Zusammenhang zwischen Bestands-, Gruppengröße und Indikatoren des Tierwohls in der konventionellen Schweinemast

Dissertation zur Erlangung des Doktorgrades der Fakultät für Agrarwissenschaften der Georg-August-Universität Göttingen

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D 7

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Zusammenfassung


Insgesamt wurden 60 Schweinmastbetriebe mit Hilfe des Welfare Quality®-Protokolls für Schweine bewertet. Unter Berücksichtigung der Betriebsgrößenentwicklung in der deutschen Schweineproduktion und in Anlehnung an die Einteilung der Betriebe nach dem Bundes-Immissionsschutzgesetz (BImSchG, 2013) wurden die untersuchten Betriebe in
ZUSAMMENFASSUNG
drei Bestandsgrößen-Kategorien (jeweils 20 Betriebe/Kategorie) eingeteilt: 1) klein = < 1.500 Mastplätze, 2) mittel = 1.500 bis 3.000 Mastplätze und 3) groß = 3.000 Mastplätze. Es wurden nur konventionell arbeitende Betriebe mit den am weitesten verbreiteten Haltungsverfahren (Planbefestigter Boden, Zwangsbelüftung, Automatische Fütterung) in die Untersuchungen einbezogen. Die teilnehmenden Betriebe hielten durchschnittlich 2.641 Schweine, wobei die Zahl der Mastplätze zwischen 260 und 11.000 varierte. Die Mehrheit der Betriebe (92%) hielt die Tiere auf Voll- und 8% auf Teilspaltenböden. Die Gruppengröße variierte von 10 bis 350 Schweinen pro Bucht (Mittelwert: 20 Schweine/Bucht, Median 16 Schweine/Bucht). Um den Einfluss der Gruppengröße auf das Tierwohl betrachten zu können, wurden drei Gruppengrößen-Kategorien definiert: klein: < 15 Schweine/Bucht, n = 207 Buchten; mittel: 15 bis 30 Schweine/Bucht, n = 257; groß: > 30 Schweine/Bucht, n = 136. Im Durchschnitt betrug das Platzangebot 0,83 m²/Schwein (0,31 m² bis 2,5 m²/Schwein).

an Mastschweinen pro Bestand deutet nicht automatisch auf eine niedrige Tierwohlbewertung hin.

Summary

Animal welfare became a significant issue in the society throughout the past decades. Many consumers tend to combine modern agricultural livestock farming primarily with a high number of animals on a confined space and consequently shortcomings when it comes to animal welfare. The term “intensive livestock farming” became a synonym for less animal-friendly husbandry and is discussed in the media under a rather negative light. In addition to the herd size, it is the size of the group that stands particularly under pressure. At the same time, the knowledge about the causal relationships between animal welfare and conventional livestock farming or the size of a herd or group is low, on a theoretical level as well as on the empirical one. Moreover, studies based on available literature do only include partial aspects of animal welfare and only certain animal species in their analyses. The current debate also focusses on fattening pig farms but only a few scientific studies cover the influence of herd- and group sizes on animal welfare. Therefore, the present study should derive a reliable statement about the connection of animal welfare indicators and the herd- and group size. The herd size was defined as the total number of animals of one field of usage at one location. The group size describes the number of pigs per pen at constant space supply per animal. Furthermore, animal welfare in conventional fattening pig farms need to be considered. This may lead to a general objectification throughout discussions in the society.

Overall, 60 pig fattening farms were evaluated with the support of the Welfare Quality® Protocol for pigs. In due consideration of the development of farms in the German pig production and in accordance with the classification of pig farms by the German Federal Pollution Protection Act (2013), the assessed farms were categorized in the three farms size categories (20 farms/category): small = < 1.500 pigs/farm, 2) medium = 1.500 to 3.000 pigs/farm and 3) large = 3.000 pigs/farm. Only conventional fattening pig farms with the most prevalent husbandry system (concrete floors, forced ventilation systems, automatic feeding systems) were included in this study. The participating farms hold an
average amount of 2.641 pigs, although the number of fattening places varies between 260 and 11.000. The majority of farms (92%) keeps animals on full- and 8% on partly slatted floors. The group size varies between 10 to 350 pigs per pen (average value: 20 pigs/pen, median: 16 pigs/pen). To analyse the influence of the group size on animal welfare, three group size categories were defined: small: 15 pigs/pen, n = 207 pens, medium: 15 to 30 pigs/pen, n = 257; large = > 30 pigs/pen, n = 136. The average pen size capacity covers 0.83 m² per pig (range 0.31 to 2.5 m² per pig).

The Welfare Quality® Protocol is an animal orientated indicator system that serves the comprehensive evaluation of animal welfare on livestock on the farm level. It includes four different steps that form out of the original 34 indicators, in a hierarchical aggregation process 12 criteria, 4 principles and finally one single overall assessment. The farms were classified on this fundament as “excellent”, “enhanced”, “acceptable” or “not classified”. The tree herd size-categories as well as group size- categories were compared to each other with reference to the averages in animal welfare evaluation from the protocol. The farm served as random effect.

Almost 80% of the evaluated farms were classified as “enhanced”, all others as “acceptable”. Generally speaking, the overall welfare level of the evaluated farms hast to be considered as low. The herd size had no significant effect on the characteristics of the overall assessment. Principle- and criteria level could not prove significant differences between the herd size categories. The principle “good feeding” reached by far the highest score, even though the appropriate criteria “absence of thirst”, due to partly deficiencies in water supply, did not reach the highest achievable points. The criteria “comfort around resting” of the principle “good housing” was assessed with the help of the indicators manure on the body and bursitis. On average, 34.7% of the pigs on 60 farms, independent of the herd size, were affected with moderate bursitis. Thereby bursitis was the most common measure on the farms. The prevalence of manure on the pigs increased according the herd size (P < 0.05): the proportion of moderate soiled animals came up to 10.7% at smaller farms, in the middle 14.7% and in larger farms 20.6%. Moreover, the feeding system can be
discussed as a potential factor of influence. The criteria “ease of movement” reached a score of 72 out of 100 possible points in average. Considering the German Farm Animal Welfare Regulations (2006), 40% of the pens were overcrowded.

Among all principles, “good health” was scored worst with an average of 29.1 of 100 points. The associated criteria “absence of injuries” included among others the indicator wounds on the body. With an average of 11% wounded pigs on all 60 farms, the proportion is comparable high. The results of the slaughterhouse belong to the criteria “absence of diseases”. The incidence of pneumonia was in tendency lower in small herds (4.2%) than in medium (11.6%) and large herds (10.7%). Tail-docking and castration of the piglets no anaesthetic was used. Thus the criteria “absence of pain” was scored worse.

The principle “appropriate behaviour” reached also a low score with 30 out of 100 points. This was mainly due to deficits for exploratory behaviour (criteria “expression of other behaviours”) and the worse evaluation of the emotional state of the animals. Intensive systems are often criticised with respect to species-specific behaviour.

The results confirm that the herd size is not adequate as an indicator for insufficient well-being. A high number of pigs per farm are not correlated to a worse assessment of animal welfare.

Regarding the relationship between the group size-categories and selected indicators of the Welfare Quality® Protocol, it was determined, that the group size has a significant effect on the indicator soiled pigs (P < 0.05). In the largest group size-category (15.8%) more pigs were significantly soiled as in the smallest group size-category (10.4%). The prevalence of moderate wounded pigs also increased significantly with a growing group size. In the largest group size-category (16.3%) the proportion was significantly higher than in the middle (11.3%) and in the smallest group size-category (8.5%). The indicator manure on the body as well as the indicator wounded pigs represent important indicators concerning animal-friendly husbandry systems. The prevalence of bursitis was not affected by the group size (P < 0.05). On the contrary, in large group sizes a better human-animal relationship was more often observed. In
conclusion, none of the evaluated group sizes with respect to the indicators of the Welfare Quality® Protocol proved to be superior to others. It is more appropriate that the importance of the group size, as well as the herd size, with regard to animal welfare seems to be overestimated. At the same time, the overall situation has to be considered as unsatisfying, based on the detected prevalence’s of technopathies. The discussion about animal protection and animal welfare has to be continued. Other factors like the management or husbandry system should be taken into the focus of further studies to improve sustainable animal welfare on farms
Abkürzungsverzeichnis

<table>
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<tr>
<th>Abkürzung</th>
<th>Definition</th>
</tr>
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<tbody>
<tr>
<td>BHZP</td>
<td>German federal hybrid breeding program</td>
</tr>
<tr>
<td>BImSchG</td>
<td>Bundesimmissionsschutzgesetz</td>
</tr>
<tr>
<td>Bspw.</td>
<td>Beispielweise</td>
</tr>
<tr>
<td>bzgl.</td>
<td>bezüglich</td>
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<td>bzw.</td>
<td>beziehungsweise</td>
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<tr>
<td>ca.</td>
<td>circa</td>
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<tr>
<td>cm</td>
<td>Centimetre/Zentimeter</td>
</tr>
<tr>
<td>EFSA</td>
<td>European Food Safety Authority</td>
</tr>
<tr>
<td>e.g.</td>
<td>For example, abbreviation of Latin ‘exempli gratia’</td>
</tr>
<tr>
<td>et al.</td>
<td>and others/und andere, abbreviation of Latin ‘et alii’</td>
</tr>
<tr>
<td>etc.</td>
<td>and the rest, abbreviation of Latin ‘et cetera’</td>
</tr>
<tr>
<td>EU</td>
<td>Europäische Union</td>
</tr>
<tr>
<td>e.V.</td>
<td>Eingetragener Verein</td>
</tr>
<tr>
<td>evtl.</td>
<td>eventuell</td>
</tr>
<tr>
<td>FAO</td>
<td>Food and Agriculture Organization of the United Nations</td>
</tr>
<tr>
<td>FAWC</td>
<td>Farm Animal Welfare Committee</td>
</tr>
<tr>
<td>g</td>
<td>Gram</td>
</tr>
<tr>
<td>i.e.</td>
<td>that is to say/das heißt, abbreviation of Latin ‘id est’</td>
</tr>
<tr>
<td>ISN</td>
<td>Interessengemeinschaft Norddeutscher Schweinhalter e.V./Association of Pig Farmers in Germany</td>
</tr>
<tr>
<td>kg</td>
<td>Kilogram</td>
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<tr>
<td>LSM</td>
<td>least square means</td>
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<tr>
<td>m²</td>
<td>square metre(s)/Quadratmeter</td>
</tr>
<tr>
<td>Max</td>
<td>Maximum</td>
</tr>
<tr>
<td>min</td>
<td>minute(s)</td>
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<tr>
<td>Min</td>
<td>Minimum</td>
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<tr>
<td>mm</td>
<td>Millimeter</td>
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<tr>
<td>MS</td>
<td>Mastschwein</td>
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<tr>
<td>n</td>
<td>Anzahl</td>
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<tr>
<td>No./Nr.</td>
<td>Number/Nummer</td>
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<tr>
<td>Abkürzung</td>
<td>Deutscher/Englischer Begriff</td>
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<td>-----------</td>
<td>----------------------------</td>
</tr>
<tr>
<td>P/p</td>
<td>Probability/Wahrscheinlichkeit</td>
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<tr>
<td>PCA</td>
<td>Principle Component Analysis</td>
</tr>
<tr>
<td>PIC</td>
<td>Pig Improvement Company</td>
</tr>
<tr>
<td>QBA</td>
<td>Qualitative Behaviour Assessment</td>
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<tr>
<td>RS</td>
<td>Rank Correlation Coefficients</td>
</tr>
<tr>
<td>s.</td>
<td>siehe</td>
</tr>
<tr>
<td>SAS</td>
<td>Statistical Analysis System</td>
</tr>
<tr>
<td>SE</td>
<td>standard error</td>
</tr>
<tr>
<td>TierSchG</td>
<td>Tierschutzgesetz</td>
</tr>
<tr>
<td>TierschNutztV</td>
<td>Tierschutz-Nutztierhaltungsverordnung</td>
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<tr>
<td>u.a.</td>
<td>unter anderem</td>
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<td>v.a.</td>
<td>vor allem</td>
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<tr>
<td>vgl.</td>
<td>Vergleich</td>
</tr>
<tr>
<td>vs.</td>
<td>versus</td>
</tr>
<tr>
<td>WBA</td>
<td>Wissenschaftlicher Beirat für Agrarpolitik, Ernährung und gesundheitlichen Verbraucherschutz</td>
</tr>
<tr>
<td>WQP</td>
<td>Welfare Quality® Assessment Protokoll für Mastschweine</td>
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<tr>
<td>z.B.</td>
<td>zum Beispiel</td>
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</table>
KAPITEL 1

