoring scheme has already been explained in a previous publication (Jais et al. 2013a).

Table 1: Example pictures of the 4-stage scoring scheme for claw condition

	Score 1	Score 2	Score 3	Score 4
Ball				
Wall cracks				
Wall abrasion				
Skin lesions above the claw				
Length ratio inner and outer claw				
Length of the dew claw				

The way of walking of the sows was assessed on four dates: when the animals were walking from the service area to the gestation stable, in the gestation stable about one week after stabling (together with the assessment of the claws), stabling from the gestation to the farrowing stable and stabling from the farrowing stable to the service area, again with a 4-step scoring scheme (1 = no results, 2 = slight lameness, 3 = moderate lameness, 4 = severe lameness). They were also individually weighed during the stabling.

Statistical analyses

Since the measured claw lengths and claw growth were continuously scaled, not normally distributed data, the Wilcoxon test was used for the comparison of means. The null hypothesis was that the means of the measured data do not differ between the examined experimental versions. The null hypothesis was rejected when the p-value was below 0.05 (significance level). For p-values below 0.001, the result was denoted as “highly significant”.

The other part of the data were scores (ordinal data) which were evaluated with the Chi-square test. The Chi-square test compares the relative frequencies of variables with a nominal or ordinal scale level. It can be used to check whether an observed distribution corresponds to a given (theoretical) distribution (null hypothesis). The null hypothesis was that the examined experimental versions do not differ regarding the frequency of the scores. The null hypothesis was rejected when the p-value was below 0.05 (significance level). For p-values below 0.001, the result was denoted as “highly significant”.

Results

The results of the different characteristics are shown below. For the evaluation, the assessments of both hind claws and hind legs per sow were taken into account independently of each other.

Claw length

In the experimental farm, dew and main claws were shortened if necessary. For the comparison of the absolute claw length of the main claws, data from sows were no longer included from the time of the first shortening. To evaluate the claw growth, those pregnancies which were affected by a shortening were excluded.

In the following Table 2, the length of the claw front wall of all sows, which completed at least 4 pregnancies in the trial without claw correction, is listed. It can be seen, that the claw length of the sows at the time of their first entry into the experiment, did not differ significantly. However, after four pregnancies, a highly significant difference between the trial versions was found. The sows, which were held on rubber mats, had about 4 mm longer claws than the sows from the pen with concrete slatted floor. The claw front wall of the animals on rubber flooring grew 5.9 mm during four pregnancies, the claws of the sows on concrete floor on average only 2.8 mm. The difference was significant.

Table 2: Length of the front wall of the claws of the sows with at least four pregnancies in the trial without claw correction

Trait	Evaluation date	Treatment	Number of claws	Mean (mm)	Standard deviation	p-value
Length of the front wall of the claw	First introduction into the gestation unit	Rubber mats	80	45.8	4.8	0.4
		Concrete floor	54	45.0	7.3	
	Check out of the gestation unit after four pregnancies	Rubber mats	80	51.7	5.6	< 0.0001
		Concrete floor	54	47.8	3.1	

The scoring of the length of the dew claw of the sows was significantly different between the two experimental versions at both times (one week after entering the gestation unit and one week after farrowing in the farrowing stable). The sows, which were held on the concrete floor in the gestation unit, received grades 1 and 2 more frequently at both times, and more rarely the notes 3 and 4 than the sows held on rubber mats (Table 3).

It was also noticeable that the difference between the two evaluation dates was independent of the experimental version. One week after introduction into the gestation unit, twice as many sows got the notes 1 and 2 as after the pregnancy (Table 3). When assessing the length ratio of the inner and outer claw, there were no differences between the treatments one week after the entry into the gestation unit. In both versions almost all claws were scored with the notes 1 or 2. After the pregnancy when leaving the farrowing pen, there was a significant difference between the treatments. On rubber mats, significantly more claws were given the scores 3 and 4. Score 3 was 12.1 % and score 4 was 2.8 %. On concrete floor, score 3 was 8.0 % and score 4 was not found (Table 3).