Allgemeine Einleitung
1 Allgemeine Einleitung


ALLGEMEINE EINLEITUNG

Nutztieren auf Betriebsebene dient. Es findet gegenwärtig in der Wissenschaft in allen an der Tierhaltung interessierten Abteilungen die größte Aufmerksamkeit (Blokhuis et al., 2013).

Anhand der vorliegenden Studie

1) sollen Aussagen zur Tiergerechtigkeit konventioneller Schweinemastbetriebe in Abhängigkeit von der Bestandsgröße gegeben werden und eine Einstufung der Betriebe hinsichtlich ihres Tierwohlniveaus ermöglicht werden (Kapitel 3),

2) soll neben dem Einfluss der Bestandsgröße auf das Tierwohl außerdem deren Effekt auf das Tierverhalten (Erleben positiver Emotionen) untersucht werden (Kapitel 4),

3) soll der Zusammenhang zwischen Gruppengröße und ausgewählten Tierwohlindikatoren des Welfare Quality® Protokolls beschrieben werden (Kapitel 5).

In der abschließenden Diskussion werden die Effekte und Zusammenhänge von Bestands- und Gruppengröße auf Tierwohl gemeinsam diskutiert und Schlussfolgerungen abgeleitet (Kapitel 6).
Literaturverzeichnis


KAPITEL 2

Literaturübersicht
2 Literaturübersicht

2.1 Entwicklung der Schweineproduktion in Deutschland

In Deutschland wurden im Jahr 2014 etwa 28,1 Millionen Schweinen gehalten (Statistisches Bundesamt, 2014). Damit nimmt Deutschland im Rahmen der europäischen und globalen Fleischwirtschaft eine bedeutende Stellung ein. Dies gilt nicht nur für die Produktion, sondern auch für den Handel (Windhorst, 2008). Während der Schweinebestand seit Jahren leicht wächst, sinkt gleichzeitig die Anzahl der schweinehaltenden Betriebe kontinuierlich. Im vergangenen Jahr gaben etwa 2.000 Betriebe (knapp 4%) ihre Schweinehaltung auf. Damit hat sich die Anzahl der Betriebe auf ca. 27.100 reduziert. Demzufolge ist eine strukturelle Entwicklung zu immer größeren Beständen und einer zunehmenden Anzahl Schweine pro Halter zu beobachten. Im Jahr 2014 stieg die Anzahl gehaltener Schweine pro Landwirt auf durchschnittlich 1.037 an (Abbildung 1).

Abbildung 1: Entwicklung der Schweineproduktion in Deutschland (Eigene Darstellung nach Statistisches Bundesamt (2014))
Abbildung 2: Entwicklung der Schweinebestände in Deutschland (Eigene Darstellung nach Statistisches Bundesamt (2014))

In Abbildung 2 sind einerseits die Anzahl Betriebe und andererseits die Anzahl Schweine in Abhängigkeit verschiedener Bestandsgrößenkategorien dargestellt. Etwa 75% aller in Deutschland gehaltenen Schweine (hellgraue Balken) werden in Betrieben mit 1.000 und mehr Schweinen gehalten. Gleichzeitig haben etwa 50% der Betriebe Bestände zwischen 500 und 2.000 Mastplätze (dunkelgraue Balken) (Abbildung 2).

welche auch finanzielle Auswirkungen haben können. Mit einem Effekt auf die künftige Strukturentwicklung in der Schweineproduktion ist zu rechnen (Windhorst, 2002).

2.2 Problemfelder der konventionellen Schweinemast in Bezug zum Tierwohl


- Haut-, Gelenk-, und Klauenverletzungen (Turner et al., 2006; Gillman et al., 2008; Busch & Wachmann, 2011)
- Lahmheiten und Fundamentprobleme (Mouttotou et al., 1998; Busch & Wachmann, 2011)
• Schwanzbeißen und Kannibalismus (Schrøder-Petersen & Simonsen, 2001; Moinard et al., 2003; EFSA, 2007b; Taylor et al., 2012; Thays Sonoda et al., 2013; D'Eath et al., 2014)
• Infektionserkrankungen (Mousing et al., 1997; Lo Fo Wong et al., 2004; Zheng et al., 2007; Maes et al., 2008; Baptista et al., 2010; Nathues et al., 2012; Grøntvedt et al., 2013).
• Vermehrt Auseinandersetzung unter den Schweinen (McGlone & Newby, 1994; Velarde & Geers, 2007)
• Stressbedingte Todesfälle von Mastschweinen (Lebret et al., 2015)
• Schmerzen durch Eingriffe wie Kastration und Schwanzkürzen (EFSA, 2007b; Sutherland et al., 2008)
• Verhaltenseinschränkung, Verhaltensstörungen und Stereotypien (Van de Weerd & Day, 2009; Tönepöhl et al., 2012)

Wichtige Einflussfaktoren auf deren Auftreten sind (WBA, 2015):

• Liegeplatz- und Bodenbeschaffenheit
• Platzangebot, Gruppengrößen
• Fütterungssysteme und Qualität des Futters
• Beschäftigungs- und Abkühlungsmöglichkeiten
• Wahlmöglichkeit zwischen verschiedenen Funktions- und Klimabereichen
• Stallklima (Luftqualität, Temperatur)
• Quantität und Qualität der Wasserversorgung
• Sachkunde der betreuenden Personen und damit Qualität des Managements
• Einhaltung und Umsetzung vorhandener Vorschriften

Kenntnisse und Fähigkeiten der betreuenden Personen einen erheblichen Einfluss (Waiblinger et al., 2006).

2.3 Tierwohl

2.3.1 Gebräuchliche Begriffe und deren Definitionen

Schmerzen, Leiden und Schäden zu vermeiden sowie ein gutes Wohlbefinden (psychischer Zustand) zu erreichen. Der Begriff „Tierschutz“ beschreibt, was veranlasst werden muss, damit ein hohes Tierwohl bzw. eine hohe Tiergerechtigkeit erreicht werden kann. Im englischen Sprachgebrauch wird üblicherweise der Begriff „animal welfare“ zur Beschreibung des physischen und psychischen Zustands von Tieren verwendet. Er schließt sowohl die Abwesenheit von körperlichen und seelischen Leiden als auch das Erleben positiver Erfahrungen ein (Scott et al., 2001; Broom & Fraser, 2007; Miele et al., 2011).


Es lässt sich zusammenfassen, dass die Begriffe Tierschutz, Tierwohl, Wohlergehen und Tiergerechtigkeit letztlich alle auf die möglichst weitgehende Abwesenheit von Schmerzen, Leiden und Schäden sowie die Sicherung von Wohlbefinden beim Tier abzielen (WBA, 2015).

2.3.2 Methoden zur Tierwohlbewertung – das Welfare Quality® Protokoll für Mastschweine

In den 1980er Jahren wurde vom britischen Farm Animal Welfare Council (FAWC) das Konzept der „5 Freiheiten“ entwickelt (FAWC, 1992). Es stellt die Basis für einen Großteil der Methoden zur Bewertung des Tierwohls in der Nutztierhaltung dar. Zu den 5 Freiheiten gehören:

- Freiheit von Hunger und Durst
- Freiheit von haltungsbedingten Beschwerden
- Freiheit von Schmerz, Verletzungen und Krankheiten
- Freiheit von Angst und Stress
- Freiheit zum Ausleben normaler Verhaltensmuster

**Tabelle 1**: Einteilung verschiedener Methoden zur Erfassung des Tierwohls (eigene Darstellung)

<table>
<thead>
<tr>
<th>Schwerpunkt</th>
<th>Umweltbezogene Methoden</th>
<th>Tierbezogene Methoden</th>
<th>Integrative Methoden</th>
</tr>
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<tbody>
<tr>
<td><strong>Beispiele</strong></td>
<td>Management und Haltung</td>
<td>Gesundheit und Verhalten</td>
<td>Management, Haltung, Gesundheit und Verhalten</td>
</tr>
<tr>
<td><strong>Vor- und Nachteile</strong></td>
<td>Gute Praktikabilität und Wiederholbarkeit, Mittlere Validität</td>
<td>Mittlere Praktikabilität und Wiederholbarkeit, Gute Validität</td>
<td>Mittlere bis gute Praktikabilität, Wiederholbarkeit und Validität</td>
</tr>
</tbody>
</table>
| Methoden          | • Tiergerechtheits-index 35  
• Tiergerechtheits-index 200  
• Kritische Kontrollpunkte | • Bedarfsdeckung- und Schadensvermeidung | • DLG-Prüfung  
• WQ®P |


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Die Praktikabilität eines Beurteilungssystems ist die Grundvoraussetzung für eine Anerkennung in der Praxis. Die Indikatoren müssen routinemäßig auf den Betrieben erhoben werden können und die Durchführbarkeit muss auch bei großen Tierzahlen möglich sein. Voraussetzung für eine standardisierte Erfassung mit einer hohen Wiederholbarkeit ist die klare Definition der Indikatoren. So muss z.B. bei dem Indikator Verschmutzungsgrad jedem Prüfer eine klare Beschreibung der Scores (keine Verschmutzung, mittlere Verschmutzung, starke Verschmutzung) vorliegen. Allerdings kann keine der beschriebenen Indikatoren gruppen für sich genommen das Tierwohl in seiner Gesamtheit erfassen (Botreau et al., 2007a; Botreau et al., 2007b).

Das Welfare Quality® Protokoll soll praktikable Indikatoren für die drei Bereiche Haltung, Management und das Tier selbst beinhalten, die den bisherigen gesellschaftlichen und wissenschaftlichen Anforderungen entsprechen (Blokhuis, 2008). Im folgenden Abschnitt wird der Aufbau des Welfare Quality® Assessment Protokolls für Schweine dargestellt. Es ist die dieser Arbeit zugrundeliegende Methode zur Bewertung des Tierwohls auf den Betrieben.

**Das Welfare Quality® Assessment Protokoll für Mastschweine**

Abbildung 3: Der Aggregierungsprozess von der Ebene der Indikatoren zum Gesamtscore (Welfare Quality®, 2009)


**Tabelle 2: Aufbau des Welfare Quality® Protokolls für Mastschweine (verändert nach Temple et al. (2011))**

<table>
<thead>
<tr>
<th>Bewertung</th>
<th>Grundsätze</th>
<th>Kriterien</th>
<th>Indikatoren</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gesamtscore</td>
<td>Fütterung</td>
<td>01 Hunger</td>
<td>Körperkondition</td>
</tr>
<tr>
<td></td>
<td></td>
<td>02 Durst</td>
<td>Wasserangebot</td>
</tr>
<tr>
<td>Haltung</td>
<td>03 Liegekomfort</td>
<td>Bursitis, Verschmutzungsgrad</td>
<td></td>
</tr>
<tr>
<td></td>
<td>04 Klimakomfort</td>
<td>Zittern, Hecheln, Haufenlage</td>
<td></td>
</tr>
<tr>
<td></td>
<td>05 Bewegungsfreiheit</td>
<td>Platzangebot</td>
<td></td>
</tr>
<tr>
<td>Gesundheit</td>
<td>06 Verletzungen</td>
<td>Lahmheit, Wunden, Schwanzbeißen</td>
<td></td>
</tr>
<tr>
<td></td>
<td>07 Krankheiten</td>
<td>Mortalität, Husten, Niesen, Schwere Atmung, verdrehte Schnauze, rektaler Prolaps, Hautkondition, Brüche, Hernien, Schlachtbefunde</td>
<td></td>
</tr>
<tr>
<td></td>
<td>08 Schmerzen</td>
<td>Kastration, Schwanzkupieren</td>
<td></td>
</tr>
<tr>
<td>Verhalten</td>
<td>09 Sozialverhalten</td>
<td>Sozialverhalten</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10 Sonstiges Verhalten</td>
<td>Erkundungsverhalten</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11 Mensch-Tier-Beziehung</td>
<td>Angst vor Menschen</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12 Emotionaler Zustand</td>
<td>Qualitative Verhaltensbeurteilung</td>
<td></td>
</tr>
</tbody>
</table>

### 2.3.3 Zusammenhang zwischen Bestandsgröße und Tierwohl

Im Rahmen des Gutachtens des wissenschaftlichen Beirates wurden Untersuchungsleitende Thesen formuliert, die die Beziehung zwischen der Größe eines tierhaltenden Betriebes und dem Tierschutz beschreiben. Die
verschiedenen Thesen werden in Abbildung 4 graphisch dargestellt (WBA, 2015):

- **Professionalisierungsthese:** Mit dem Wachstum und der Spezialisierung der Betriebe sind meistens ökonomische Vorteile verbunden, die größer sind als mögliche grösstenbedingte Nachteile für das Tierwohl. Demnach sind größere Betriebe auch im Tierschutz führend. Dagegen spricht, dass größere Betriebe zwar oft professioneller wirtschaften, aber aus Kostengründen vielfach angelernte Arbeitskräfte anstelle von Fachkräften beschäftigen, wodurch Defizite in der Tierbetreuung entstehen können. Das Ziel einer strikten Kostensenkung kann dazu führen, dass Aufwendungen für mehr Tierwohl unterlassen werden.

- **Small is beautiful - These:** Kleinere Familienbetriebe mit mehreren Betriebszweigen, ohne Fremdarbeitskräfte und mit der Motivation und Kompetenz des Betriebsleiters können Vorteile haben. Allerdings können gerade die wenig spezialisierten Betriebe Kompetenzdefizite in bestimmten Bereichen aufweisen und haben oft wenig ökonomischen Spielraum, was sich negativ auf bestimmte tierwohlsteigende Maßnahmen auswirken kann.

- **U-Kurven - Hypothese:** Kleinere Betriebe können Vorteile im Tierwohl aufweisen (s. Small is beautiful - These: intensivere Tierbetreuung), die mit steigender Betriebsgröße verloren gehen. Ab einer gewissen Betriebsgröße steigt das Tierwohl jedoch möglicherweise wieder an, da eine zunehmende Professionalisierung stattfindet (s. Professionalisierungsthese).

- **Umgekehrte U-Kurven - Hypothese:** Während kleinere Betriebe aufgrund der starken multifaktoriellen Ausrichtung und möglicher damit einhergehender Wissensdefizite im Speziellen Nachteile aufweisen können, haben große Betriebe häufig nicht entsprechend ausgebildetes bzw. motiviertes Personal, sodass mittlere Betriebsgrößen Vorteile im Hinblick auf das Tierwohl haben können.
- Indifferenzthese: Es gibt keinen Zusammenhang zwischen der Größe eines tierhaltenden Betriebes und dem Tierwohl. Vielmehr wird das Tierwohl durch Managementmaßnahmen und das Haltungssystem beeinflusst.

Abbildung 4: Theorien zum Zusammenhang Bestandsgröße und Tierwohl (WBA, 2015)

Das Risiko der Eintragung von Pathogenen von außen in die Herde ist größer (durch vermehrten Zukauf) (Gardner et al., 2002)

Das Risiko der Übertragung von Pathogenen innerhalb und zwischen Herden auf Grund einer höheren Anzahl potentiell empfänglicher Tiere ist größer (Gardner et al., 2002)

Es gibt eine Kumulation von verschiedenen Risikofaktoren (Broens et al., 2011)

Es besteht evtl. eine höhere Stressanfälligkeit beim Tier, die zu einer Schwächerung des Immunsystems führen und die Schweine damit empfänglicher für Infektionskrankheiten machen kann (Maes et al., 2008)

Andererseits sind Hygienevorrichtungen, die das Risiko einer Infektion und deren Verbreitung herabsetzen, in großen Betrieben häufiger vorhanden. Zudem sind die Einhaltung der Hygienepraxis sowie andere Managementmaßnahmen besser durchzuführen als in kleineren Betrieben (Gardner et al., 2002). Demnach kann angenommen werden, dass durch ein vermeintlich besseres Management in größeren Betrieben das zunächst höher angenommene Infektionsrisiko sowie die Verbreitung von Erregern reduziert werden kann.

**Tabelle 3:** Zusammenhang zwischen dem Vorkommen von Salmonellosen, Pneumonie, Influenza sowie der Prävalenz bestimmter Verhaltensweisen und der Bestandsgröße (eigene Darstellung)

<table>
<thead>
<tr>
<th>Studie</th>
<th>Land</th>
<th>Bezugsgröße: Herden(n) oder MS(n)/Herde</th>
<th>Einfluss Bestandsgröße (+/-/0)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Salmonellose</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mousing et al. (1997)</td>
<td>DK</td>
<td>100 bis &gt; 5.000 MS/Herde</td>
<td>&lt; 3.000 MS + 3.000 MS -</td>
</tr>
<tr>
<td>Zheng et al. (2007)</td>
<td>DK</td>
<td>300 bis 5.000 MS/Herde</td>
<td>&lt; 1.000 MS + 1.000 MS -</td>
</tr>
<tr>
<td>Van der Wolf (2001)</td>
<td>NL</td>
<td>353 Herden</td>
<td>-</td>
</tr>
<tr>
<td>Lo Fo Wong et al. (2004)</td>
<td>D, DK, G, NL, S</td>
<td>359 Herden</td>
<td>0</td>
</tr>
<tr>
<td>Baptista et al. (2010)</td>
<td>P</td>
<td>108 Herden</td>
<td>0</td>
</tr>
<tr>
<td><strong>Pneumonie</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Grosse Beilage et al., 2009)</td>
<td>D</td>
<td>67 Sauenherden</td>
<td>0</td>
</tr>
<tr>
<td>Nathues et al. (2012)</td>
<td>D</td>
<td>112 Sauenherden</td>
<td>0</td>
</tr>
<tr>
<td>Maes et al. (2000)</td>
<td>B</td>
<td>50 bis &gt; 200 Sauen/Herde</td>
<td>0</td>
</tr>
<tr>
<td>Enoe et al. (2002)</td>
<td>DK</td>
<td>500 bis &gt; 2.000 MS/Herde</td>
<td>-</td>
</tr>
<tr>
<td><strong>Influenza</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grøntvedt et al. (2013)</td>
<td>N</td>
<td>118 Sauenherden</td>
<td>+</td>
</tr>
</tbody>
</table>
LITERATURÜBERSICHT

<table>
<thead>
<tr>
<th>Maes et al. (2000)</th>
<th>B</th>
<th>50 bis 250 Sauen/Herde</th>
<th>0</th>
</tr>
</thead>
</table>

**Normalverhalten/**

**Welfare Index**

<table>
<thead>
<tr>
<th>Lawrence, 2013</th>
<th>UK</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knage-Rasmussen et al. (2013)</td>
<td>DK</td>
<td>37 Herden</td>
</tr>
<tr>
<td></td>
<td></td>
<td>120 bis 7.825 MS/Herde</td>
</tr>
</tbody>
</table>

**Schwanzbeißen**

| Moinard et al. (2003) | UK  | 92 Herden | - |

MS = Mastschweine; n = Anzahl Tiere bzw. Herden; Salmonellosen, Pneumonie, Influenza sowie die Prävalenz bestimmter Verhaltensweisen nimmt zu (+), bleibt unbeeinflusst (0) oder nimmt ab (-) mit steigender Bestandsgröße; DK = Dänemark, NL = Niederlande, D = Deutschland, G = Griechenland, S = Schweden, P = Portugal, B = Belgien, N = Norwegen

2.3.4 Zusammenhang zwischen Gruppengröße und Tierwohl


Die steigenden Gruppengrößen in der Tierhaltung stehen allerdings zunehmend in der gesellschaftlichen Kritik (Schröder & McEachern, 2004; Vanhonacker et al., 2009; Velarde et al., 2015). Umfassende Studien bezüglich des Zusammenhangs zwischen Tierwohl und Gruppengrößen in der Schweinemast wurden bisher jedoch kaum angegangen. Untersuchungen zu den

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landwirtschaftliche Nutztiere aus ethologischer Sicht. Tierärztliche
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allowance on performance, aggression and immune competence of
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Livestock Production Science 66: 47-55


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KAPITEL 3

Welfare Quality® assessment in intensive fattening pig farms in Germany: Does herd size have an impact?

Livestock Science
Under Review
Welfare Quality® assessment in intensive fattening pig farms in Germany: Does herd size have an impact?