Table 3: Evaluation of the length of the dew claws and the length rate of the claws of the hind legs (two values per sow) of all pregnacies of all sows without claw-correction

Trait	Evaluation date	Treatment	Number of claws	Score 1	Score 2	Score 3	Score 4	p-value
Length of the dew claws	Entering the gestation unit	Rubber mats	549	16.6 %	55.4 %	25.1 %	4.9 %	0.03
		Concrete floor	586	19.3 %	56.0 %	22.2 %	2.6 %	
	Leaving the farrowing pen	Rubber mats	544	3.3 %	32.5 %	50.9 %	13.2 %	0.0002
		Concrete floor	572	4.5 %	42.5 %	45.6 %	7.3 %	
Length of the inside- and outside claw	Entering the gestation unit	Rubber mats	549	50.1 %	45.5 %	4.0 %	0.4 %	0.4
		Concrete floor	586	52.4 %	44.5 %	3.1 %	0.0 %	
	Leaving the farrowing pen	Rubber mats	544	21.5 %	63.6 %	12.1 %	2.8 %	< 0.0001
		Concrete floor	572	28.0 %	64.0 %	8.0 %	0.0 %	

Further claw criteria

In the criteria, which were unaffected by a claw correction, the data of all pregnancies of all sows were taken into account, both claws per sow independently of each other. The results of the scoring of the ball zones between the rubber and concrete floor were significantly different at both evaluation times. Sows, which were held on concrete floor, had little higher scores than the sows on rubber mats. A shift to higher scores from the first to the second evaluation was seen in both treatments, too (Table 4).

In the case of the skin lesions, a significant difference between the rubber and concrete floor existed one week after entering into the gestation area. Score 3 was more frequently given on concrete floor than on the sows on rubber mats. This difference no longer existed at the second evaluation.

In the scores of wall horn abrasion and wall horn cracks, there were highly significant differences between the treatments at both evaluation times. The sows in the pen with concrete floor were more frequently evaluated with scores 2, 3, and 4 than the sows in the pen with rubber mats. Deterioration during the pregnancy was observed, too. The joints showed no differences in the evaluation scores between the two treatments, also the evaluation dates hardly differed.

Table 4: Evaluation of the ball-zone, skin, joints and wall-horn damages of all hind legs (two values per sow)

Trait	Evaluation date	Treatment	Number of claws	Score 1	Score 2	Score 3	Score 4	p-value
Ball-zone damages	1 week after entering the gestation unit	Rubber mats	629	43.6 %	52.5 %	4.0 %	0.0 %	0.04
		Concrete floor	616	36.5 %	59.6 %	4.0 %	0.0 %	
	Leaving the farrowing pen	Rubber mats	628	18.9 %	68.3 %	11.6 %	1.1 %	0.05
		Concrete floor	602	15.6 %	66.9 %	16.9 %	0.5 %	
Skin lesions	1 week after entering the gestation unit	Rubber mats	629	19.2 %	78.1 %	2.7 %	0.0 %	0.006
		Concrete floor	616	15.6 %	77.9 %	6.3 %	0.2 %	
	Leaving the farrowing pen	Rubber mats	628	16.7 %	77.4 %	5.1 %	0.8 %	0.7
		Concrete floor	602	16.8 %	78.2 %	4.7 %	0.3 %	
Wall horn abrasion	1 week after entering the gestation unit	Rubber mats	629	67.6 %	31.3 %	1.1 %	0.0 %	< 0.0001
		Concrete floor	616	55.0 %	40.6 %	4.4 %	0.0 %	
	Leaving the farrowing pen	Rubber mats	628	48.6 %	49.2 %	1.9 %	0.3 %	< 0.0001
		Concrete floor	602	27.2 %	66.4 %	6.3 %	0.0 %	
Wall horn cracks	1 week after entering the gestation unit	Rubber mats	629	57.9 %	40.7 %	1.4 %	0.0 %	< 0.0001
		Concrete floor	628	22.5 %	64.2 %	11.5 %	1.9 %	
	Leaving the farrowing pen	Rubber mats	616	48.1 %	46.3 %	5.4 %	0.3 %	< 0.0001
		Concrete floor	602	17.3 %	58.5 %	23.9 %	0.3 %	
Joints	1 week after entering the gestation unit	Rubber mats	629	14.1 %	80.0 %	5.6 %	0.3 %	0.6
		Concrete floor	616	14.8 %	77.8 %	7.3 %	0.2 %	
	Leaving the farrowing pen	Rubber mats	628	13.1 %	74.2 %	12.3 %	0.5 %	0.7
		Concrete floor	602	12.3 %	73.9 %	13.6 %	0.2 %	

Lameness

The lameness was assessed four times, always at the time of moving to the next area. There were no significant differences between the treatments at any of the four evaluation times. It was noticeable, however, that the way of walking was best scored at the changeover from the service unit to the gestation unit in both treatments (Table 5). The evaluation ranged from score 1 (no findings) to low grade (score 2), medium grade (score 3) and high grade lameness (score 4).