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Abstract

The pig fattening industry has been recently under serious discussion mainly due to animal welfare concerns. Primarily, large production units have been often criticized, though scientifically-based knowledge on the animal welfare status in these systems is still lacking. Therefore, the aim of this study was to assess the relationship between different herd sizes and the welfare level of fattening pig farms in Germany. In total, 60 farms were assessed using the Welfare Quality® protocol for pigs. Farms were classified according to their herd size into small (< 1,500 pigs/farm), medium (1,500 – 3,000 pigs/farm) and large (> 3,000 pigs/farm) with 20 farms in each class. Multiple Generalized Linear Mixed Models were used to evaluate differences between herd sizes. While none of the farms were classified as “excellent” or “not classified”, 80% of the farms achieved “enhanced” and the remaining 20% “acceptable” independent of the herd size. Herd sizes did also not differ in terms of the four principles “good feeding”, “good housing”, “good health” and “appropriate behaviour”. Among the 12 criteria of the Welfare Quality® protocol, a tendency for a superior score in small compared with medium and large herds was only found for “absence of diseases” caused by the fact that the incidence of pneumonia was lower in small (4.2%) than in medium (11.6%) and large herds (10.7%). Overall, moderate bursitis (35%) was found as the most prevalent indicator of welfare-related problems without a difference between herd sizes ($P > 0.05$). Moderate manure (15.5%) was the second most common indicator of poor welfare, while the prevalence increased with herd size. Moderate wounds were detected at a rate of 10.5% independently of herd size. Tail biting was observed at very low rates, given that all pigs were tail-docked. In conclusion, findings of this preliminary study showed that none of the herd sizes proved to be clearly superior to others in terms of animal welfare. Nevertheless, the overall welfare level of the studied farms has to be considered as low. Further studies should also focus on issues such as the management (e.g. care of animals, health
check, hygiene regime and climate management), feeding system and floor type to substantiate the present findings.

**Keywords:** fattening pigs; herd size; Welfare Quality® assessment protocol

**Introduction**

Designed to optimize management and increase efficiency, modern pig fattening facilities are generally characterized as large production units (Turner et al., 2003; FAWC, 2012). Standard indoor barns are generally equipped with fully slatted floors, forced ventilation and an automatic feeding system (Hoy et al., 2006). Recently, these production conditions have been under serious discussion among farmers, consumers, media, animal-rights activists, veterinarians, and actors from the industry mainly due to animal welfare concerns (Kayser et al., 2012; Velarde et al., 2015). Apart from the fact that there is no clear definition of intensive or industrial farming, scientifically-based knowledge on the effects of varying herd sizes on the animal welfare status is still lacking (Winckler & Leeb, 2010).

So far, studies mainly focused on the relationship between herd size and health parameters with contradictory results. As proposed by Gardner et al. (2002), animals in large units may on the one hand be at a greater risk of pathogens imported into the farm through purchased animals and transmitted as a high number of potentially susceptible animals is raised together, while on the other hand improved hygiene measures might be implemented on these farms. While Carstensen & Christensen (1998) reported a higher salmonellosis incidence with increasing herd size, Van der Wolf (2001) found it vice versa. In contrast, no herd size effect was found for salmonellosis by Zheng et al. (2007) and Baptista et al. (2010) as well as for respiratory diseases, i.e. enzootic pneumonia and influenza, by Maes et al. (2008) and Grøntvedt et al. (2013). Studies investigating the effect of herd size on animal welfare are rare and only focused on a very limited number of welfare indicators. Knage-Rasmussen et al.
(2013), for example, did not find any relationship between herd size (120 to 7,825 pigs/farm) and the expression of normal behaviour and health parameters. Also, the occurrence of tail biting, one of the major welfare problems in pig fattening, did not differ between farm sizes (500 to 7,500 pigs/farm) (Moinard et al., 2003). Generally, comparisons between studies are difficult due to widely variable study designs, country-specific production and environmental conditions, and studied welfare indicators. As an adequate assessment tool, the Welfare Quality® assessment protocol (Welfare Quality®, 2009) was developed. Because the welfare status of animals is multi-factorial, a combination of various parameters is necessary for its evaluation (Blokhuis et al., 2003). In the protocol, animal welfare is defined as a multidimensional concept consisting of the absence of thirst, hunger, discomfort, disease, pain and injuries, stress and the expression of normal behaviour (Veissier, 2007). It is widely accepted by stakeholders and researchers (Blokhuis et al., 2013). For growing pigs raised under intensive conditions only minor differences between farms were found (Temple et al., 2011a; Temple et al., 2012). But, effects of varying herd sizes on the animal well-being of fattening pigs were not assessed, yet. Therefore, the aim of this study was to assess the relationship between different herd sizes and the welfare level of fattening pig farms. In total, 60 conventional fattening pig farms, with sizes ranging from 250 to 11,000 pigs per farm, were assessed using the WQP.

Material and methods

Farms and animals

A total of 60 conventional pig fattening farms, located in Northern Germany, were assessed using the WQP. The farm acquisition was organised with the help of the Association of Pig Farmers in Germany (ISN e.V.). Only conventional full-time farms with indoor barns, equipped with fully or partly slatted concrete floors, forced ventilation system, automatic feeding systems
and “all in all out” management were included. Participation was voluntary, with all farms being members of the mentioned association.

Data collection was performed between September 2013 and June 2014 by one single assessor, who received intensive training on the correct application of the protocol beforehand. Assessment on all farms started in the morning. The assessor was trained in the theory and practice of the WQP by two persons, who participated in a training session held by experienced trainers of the Welfare Quality® Network group. Intensive on-farm training was done and agreement between observers was obtained during training until a consensus of at least 80% between the observer and the two trainers was reached.

The size of the farms ranged from 250 to 11,000 pigs. Farm size was defined as the number of pigs raised at the same location (Report of the agricultural policy advisory council, 2015). Three farm size categories were defined: 1) small: < 1,500 pigs/farm; 2) medium: 1,500 to 3,000 pigs/farm; and 3) large: > 3,000 pigs/farm. Each category consisted of 20 farms. Categories were defined under consideration of the development of farm sizes in the pig production industry in Germany in recent years according to the federal statistical office (Statistisches Bundesamt, 2014) and in accordance with the classification of pig farms by the German Federal Pollution Protection Act (Bundes-Immissionsschutzgesetz, 2013). Eighty % of the farms only fattened pigs, while 20% had a closed system raising sows, piglets and fattening pigs. Animals were raised in pens of 10 to 350 animals. All animals were hybrid breeding pigs with the most common female line being of Danish origin called DanZucht (45%). Other common lines were from the German federal hybrid breeding program (BHZP) (Ellringen, Germany), Topigs (Senden, Germany), Pig Improvement Company (PIC) (Schleswig, Germany), Hypor (Sittensen, Germany) or JSR Hybrid (Ahaus, Germany). Sows were bred by AI with Pietrain (73%) or Duroc (27%) semen. All barns were insulated and had different mechanical ventilation systems, namely doorway ventilation, channel ventilation, underfloor extraction, perforated steel plates or wood wool cement boards. Pigs were kept on fully- (92% of the farms) or partly-slatted (8%) concrete floors. Two different feeding systems were
implemented on the farms (62% automatic or sensor-controlled liquid feeders; 38% dry or pulp feeding automats). Pigs entered the fattening farms with a mean body weight of $29.9 \pm 2.8$ kg and were slaughtered at $120.8 \pm 3.5$ kg. Boars and female pigs were kept on 15% of the farms, while two of these farms fattened boars as well as castrated pigs. All other farms raised castrates and females. Tail-docking was performed in all pigs.

Assessment of growing pigs using the Welfare Quality® protocol

An overview of the principles, criteria and measures that were assessed is presented in Table 1. Briefly, farm-related data (feeding and hygiene management, prevention of diseases, mortality rate, castration and tail docking practices) were gathered by farmer interviews prior to the further assessments. Data on the prevalence of pneumonia, pleurisy, ascites and pericarditis were collected from records of the slaughterhouse over a year. After the assessor completed a tour through all stables of the farm to get an overview of the design of the barns and the herd, 10 pens for the animal-based assessment and the observation points for the behavioural observations, which are described in more detail in the following, were randomly selected. In every pen up to 15 individuals were randomly selected for observation. If pigs of different ages were raised on a farm, pens of all age categories were included. Hospital pens were excluded. Both the pens and the pigs were chosen according to the random principle. Hospital pens not considered. In the majority of the studied pens (60%) females and castrates were kept in mixed groups, while boars mixed with females (6%) and boars alone (4%) were only found exceptionally. In all other pens, males and females were raised separately.
Table 1: Principles, criteria and indicators of the Welfare Quality® assessment protocol

<table>
<thead>
<tr>
<th>Principle</th>
<th>Criteria</th>
<th>Indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good feeding</td>
<td>Absence of prolonged hunger</td>
<td>Body condition score</td>
</tr>
<tr>
<td></td>
<td>Number of drinking places</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Functioning of drinkers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cleanliness of drinkers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Absence of prolonged thirst</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Comfort around resting</td>
<td>Bursitis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Manure on the body</td>
</tr>
<tr>
<td>Good housing</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Thermal comfort</td>
<td>Huddling</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Shivering</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Panting</td>
</tr>
<tr>
<td></td>
<td>Ease of movement</td>
<td>Space allowance</td>
</tr>
<tr>
<td></td>
<td>Absence of injuries</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lameness</td>
<td>Mortality</td>
</tr>
<tr>
<td></td>
<td>Wounds on the body</td>
<td>Coughing</td>
</tr>
<tr>
<td></td>
<td>Tail biting</td>
<td>Sneezing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pumping</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Twisted snouts</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rectal prolapse</td>
</tr>
<tr>
<td>Good health</td>
<td>Absence of disease</td>
<td>Scouring</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Skin condition</td>
</tr>
<tr>
<td></td>
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<td>Hernias</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pneumonia</td>
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<tr>
<td></td>
<td></td>
<td>Pleurisy</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pericarditis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>White spots</td>
</tr>
<tr>
<td></td>
<td>Absence of pain induced by</td>
<td>Castration</td>
</tr>
<tr>
<td></td>
<td>management procedures</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tail docking</td>
</tr>
<tr>
<td>Appropriate</td>
<td>Expression of social behaviours</td>
<td></td>
</tr>
<tr>
<td>behaviour</td>
<td></td>
<td>Social behaviour</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Expression of other behaviours</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Exploratory behaviour</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Good human-animal relationship</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fear of humans</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Positive emotional state</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Qualitative Behaviour</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
An overview of the different indicators and their scoring is given in table 2. Measures were scored on a three point scale (0 = absent, 1 = light affection, 2 = strong affection) or a two point scale (0 = absent, 2 = present). Pigs were individually scored from inside the pen for body condition, bursitis, manure on the body, wounds, tail biting, lameness, laboured breathing, twisted snouts, rectal prolapse, skin condition and hernias. Wounds and manure on the body, skin condition and bursitis were observed only on one side of the pig as there are no significant differences between the right and the left side of the animal with respect to these measures (Courboulay & Foubert, 2007). Shivering, panting, and huddling were scored before the assessor entered the pen. Huddling was assessed only in resting animals.

**Table 2:** Indicators of the Welfare Quality® assessment protocol and their scoring

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body condition</td>
<td>0</td>
<td>Good body condition</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Poor body condition; pigs with visible spine, hip and pin bones</td>
</tr>
<tr>
<td>Water supply</td>
<td>0</td>
<td>Function correctly and clean</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Do not function properly/dirty</td>
</tr>
<tr>
<td>Bursitis</td>
<td>0</td>
<td>No evidence of bursae/swelling</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Moderate bursitis: several small (1.5-2.0 cm) bursae on the same leg or one large (2.0-5.0 cm) bursae</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Severe bursitis: several large bursae on the same leg or one extremely large (5.0-7.0 cm) bursae or any eroded bursae</td>
</tr>
<tr>
<td>Manure</td>
<td>0</td>
<td>Less than 20% of the body surface is soiled</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Moderately soiled body: more than 20% but less than 50% of the body surface is soiled with faeces</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Severely soiled body: over 50% of the body surface is soiled with faeces</td>
</tr>
<tr>
<td>Huddling</td>
<td>0</td>
<td>Pig lying with less than half of its body lying on top of another pig (only assessed in resting animals and visually from the corridor)</td>
</tr>
</tbody>
</table>
WELFARE QUALITY® ASSESSMENT IN INTENSIVE FATTENING PIG FARMS IN GERMANY: DOES HERD SIZE HAVE AN IMPACT?

<table>
<thead>
<tr>
<th>Behavior</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pig lying with more than half of its body lying on top of another pig</td>
<td>2</td>
<td>Panting</td>
</tr>
<tr>
<td>Normal breathing (only assessed in resting animals and visually from the corridor)</td>
<td>0</td>
<td>Shivering</td>
</tr>
<tr>
<td>Rapid breath in short gasp</td>
<td>2</td>
<td>Wounds</td>
</tr>
<tr>
<td>No vibration of any body part (only assessed in resting animals and visually from the corridor)</td>
<td>0</td>
<td>Tail biting</td>
</tr>
<tr>
<td>Slow and irregular vibration of any body part, or the body as whole</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>If all regions of the animal’s body have up to four lesions</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Moderately wounded: five to 10 lesions visible</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Severely wounded: 11 lesions are observed on at least two zones of the body or if any zone has more than 15 lesions</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>No evidence of tail biting, superficial biting but no evidence of fresh blood or of any swelling</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Bleeding tail and/or swollen infected tail lesion, and/or part of tail tissue missing and presence of crust</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Normal gait or difficulty in walking, but still using all legs</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Severely lame, minimum weight-bearing on the affected limb</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>No weight bearing on the affected limb, or not able to walk</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>No evidence of laboured breathing</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Evidence of laboured breathing</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>No liquid manure visible in the pen</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Areas in the pen with some liquid manure visible</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>All faeces visible inside the pen is liquid manure</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>No evidence of skin inflammation or discoloration</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Localized skin condition: more than zero, but less than 10% of the skin is inflamed, discoloured or spotted</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Widespread skin condition: more than 10% of the skin has an abnormal colour or texture</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>No hernia/rupture</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Hernias/ruptures without bleeding lesion or touching the floor</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Hernias/ruptures with bleeding lesion or touching the floor</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>
Appropriate behaviour was assessed by means of social and exploratory behaviour, qualitative behaviour assessment (QBA) and human-animal relationship test. In all farms, QBA was carried out at four randomly chosen observation points. At each point, animals were observed for 5 min after which they were rated on a 125 mm visual analogue scale with the following 20 adjectives: active, relaxed, fearful, agitated, calm, content, tense, enjoying, frustrated, bored, playful, positively occupied, listless, lively, indifferent, irritable, aimless, happy, distressed and sociable.

Following QBA, social and exploratory behaviour were assessed using the scan sampling method at three randomly chosen observation points of the farm different from the QBA points. For the assessment of the social and exploratory behaviour, all pigs in the pens had to stand up. If necessary, hands were clapped before starting with the observation 5 minutes later. During this time,
coughing and sneezing was counted and scouring assessed. Afterwards, 40-60 animals were scan-sampled with 2-min intervals for a total of 10 min at each observation point. Positive social, negative social, pen investigation, use of enrichment material and other active behaviour or resting were differentiated as explained in detail in table 2.

The human-animal relationship test was performed after entering the pen and walking around it in one direction. Then, the observer waited in the middle of the pen for 30 sec, before walking around the pen in the other direction and scoring the animals as given in table 2.

Furthermore, resource-based parameters such as the number, functioning and cleanliness of the drinkers were recorded. The pen size was measured and the average weight of the animals was calculated using the weight at the start of the fattening period, the length of the fattening period at the assessment and assuming an average weight gain of 800g/day to determine the space allowance.

The evaluation of the data was done using the algorithm of the WQP. The overall evaluation on the 0 - 100 (range of scores = 0 - 100) of a farm is rated as “excellent”, “enhanced”, “acceptable” or “not classified”. On the given scale, 0 presents the worst and 100 the best welfare state. In the overall evaluation, the individual criteria within a particular principle do not compensate for each other, thus a high score in one will not compensate for a low score in another. A farm is considered to be “excellent” if it scores more than 55 in all principles and more than 80 in two of them, “enhanced” if it scores more than 20 in all principles and more than 55 in two of them, “acceptable” if it scores more than 10 in all principles and more than 20 in three of them and is “not classified” if this minimum standard is not reached (Welfare Quality®, 2009). Given that all farms performed tail docking and most of them castration, a maximum score of 8 in farms conducting both handling procedures and 38 in boar farms could have been reached for the criteria “absence of pain induced by management practice”.

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*Statistical analyses*

The SAS statistical package version 9.3 (SAS Institute Inc., Cary, NC, 2010) was used. The individual animal-based measures were expressed as the number of pigs in the pen having a score of 1 or 2 indicating poor welfare in relation to the total number of pigs evaluated in each pen. The assessed parameters were aggregated to the 12 criteria, four welfare principles and overall assessment as given by the WQP. Pen was defined as the statistical unit and results were considered statistically significant at $P < 0.05$. Multiple Generalized Linear Mixed Models using the GLIMMIX procedure were performed separately for the animal-based parameters, criteria, principles and the overall assessment. A Poisson distribution and a logarithmic link function were assumed. As fixed effect the farm category (small, medium and large) was included. The farm served as random effect to account for the possible dependence between observations of pens from the same farm. Scores are presented as Least Square Means (LSM) and standard error.

Additionally, a Principle Component Analysis (PCA) applying the FACTOR procedure without rotation was performed at the level of the 12 different WQP-criteria in order to highlight the relationship among them. The constitutional theory of this method is that there are underlying principles in the indicators and criteria, respectively, which might influence each other (O'Rourke & Hatcher, 2013). Single PCAs were applied for each farm size category. The first two Principle Components (Factor 1 and Factor 2) identified with an Eigenvector of greater than 1.0 were applied. Each criterion achieved a certain factor loading on Factor 1 and Factor 2, which is a dimensionless number between -1 and 1. The factor loadings quantified the weight each adjective had on the two main axes (Rencher, 2002). Factor loadings greater than or equal to 0.40 were interpreted as highly positive and factor loadings less than or equal to -0.40 as highly negative (O'Rourke & Hatcher, 2013). The values obtained were plotted in a two dimensional interpretative word chart.
Results

Without any of the farms being classified as “excellent” or “not classified”, 17, 16 and 15 of the small, medium and large farms achieved the overall WQP evaluation “enhanced”, while the remaining farms were classified as “acceptable”. The scores for the different criteria and principles separated by herd size are shown in table 3. Highest values were achieved for the principle “good feeding”. This was mainly due to the fact, that only a very limited number of pigs was found with a poor body condition. The criterion “absence of prolonged thirst” was scored more than 10 points lower due to an insufficient number and poor functionality of the drinkers. The number of animals per drinker ranged from 2 to 43. On 22% of the farms more than 10 pigs had to share one drinker. Furthermore, in 6.7% of pens only one drinker for seven to 22 pigs was available. On 38% of the farms at least one drinker did not function correctly. There were farms with a liquid feeding systems (n = 3), which had either no drinkers or turned them off after a certain period of the fattening period, which does not fulfil the legal requirements.

For “good housing”, differences between the herd sizes were not significant ($P > 0.05$). Among the animal-based measures the highest prevalence rate was determined for moderate bursitis (35%), independent of the herd size ($P > 0.05$). Moderate manure (16%) was the second most common measure on the farms. Medium and large herd sizes had a significantly higher occurrence of moderate soiled pigs than small ($P < 0.05$). The mean space allowance was 0.83 m$^2$/pig ranging from 0.3 to 2.5 m$^2$. Actually, the space allowance of more than 40% of the pens was below the German Farm Animal Welfare Regulations (Tierschutz-Nutztierhaltungsverordnung, 2006) and over-crowded pens were found on 92% of the farms.

Among all principles, “good health” was scored worst. Without differences between herd sizes, moderate wounds (11%) were the third most common indicator of poor welfare. Tail biting was only observed at very low rates. The incidence of pneumonia was in tendency lower in small herds ($4.2% \pm 2.8$) than
in medium (11.6% ± 2.8) and large herds (10.7% ± 2.8) ($P = 0.081$). The mortality rate averaged 2.5%, ranging between 0.9 and 5.2% ($P > 0.05$). Within the principle “appropriate behaviour”, low scores for all herd sizes were recorded for the criterion “expression of other behaviours” mainly due to the low investigative behaviour shown by the pigs.
Table 3: Scores (least square means (LSM), standard error (SE), range) of the principles (bold) and criteria of the Welfare Quality® protocol, separated by farm size (small: < 1,500 pigs/farm, medium: 1,500 to 3,000 pigs/farm and large: > 3,000 pigs/farm)