Table 5: Evaluation of the way of walking of all sows in all pregnancies at four different points of time

Trait	Evaluation date	treatment	Number of sows	Score 1	Score 2	Score 3	Score 4	p-value
Lameness	Moving from the service unit to the gestation unit	Rubber mats	319	19.4 %	52.4 %	26.0 %	2.2 %	0.8
		Concrete floor	311	20.6 %	54.3 %	22.8 %	2.3 %	
	After 1 week in the gestation unit	Rubber mats	314	4.8 %	52.2 %	37.9 %	5.1 %	0.9
		Concrete floor	307	4.2 %	54.7 %	36.8 %	4.2 %	
	Moving from the service unit to the gestation unit	Rubber mats	314	7.0 %	57.0 %	28.0 %	8.0 %	0.2
		Concrete floor	303	7.6 %	61.7 %	26.4 %	4.3 %	
	Moving from the farrowing unit to the sevice unit	Rubber mats	309	5.8 %	51.1 %	40.1 %	2.9 %	0.4
		Concrete floor	295	6.8 %	55.9 %	35.6 %	1.7 %	

Live weight of the sows

The live weight of the sows was around 250 kg in both variants when entering the gestation unit, and around 290 kg when moving to the farrowing pens. There were no significant differences between the variants.

Reasons of sow losses

To compare the reasons of sow losses between the two trial variants those sows were regarded which entered the trial in their second pregnancy and which were culled during the first five trial runs.

Out of these 124 sows a total of 13 animals bowed out during the first five trial runs even during the course of pregnancy. Four of which came from the trial pen with rubber mats, nine came from the control pen with concrete floor. At the end of the farrowing phase following the pregnancies another 81 sows were culled, 33 of which from the trial pen and 48 of the control pen. Only in few cases leg problems were identified as the reason of sow loss. Although sow losses occurred more frequently on concrete floor, the difference to the rubber mats was not significant.

Discussion

The present results show that the use of rubber mats in the lying and walking area of the sows has an influence on the condition of the claws. Mainly, the abrasion of the claws is reduced, which means that they are significantly longer on rubber mats than on concrete floor. On the one hand, claw-care measures are more frequently required. On the other hand, however, it can be assumed that negative effects of extreme abrasion and pressure stress on the claws can be reduced by rubber mats. The trait "ball zone damages" could be viewed as an indication of a prevailing, high pressure stress. In this trait, significant differences were found between the treatments. The balls of the sows, which were held on rubber mats, were scored better than on concrete floor.

The only partial equipment of the walking areas with rubber mats showed advantages with regard to the abrasion. In a former study where even the outdoor area was completely equipped with rubber mats, the abrasion of the claws was insufficient. While only one pregnancy, the claws grew on an average of 8.7 mm (Jais et al. 2013c). In the present experiment, in which the outdoor area consisted of concrete elements without rubber mats, the claws grew on an average of 5.9 mm and in the control pen with only concrete floor 2.8 mm.

However, in the evaluation of the "wall horn cracks", which are probably caused by pressure loads during standing or walking, significantly better results could be achieved in the claws on rubber mats. The wall horn abrasion, which is a lateral abrasion of the horn caused by the tightening of the legs while lying, was also significantly reduced in the sows in the test pen.

Skin injuries above the claws were a little more pronounced one week after entering the waiting area on concrete floor than on rubber mats. Probably they were caused by ranking fights of the sows, which led to injuries of the legs on concrete floor rather than on rubber mats. No differences between the variants could be found here at the second evaluation date. The condition of the joints of the sows was also not significantly different between the two experimental versions.

The consideration of the dwell times of the sows in the trial as well as the causes of culling out show a slight tendency that the sows on rubber mats reached higher numbers of litter than the sows on concrete floor. However, the differences could not be ensured statistically. For this, presumably longer-term observations and higher numbers of sows would be necessary in order to be able to make assured statements.