<table>
<thead>
<tr>
<th>Principle/Criteria</th>
<th>Farm size</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Small</td>
<td>Medium</td>
<td>Large</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LSM</td>
<td>SE</td>
<td>Range</td>
<td>LSM</td>
<td>SE</td>
<td>Range</td>
<td>LSM</td>
</tr>
<tr>
<td>Good feeding</td>
<td>86.9</td>
<td>4.8</td>
<td>41.4-100</td>
<td>86.7</td>
<td>4.8</td>
<td>57.0-100.0</td>
<td>86.6</td>
</tr>
<tr>
<td>Absence of prolonged hunger</td>
<td>99.7</td>
<td>0.2</td>
<td>95.2-100.0</td>
<td>99.8</td>
<td>0.2</td>
<td>98.4-100.0</td>
<td>99.8</td>
</tr>
<tr>
<td>Absence of prolonged thirst</td>
<td>86.5</td>
<td>5.1</td>
<td>40.0-100.0</td>
<td>87.0</td>
<td>5.1</td>
<td>55.0-100.0</td>
<td>87.0</td>
</tr>
<tr>
<td>Good housing</td>
<td>71.7</td>
<td>1.6</td>
<td>56.9-81.5</td>
<td>71.3</td>
<td>1.6</td>
<td>61.2-82.4</td>
<td>70.5</td>
</tr>
<tr>
<td>Comfort around resting</td>
<td>69.2</td>
<td>2.2</td>
<td>48.7-82.9</td>
<td>69.6</td>
<td>2.2</td>
<td>55.2-80.9</td>
<td>66.4</td>
</tr>
<tr>
<td>Thermal comfort</td>
<td>100.0</td>
<td>1.2</td>
<td>100.0-100.0</td>
<td>98.0</td>
<td>1.2</td>
<td>59.0-100.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Ease of movement</td>
<td>73.0</td>
<td>1.7</td>
<td>59.7-88.6</td>
<td>71.0</td>
<td>1.7</td>
<td>56.8-86.6</td>
<td>75.7</td>
</tr>
<tr>
<td>Good health</td>
<td>29.8</td>
<td>1.9</td>
<td>20.1-38.4</td>
<td>28.2</td>
<td>1.9</td>
<td>16.8-48.9</td>
<td>29.4</td>
</tr>
<tr>
<td>Absence of injures</td>
<td>84.3</td>
<td>2.3</td>
<td>65.5-98.4</td>
<td>87.6</td>
<td>2.3</td>
<td>59.6-99.7</td>
<td>89.9</td>
</tr>
<tr>
<td>Absence of diseases</td>
<td>71.4</td>
<td>4.7</td>
<td>29.0-100.0</td>
<td>56.3</td>
<td>4.7</td>
<td>29.0-100.0</td>
<td>64.2</td>
</tr>
<tr>
<td>Absence of pain</td>
<td>11.0</td>
<td>2.4</td>
<td>8.0-38.0</td>
<td>14.0</td>
<td>2.4</td>
<td>8.0-38.0</td>
<td>12.5</td>
</tr>
<tr>
<td>Appropriate behaviour</td>
<td>30.9</td>
<td>1.2</td>
<td>21.9-39.9</td>
<td>33.1</td>
<td>1.2</td>
<td>25.1-46.7</td>
<td>33.7</td>
</tr>
<tr>
<td>Expression of social behaviour</td>
<td>52.8</td>
<td>3.4</td>
<td>29.3-74.6</td>
<td>57.1</td>
<td>3.4</td>
<td>34.4-85.1</td>
<td>61.6</td>
</tr>
<tr>
<td>Expression of other behaviours</td>
<td>23.7</td>
<td>1.6</td>
<td>15.2-38.4</td>
<td>26.8</td>
<td>1.6</td>
<td>16.4-41.7</td>
<td>26.9</td>
</tr>
<tr>
<td>Good human-animal relationship</td>
<td>65.5</td>
<td>6.4</td>
<td>15.5-100.0</td>
<td>69.0</td>
<td>6.4</td>
<td>15.5-100.0</td>
<td>75.3</td>
</tr>
<tr>
<td>Positive emotional state</td>
<td>37.9</td>
<td>2.4</td>
<td>15.4-60.1</td>
<td>36.4</td>
<td>2.4</td>
<td>15.1-53.0</td>
<td>37.0</td>
</tr>
</tbody>
</table>

NS = non-significant
A good agreement, expressed as short distances of the same criteria between farm sizes could not be displayed by the results of the PCA (Figure 1). In the PCA, factor 1 explained 31.0% and factor 2 another 23.5% of the total variance. The criteria hunger, diseases and QBA showed high loadings on the first axis independent of the farm size. In contrast, high positive values were shown for resting, movement and pain in medium and large farms, but high negative values for small farms. Regarding axis 2, high positive values were found independent of the farm size for the criteria other as well as social behaviour. In summary, a clear differentiation by farm size was not possible at the level of the different criteria. The PCA at the level of the individual WQP-measures (data not shown) showed a similar heterogeneous distribution for factor 1 and 2, which explained 26.0 and 20.0% of the variance, respectively.
Discussion

In Germany, the term ‘intensive farming’ was established following the "Regulation to protect against hazards of animal diseases by keeping pigs" in 1975 being used for farms with more than 1,250 pigs. FAO defined ‘intensive livestock farming’ as a system in which less than 10% of the dry matter feed are produced by the farm itself and the stocking density exceeds ten livestock units per hectare of farmland (FAO, 1995). In addition, Kayser et al. (2012) recently demonstrated that German consumers associate the term ‘intensive farming’ with herd sizes of more than 1,000 pigs per farm. In Germany, the mean herd

Figure 1: Word chart presenting loadings on factor 1 and 2 of the Principal Component Analysis for the twelve different criteria scores for small (black), medium (dark grey) and large (light grey) farms.
size is 1,037 fattening pigs per farm, whereas approximately 74% of all pigs are kept in farms with more than 1,000 and 18% in farms with more than 5,000 fattening places (Statistisches Bundesamt, 2014). Particularly the proportion of the latter category is continually growing mainly in order to optimize management and increase labour efficiency (FAWC, 2012). Thus, farms of this study are representative conventional pig fattening farms in Germany. However, results might be biased by the fact, that all participating farms were members of the Association of German Pig Farmers. Another issue that has to be considered is that several farms (20%) managed a closed system. In general, closed systems require a higher level of management practice and expertise, which could also impact the way fattening pigs are raised. Another influencing factor, which was not assessed in this study, is the use of employee. At herd sizes of more than 2,000 pigs, farmers generally have to recruit external labour, which are often less skilled and experienced in animal management. So far, this is the first study evaluating the relationship between herd size and animal welfare status. Following, results should give a first overview in the actual welfare debate considering the size of the farms.

In general, the welfare level in the present study has to be considered as low. This is widely in agreement with other recent studies using WQP in pigs and supports the fact that the studied farms were representative for the actual production conditions of fattening pigs. Studying only three intensive fattening pig farms, Otten et al. (2013) found values for the “overall assessment” comparable to our findings. Similar to the results obtained in the pig husbandry, studies on cattle using WQP were also not able to classify farms with “excellent” (Kirchner et al., 2014; Popescu et al., 2014). In terms of herd size, our results confirm those of Knage-Rasmussen et al. (2013), who did not find any relationship between the number of pigs per farm (120 to 7,825 pigs/farm) and a welfare index composed of behavioural measurements and clinical examinations. Otten et al. (2013) also figured out the highest scores the principle “good feeding”. Expectedly, pigs under intensive production conditions, which are usually fed ad libitum, very rarely (below 1%) show a poor body
condition (Temple et al., 2012). However, under extensive or straw-bedding conditions, this indicator may become more relevant (Scott et al., 2006). Similar to the occurrence of pigs with a poor body condition, the prevalence of lameness, hernia and skin lesions largely depend on management factors such as medical care and the correct use of hospital pens. However, it has to be mentioned here that hospital pens are not assessed by WQP, thus the actual prevalence’s in the studied farms might have been greater. Consequently, the presence of lameness or hernia reflects not only health but also management problems as affected pigs should be separated in hospital pens (Temple et al., 2011a). Supporting our findings, Otten et al. (2013) found an inadequate water supply under comparable production conditions. A sufficient water supply for all pigs should be seen as a first and simple step to improve the welfare level.

Moderate bursitis is a sensitive indicator to compare different production systems and differentiating farms, because of high between-farm variability and low within-farm variability (Temple et al., 2012). First of all, the occurrence of bursitis can be associated with the environment, especially the floor type. A concrete floor increases pressure on the limbs and has an effect on the severity of bursitis (Gillman et al., 2008). Thus, animals raised on concrete floors, especially when fully-slatted, are exposed to a higher risk of bursitis compared with bedded floors, explaining the high prevalence of bursitis under conventional conditions. Pigs in the last period of fattening have a higher risk of bursitis than younger animals, because the greater weight exerts additional pressure of the concrete on the limbs (Gillman et al., 2008). Consequently, the prevalence is not consistent over the whole fattening period (Temple et al., 2013). The prevalence of bursitis was not affected by herd size, which can be mainly explained by the fact that all farms raised animals at different stages of the fattening period. Differences might have become present if all farms would have been assessed at the very end of the fattening period. Values of moderate manure on the body are similar to those of Temple et al. (2011a) of fattening pig farms with concrete floors. The reasons for the occurrence of soiled bodies are multifactorial including mainly environmental factors (Velarde & Geers, 2007).
As valid for bursitis, too, the type of floor is a predominant causal factor for dirty pigs in conventional housing systems (Temple et al., 2011a), while on partly-slatted floors the risk is generally higher than on fully-slatted floors (Temple et al., 2012). Consistently, the prevalence of pigs with moderate manure on the body was 13.4% on fully- and 20.6% on partly-slatted floors, which were similarly distributed among farm size categories. However, the floor type cannot be used as an exploratory variable in the present study, because more than 90% of the animals were raised on fully-slatted floors. Besides, another determining factor is the feeding system. Liquid-fed pigs were dirtier than those fed by dry feeders, while the use of liquid feeding systems increased with the number of fattening places. This may partly explain the higher occurrence of dirty pigs in large herds.

Moderate wounds in this study were found more often than by Temple et al. (2011a). In general, it remains questionable whether these wounds are a consequence of social interactions between animals (fights) or deficiencies in the physical environmental (inappropriate design of facilities). Factors that are described in the literature as determining factors for wounds such as sex (Fredriksen et al., 2008) could not be analysed in detail in this study. In general, a higher prevalence of wounds can be expected in pens with boars and castrates (Temple et al., 2012), a dry feeding system (Botermans & Svendsen, 2000), large group sizes (Velarde & Geers, 2007), higher stocking density (Turner et al., 2000) and at the beginning of the fattening period (Temple et al., 2013). The low prevalence of tail biting, which was in the range presented by Temple et al. (2012), can be mainly attributed to tail-docking. In fact, it has been shown that docked pigs are less bitten than undocked pigs (Sutherland et al., 2008), though tail docking does not prevent tail biting completely (Moinard et al., 2003). Because all pigs were tail-docked without anaesthetics, “absence of pain induced by management practice” was scored lower than the other two criteria of that principle. Research studies have shown that tail docking itself can be painful (Van Beirendonck et al., 2012). As the other major practice, castration was performed on most of the farms. Fattening boars seems to be of
advantage, because there is no more reason for a painful and stressful surgical castration (Rault et al., 2011), but it remains unclear from this study, whether behavioural differences between castrates and boars, that may lead to management and housing problems (Boyle & Björklund, 2007), may also result in impaired welfare. The low mortality rate indicates that poor animal husbandry and stockmanship were rarely found (Velarde & Geers, 2007).

According to Van de Weerd & Day (2009), intensive systems are often criticised with respect to species-specific behaviour, explaining the low score for the principle “appropriate behaviour”. The assessment of behaviour involves a greater degree of subjectivity in comparison to the three other principles (Temple et al., 2011b), but it is still useful to include both psychological and physiological parameters in the welfare assessment (Duncan & Petherick, 1991). In general, behaviour is an important component of animal welfare, because it occurs as a consequence of animal’s feeling. The quantification of behaviour has become of considerable interest in the last years, whereby emotions are still difficult to assess with the available methods (Boissy et al., 2007). Furthermore, the interpretation remains complicated due to the complex physiological system involved with emotions (Temple et al., 2011b).

In addition, the very low correlations between the factors of the PCAs of the different animal-based measures emphasize their individual importance for WQP. According to Temple et al. (2012), each indicator should be analysed separately, whereby the weight of each indicator should be directly associated with its impact on welfare. For example, the weight of the indicator bursitis should be lower than for wounds or lameness, which are directly associated with pain (Velarde & Geers, 2007).

The results of the PCA confirm that the three different herd sizes showed a wide agreement in terms of the indicators and the criteria in terms of short distances between the factor loadings. Given the low proportion of variance explained by the first two factors, it was not possible to differentiate farm categories. In order to identify determining factors on the welfare level of fattening pig farms, further assessments should also take management practices, expertise of the
Conclusion

Findings of the present study showed that none of the herd sizes (< 1,500 vs 1,500 – 3,000 vs > 3,000 pigs/farm) proved to be superior in terms of animal welfare. Nevertheless, the overall welfare level of the studied farms has to be considered as low. The present findings indicate that the farm size cannot be associated with an impaired animal welfare, though further studies should especially focus on factors such as the management, feedings system or the floor type in combination with the farm size. The high prevalence of bursitis and soiled animals underline the necessity to improve the quality of floors and climate management under practical fattening conditions.

Acknowledgements

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WELFARE QUALITY® ASSESSMENT IN INTENSIVE FATTENING PIG FARMS IN GERMANY: DOES HERD SIZE HAVE AN IMPACT?


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Zheng D.M., Bonde M. & Sørensen J.T. 2007. Associations between the proportion of Salmonella seropositive slaughter pigs and the presence of herd level risk factors for introduction and transmission of Salmonella in 34 Danish organic, outdoor (non-organic) and indoor finishing-pig farms. Livestock Science 106: 189-199
KAPITEL 4

Behavioural indicators of welfare in fattening pigs: Does herd size matter?
Behavioural indicators of welfare in fattening pigs: Does herd size matter?

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Abstract

Conventional production systems for fattening pigs that are characterized by large units are often criticized due to limitations for the animals to express their species-specific behaviour. Apart from the fact that there is no clear definition of intensive farming, scientifically-based knowledge on the effects of varying herd sizes on animal behaviour is still lacking. Therefore, the aim of this study was to assess the relationship between herd size and behavioural indicators. In total, 60 farms were evaluated using the various behavioural indicators of the Welfare Quality® protocol for pigs. Farms were classified according to their herd size into small (< 1,500 pigs/farm), medium (1,500 – 3,000 pigs/farm) and large (> 3,000 pigs/farm) farms with 20 farms in each class. Multiple Generalized Linear Mixed Models were used to evaluate differences between herd sizes. Data of the qualitative behaviour assessment were subjected to a Principle Component Analysis (PCA). Differences between the farm sizes were not found for the principle “appropriate behaviour”, which aggregates all of the behavioural measures, and the criteria (social and other behaviour, positive emotional state and human-animal relationship) (P > 0.05). In tendency (P < 0.10), the panic response observed in 10% of the pens in large herds was lower than the 15 and 20% found in medium and small herds. The total active behaviour increased significantly with increasing farm size. Independent of the farm size, positive (10%) was observed three times more often than negative social behaviour (3%). However, determining factors that might influence social behaviour were not identified, mainly because the housing and management systems on the studied farms were similar. Among the different indicators that belong to the criterion “expression of other behaviours”, pen investigation was observed at a rate of more than 20%. The use of enrichment material, in contrast, was only performed for 2 to 4% of the total active behaviour. The proportion of investigation of the pen and exploration of enrichment material clearly indicates that under intensive fattening conditions the behavioural needs are not fulfilled. According to the PCA, none of the factors explained more than 39% of the total
variance. Therefore, this method was not able to distinguish differences between the three farm sizes. In conclusion, findings of this preliminary study showed that none of the herd sizes proved to be clearly superior to others in terms of the expression of species-specific behaviour. Nevertheless, findings clearly indicate limitations of the current production systems.

**Keywords:** fattening pigs; herd size; behavioural indicators of the Welfare Quality® assessment protocol

**Introduction**

As one of the four principles in Welfare Quality® assessment protocol (Welfare Quality®, 2009) “appropriate behaviour” plays a major role and several measures were defined to assess it on-farm. In general, behavioural observations are useful to evaluate the expression of normal behaviour (Barnett & Hemsworth, 1990). However, the affective state and positive emotions are difficult to assess and were highly neglected in previous studies (Ohl & van der Staay, 2012). Recently, different approaches for the assessment of positive emotions have been tested (Meehan & Mench, 2007; Dalmau et al., 2009). But, complex interactions still complicate interpretations (Boissy et al., 2007; Temple et al., 2011b). As a relatively new method, Qualitative Behaviour Assessment (QBA) integrates information from multiple behavioural signals and styles of behavioural expression directly in terms of their emotional expression (Wemelsfelder et al., 2000; Rutherford et al., 2012). According to Wemelsfelder & Millard (2009), QBA is a valuable methodology for assessing animal behaviour under field conditions and is the most immediately practicable method for assessing positive emotions in animals (Rutherford et al., 2012). Consequently, QBA was integrated into the WQP as an animal-based measurement tool to assess “positive emotional state”. Next to it, the social and exploratory behaviour and human-animal relationship were implemented to complement the behavioural assessment. With the help of human-animal
relationship it is possible to detect the panic response of the pigs towards the farmer (Hemsworth et al., 1993). Animals under intensive production are not anymore able to express their species-specific behaviour (Van de Weerd & Day, 2009). This aspect has been criticised by politicians and many other stakeholders including farmers, consumers, media, animal-rights activists, veterinarians, and other actors from the industry. This criticism has intensified in recent years (Kayser et al., 2012; Velarde et al., 2015). Next to the conventional production systems for fattening pigs, which are characterized by fully slatted floors, forced ventilation and automatic feeding systems (Hoy et al., 2006) the increasing herd sizes (Turner et al., 2003; Windhorst & Bräule, 2011; FAWC, 2012) were often criticised. Apart from the fact that there is no clear definition of intensive or industrial farming, scientifically-based knowledge on the effects of varying herd sizes on the animal welfare status and especially animal behaviour is still lacking (Winckler & Leeb, 2010). So far, studies mainly focused on the relationship between herd size and health parameters, like salmonellosis (Carstensen & Christensen, 1998; Van der Wolf, 2001; Zheng et al., 2007; Baptista et al., 2010) or respiratory diseases (Maes et al., 2008; Grøntvedt et al., 2013). The results are contradictory. On the one hand, animals in larger units may be at a greater risk of pathogens imported into the farm with purchased animals and transmission of pathogens may be enhanced when a higher number of potentially susceptible animals is raised together (Gardner et al., 2002). On the other hand, larger farms usually are able to implement improved hygiene measures (Gardner et al., 2002). Studies exploring the effect of herd size on animal behaviour are rare, even though animal health and animal behaviour are closely linked. The occurrence of tail biting, an abnormal behaviour in pigs and one of the most common welfare problems in the pig industry (Schrøder-Petersen & Simonsen, 2001), did not differ between farm sizes (500 to 7,500 pigs/farm) (Moinard et al., 2003). Also, Knage-Rasmussen et al. (2013) did not find any relationship between the farm size (120 to 7,825 pigs/farm) and the performance of normal behaviour. Generally, comparisons are difficult due to
widely variable study designs, country-specific production and environmental conditions and studied welfare indicators. Recently, Temple et al. (2011a) found only minor differences of the welfare status through behavioural parameters in Iberian pigs raised under intensive and extensive conditions between farms. No differences are seen in the expression of other behaviors, such as exploratory behavior and in human–animal relationship. They observed high occurrences of negative social behavior recorded in intensive conditions, which is clearly an indicator of poor welfare. But, effects of varying herd sizes on the animal behaviour and in particular positive emotions of fattening pigs were not assessed, yet. Therefore, the aim of this study was to assess the relationship between different herd sizes and behavioural indicators of welfare. In total, 60 conventional fattening pig farms, with herd sizes ranging from 250 to 11,000 pigs, were assessed using various behavioural indicators.

Materials and methods

Farms and animals

Data were recorded between September 2013 and June 2014 on 60 conventional pig fattening farms, located in Northern Germany. All farms were assessed by the same observer, who received intensive training on the correct application of the assessment according to the recommendation of the Welfare Quality® assessment protocol for growing pigs (WQP) beforehand.

A minimum herd size of 250 pigs was required and only conventional farms with common production systems (automatic feeding system, fully or partly-slatted floors, forced ventilation, all in-all out system) were included. The size of the farms ranged from 250 to 11,000 pigs. Farm size was defined as the number of pigs at one location, independent of whether the farmer raised pigs at other locations, too. Three farm size categories were defined: 1) small: < 1,500 pigs/farm; 2) medium: 1,500 to 3,000 pigs/farm; and 3) large: > 3,000 pigs/farm. Twenty farms belonged to each of the categories. Eighty % of the farms only
fattened pigs, while 20% had a closed system keeping sows, piglets and fattening pigs. All barns were insulated and had different mechanical ventilation systems. Two different feeding systems were implemented on the farms (62% automatic or sensor-controlled liquid feeders; 38% pulp feeding automat). Pigs were kept on fully (92% of the farms) or partly-slatted (8%) concrete floors. More information about the farms and animals (genetic, sexes, management practice) can be looked up in detail in Meyer-Hamme et al. (2016).

**Behavioural assessment**

In this study, all measures that are used in the WQP to asses “appropriate behaviour” were used. “Appropriate behaviour” was assessed by means of the criteria social and other behaviour, positive emotional state and good human-animal relationship test. The criterion positive emotional state is measured with the help of qualitative behaviour assessment (QBA). The criterion expression of social behaviour is defined in terms of the measures of positive and negative social behaviour and the criterion exploratory behaviour is defined in terms of pen investigation and use of enrichment material. With the help of the panic response the criterion good human-animal-relationship was assessed.

**Qualitative Behaviour Assessment (QBA)**

The QBA is the animal-based measure for the evaluation of positive emotions. It is a behaviour observation method, where the observer looks at the animals without any restrictions. Not the original form of the QBA with a free choice profiling methodology was included in the Welfare Quality® protocol. In all farms, QBA was carried out for a total duration of 20 min at four viewpoints at each farm, which were randomly chosen. After 5 min at each observation point, the observer left the stable and recorded the observation. The behaviour of the pigs was described with a list of 20 fixed adjectives (Welfare Quality®, 2009): 1. active, 2. relaxed, 3. fearful, 4. agitated, 5. calm, 6. content, 7. tense, 8. enjoying, 9. frustrated, 10. bored, 11. playful, 12. positively occupied, 13.
listless, 14. lively, 15. indifferent, 16. irritable, 17. aimless, 18. happy, 19. distressed and 20. sociable. A 125 mm visual analogue scale was assigned on which a line was drawn to signal whether that term was rather absent (0 mm, left side of the scale) or dominant (125 mm, right side of scale) in the previously observed pig groups. The values between 0 and 125 obtained on each farm for the 20 terms of the QBA are turned into an index due to a weighted sum. This index is then transformed into a score using I-spline function (Welfare Quality®, 2009). QBA data were expressed at farm level.