With the observed positive effects of the rubber mats on the wall horn and ball zones, this study agrees with the results of other investigations (Meyer 2013, Baumann 2014). The comparison with previous investigations, which tested the rubber mats only in the lying area (Jais 2013b), shows that the soft floor in the running area has a positive effect. Running is thus the greatest burden on animals (Meyer 2013). This explains the deterioration of pathological changes in the course of pregnancy.

Conclusions

Notwithstanding the advantages for wall horn and ball zones, the rubber mats never led to an improvement in the way of walking of the sows. The extent to which possible positive effects have been covered by observed slipperiness of the rubber mats cannot be reliably answered on the basis of the available data. However, the evaluation was carried out on concrete floor at the changeover between the compartments and there the sows should have run better then. This raises the question if the evaluated characteristics of the claws and joints are actually relevant to the welfare of the animals.

To what extent even softer walking areas, that means softer rubber mats, could achieve a further improvement, must remain open. In general, softer rubber mats also result in a lower durability. The durability of the rubber mats was good during the present experimental period in the lying and walking area. It was only necessary to regularly retighten individual screws. In front of the feeding station, on the other hand, the mats were often more damaged, because waiting sows worked the mats with the snout.

References

Baumann, S.; Pflanz, W. (2014): Entwicklung von Komfortmatten für den Liege- und den Laufbereich in der Sauenhaltung (PigComfort), Artikelserie Teil 2: Untersuchungen zur Klauengesundheit. LSZ Boxberg

Calderón Díaz, J. A.; Fahey, A. G.; KilBride, A. L.; Green, L. E.; Boyle, L. A. (2014): Longitudinal study of the effect of rubber slat mats on locomotory ability, body, limb and claw lesions, and dirtiness of group housed sows1, Journal of Animal Science 91(8), pp. 3940–3954, http://www.doi.org/10.2527/jas.2012-5913

Falke, A.; Sidler, X.; Wechsler, B; Weber, R. (2015): Einfluss gummierter Liegeflächen auf die Klauen- und Gliedmaßengesundheit von Mastschweinen. In: Aktuelle Arbeiten zur artgemäßen Tierhaltung 2015, DVG, 19.–21.11.2015, Freiburg, KTBL-Schrift 510, S. 270–272

Jais, C.; Oppermann, P. (2012): Einsatz von Gummimatten bei tragenden Sauen – Haltbarkeit und Sauberhaltung. Landtechnik 67(4), S. 291–294, http://dx.doi.org/10.15150/lt.2012.313

Jais, C.; Oppermann, P., Schwanfelder, J.; Ebert, J. (2013a): Gummimatten im Liegebereich tragender Sauen – Teil 1. Auswirkungen auf die Klauenlänge. Landtechnik 68(2), S. 117–121, http://dx.doi.org/10.15150/lt.2013.215

Jais, C.; Oppermann, P., Schwanfelder, J. (2013b): Einsatz von Gummimatten im Liegebereich tragender Sauen – Teil 2: Klauen, Gelenke und Gangweise. Landtechnik 68(3), S. 295–300, http://dx.doi.org/10.15150/lt.2013.223

Jais, C; Oppermann, P., Schwanfelder, J. (2013c): Langer Weg zum Ziel. Profi 7, S. 60–63

Meyer, E. (2013): Immer mehr Sauen mit Klauenproblemen. top agrar 3, S. S14–S17

Rähse, E. (2006): Untersuchungen zu Klauenmaßen und Klauenveränderungen bei Mastschweinen unter Beachtung der Haltungsbedingungen. Dissertation, Justus-Liebig-Universität Gießen

Authors

Peter Oppermann, **Dr. Christina Jais** and **Miriam Abriel** work in the team "Pig Husbandry" at the Institute for Agricultural Engineering and Animal Husbandry of the Bavarian State Research Centre for Agriculture in Grub, **Josef Schwanfelder** at the Centre for Pig Husbandry at Schwarzenau. Bavarian State Research Centre for Agriculture, Prof.-Dürrwaechter-Platz 2, D-85586 Poing/Grub, e-Mail: christina.jais@LfL.bayern.de.