Expression of social and exploratory behaviour

Following QBA, social and explanatory behaviour were assessed using the scan sampling method on three view points of the farm, which differed from the QBA points. First, all pigs in the pens had to stand up. If necessary, the hands were clapped before starting with the observation. Then, the pigs had 5 min time to calm down. Afterwards, 40-60 animals were scanned for a total time of 10 min at each observation point. A scan was made every 2 min. At first, pigs were scored as active or inactive (resting). Active behaviour was then further differentiated into positive social, negative social, pen investigation, use of enrichment material and other active behaviour. Negative social behaviour was defined as aggressive interaction, including any social behaviour with a response from the disturbed pig. Positive social behaviour is described as sniffing or nosing and moving gently away from the pig without an aggressive reaction. Investigation of the pen was defined as sniffing, nosing or licking all features of the pen, whereby use of enrichment material is described as play or exploring towards enrichment materials. Other active behaviour includes eating, drinking or air sniffing. The results of the behaviour observation were expressed as performed behaviour in percent of the total active behaviour. Thereby, positive and negative social behaviour were summarized to total social behaviour.
Human-Animal Relationship

Ten randomly chosen pens were entered and the reaction of the animals towards the assessor was evaluated by a human-animal relationship test. After entering the pen and walking around it in one direction, the observer stood still in the middle of the pen for 30 sec. Subsequently, he walked around the pen in the other direction. Ratings were: 0 – no panic present and 2 – more than 60% of the pigs showed panic behaviour (e.g. fleeing). For the human-animal relationship test, the amount of pens with a panic response from the total observed pens per farm expressed in percent was used for further analysis.

Statistical analyses

The SAS statistical package version 9.3 (SAS Institute Inc., 2010) was used to analyse the data. Farm was defined as the statistical unit. A log- or an arcsin-transformation was done before further analysis. Results were considered statistically significant at $P < 0.05$. Multiple Generalized Linear Mixed Models were performed separately for the scores calculated for the principle “appropriate behaviour”, the associated criteria and behavioural measures (the 20 adjectives of the QBA, the results of the behaviour observation and of the human-animal relationship test) using the GLIMMIX procedure. The statistical model included the farm size (small, medium and large) as a fixed and the farm as random effect.

Data of QBA were, in addition, analysed with a Principle Component Analysis applying the PROC FACTOR procedure. The constitutional theory of this method is that there are underlying principles in the adjectives which influence each other (O'Rourke & Hatcher, 2013). For example, an animal cannot be content without being happy and there might be an influence between active and playful. Single PCAs were calculated for each farm size category. The first two Principle Components (Factor 1 and Factor 2) identified with an Eigenvector of greater than 1.0 were applied. They explained at least 23.6% up to 31.4% of the total variance in the different PCAs. Each adjective achieved a
certain factor loading on Factor 1 and Factor 2, which is a dimensionless number between -1 and 1. The factor loadings quantified the weight each adjective had on the two main axes (Rencher, 2002). Factor loadings greater than or equal to 0.40 were interpreted as highly positive and factor loadings less than or equal to -0.40 as highly negative (O'Rourke & Hatcher, 2013). The values obtained were plotted in two dimensional interpretative word charts, which were used to lead the interpretations of the first two Factors. 

Finally, Spearman Rank Correlation Coefficients (RS) between factor loadings on Factor 1 and Factor 2 of different farm size categories were calculated for each main Factor by the PROC CORR procedure. A correlation coefficient equal to or greater than 0.4 was interpreted as a moderate correlation whereby a coefficient equal to or greater than 0.7 as a strong correlation.

Results

Qualitative Behaviour Assessment (QBA)

The mean length of the scale scored by QBA is shown in Table 1. Generally, high standard deviations of descriptors were found, except for “distressed”, “indifferent” and “aimless”. For none of the 20 tested adjectives of the QBA a difference was found between the three farm size categories (P > 0.05).
Table 1: Qualitative behaviour assessment of the Welfare Quality® assessment protocol for growing pigs expressed in mm and the standard division of the scale (0 – 125 mm) separated by farm size (small: < 1,500 pigs/farm, medium: 1,500 to 3,000 pigs/farm and large: > 3,000 pigs/farm)

<table>
<thead>
<tr>
<th>Farm size</th>
<th>Small</th>
<th>Medium</th>
<th>Large</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LSMeans</td>
<td>SE</td>
<td>LSMeans</td>
</tr>
<tr>
<td>Active</td>
<td>52.75</td>
<td>24.38</td>
<td>61.70</td>
</tr>
<tr>
<td>Relaxed</td>
<td>38.60</td>
<td>25.33</td>
<td>27.60</td>
</tr>
<tr>
<td>Fearful</td>
<td>24.55</td>
<td>14.83</td>
<td>25.90</td>
</tr>
<tr>
<td>Agitated</td>
<td>37.45</td>
<td>23.24</td>
<td>49.85</td>
</tr>
<tr>
<td>Calm</td>
<td>37.45</td>
<td>19.21</td>
<td>24.65</td>
</tr>
<tr>
<td>Content</td>
<td>40.50</td>
<td>11.11</td>
<td>40.75</td>
</tr>
<tr>
<td>Tense</td>
<td>24.95</td>
<td>16.14</td>
<td>30.60</td>
</tr>
<tr>
<td>Enjoying</td>
<td>42.20</td>
<td>13.68</td>
<td>43.30</td>
</tr>
<tr>
<td>Frustrated</td>
<td>9.60</td>
<td>9.77</td>
<td>13.15</td>
</tr>
<tr>
<td>Sociable</td>
<td>42.70</td>
<td>18.94</td>
<td>44.30</td>
</tr>
<tr>
<td>Bored</td>
<td>24.80</td>
<td>19.04</td>
<td>13.75</td>
</tr>
<tr>
<td>Playful</td>
<td>37.60</td>
<td>18.25</td>
<td>42.20</td>
</tr>
<tr>
<td>Positively occupied</td>
<td>42.90</td>
<td>13.66</td>
<td>42.15</td>
</tr>
<tr>
<td>Listless</td>
<td>18.00</td>
<td>16.08</td>
<td>9.05</td>
</tr>
<tr>
<td>Lively</td>
<td>47.60</td>
<td>22.38</td>
<td>50.85</td>
</tr>
<tr>
<td>Indifferent</td>
<td>9.85</td>
<td>7.49</td>
<td>7.55</td>
</tr>
<tr>
<td>Irritable</td>
<td>31.20</td>
<td>20.95</td>
<td>36.50</td>
</tr>
<tr>
<td>Aimless</td>
<td>10.20</td>
<td>11.50</td>
<td>4.00</td>
</tr>
<tr>
<td>Happy</td>
<td>35.45</td>
<td>10.01</td>
<td>39.10</td>
</tr>
<tr>
<td>Distressed</td>
<td>2.90</td>
<td>1.07</td>
<td>3.25</td>
</tr>
</tbody>
</table>
Figure 1 visualises the factor loadings of each QBA adjective on Factor 1 and Factor 2 separated by farm size. Exemplarily, a comparison between farm size categories is displayed for the three selected adjectives agitated (ag), listless (li) and bored (bo).

For the small farm size, Factor 1 retained 39.4% and Factor 2 another 21.0% of the total variance. In the PCA of the medium farm size, Factor 1 explained 35.3% and Factor 2 another 22.8% of the total variance. For large farms, Factor 1 explained 32.4% and Factor 2 another 23.9% of the total variance.

Visible from Figure 1, certain adjectives vary largely between the three farm size categories (content, happy, aimless). Factor 1 of the small and large herd sizes had highly positive values for adjectives describing active behaviour with a positive connotation (active, agitated, enjoying, playful, lively, sociable) and highly negative values for adjectives describing inactivity (bored, calm, relaxed). Factor 1 of the medium herd size, on the other hand, showed adjectives expressing negative behaviour (fearful, agitated, tense, frustrated and irritable) with highly positive loadings and descriptive terms in the sense of positive inactivity (relaxed, calm, content, enjoying, happy) with highly negative loadings.

This non-conformity is also found in the examination of Factor 2. This is described with highly positive loadings for terms suggesting frustration (irritable, aimless and listless) and with highly negative loadings for terms of relaxation (relaxed, calm, happy and positively occupied) for small and large farm sizes. However, in terms of the Factor 2 of the medium farms, highly positive loadings for adjectives describing activity (active, lively) and highly negative loadings for those describing negatively connoted behaviour (bored, listless, indifferent).
Figure 1: Word chart presenting loadings on factor 1 and 2 of the Principal Component Analysis for the twenty different adjectives scores for small (black), medium (dark grey) and large (light grey) farms (ac = active, re = relaxed, fe = fearful, ag = agitated, ca = calm, co = content, te = tense, en = enjoying, fr = frustrated, so = sociable, bo = bored, pl = playful, po = positively occupied, ls = listless, lv = lively, in = indifferent, ir = irritable, ai = aimless, ha = happy, di = distressed)

A good agreement, expressed as short distances of the same adjective between farm sizes was found for the adjectives agitated (ag), tense (te), calm (ca), irritable (ir) and relaxed (re) (Figure 1). There is still an equal distribution of adjectives like sociable (so), content (co) and aimless (ai) in the word chart. For the adjectives listless (li), bored (bo), interesting (in), enjoying (en) and frustrated (fr) distances were large between medium farms and the two other farm sizes, which were close to each other.
In Table 2, the Spearman Rank Correlation Coefficients (RS) for Factor 1 and Factor 2 are presented. The RS for Factor 1 (0.91) and 2 (0.86) indicate a strong and significant correlation between the small and large farm. Factor 1 and Factor 2 were less consistent between small and medium as well as between medium and large farms.

**Table 2: Spearman Rank Correlation Coefficients for Principle Component 1 (Factor 1) and 2 (Factor 2) between the three different farm size categories**

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Spearman Rank Correlation Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Factor 1</td>
</tr>
<tr>
<td>Farm size</td>
<td></td>
</tr>
<tr>
<td>Small to medium</td>
<td>0.10</td>
</tr>
<tr>
<td>Small to large</td>
<td>0.91*</td>
</tr>
<tr>
<td>Medium to large</td>
<td>0.32</td>
</tr>
</tbody>
</table>

*P<0.05.

**Expression of social and other behaviour**

The total active behaviour increased, in tendency, with increasing farm size according the F-Test ($P = 0.0545$). After adjusting for multiple comparisons there was a significant difference between small and large farms ($P < 0.05$). Independent of the farm size, positive (10%) was observed three times as often as negative social behaviour (3%). Among the different indicators that belong to the criterion “expression of other behaviours”, pen investigation was observed most often at a rate of more than 20%. The use of enrichment material, in contrast, was only performed for 2 to 4% of the total active behaviour.
Table 3: Effect of farm size (small: < 1,500 pigs/farm, medium: 1,500 to 3,000 pigs/farm and large: > 3,000 pigs/farm) on the variables of the social and exploratory behaviour (LSMeans ± SE)

<table>
<thead>
<tr>
<th>Behavioural measure</th>
<th>Farm size</th>
<th></th>
<th>Minimum</th>
<th>Maximum</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Small</td>
<td>Medium</td>
<td>Large</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Active</td>
<td>56.57 ± 2.33</td>
<td>58.60 ± 2.26</td>
<td>64.61 ± 2.52</td>
<td>36.25</td>
<td>83.66</td>
</tr>
<tr>
<td>Negative social</td>
<td>3.12 ± 0.43</td>
<td>3.25 ± 0.41</td>
<td>2.63 ± 0.46</td>
<td>0.41</td>
<td>8.92</td>
</tr>
<tr>
<td>Positive social</td>
<td>9.41 ± 0.71</td>
<td>10.05 ± 0.69</td>
<td>10.87 ± 0.77</td>
<td>3.56</td>
<td>18.79</td>
</tr>
<tr>
<td>Exploration of pen</td>
<td>22.48 ± 1.70</td>
<td>22.45 ± 1.65</td>
<td>24.71 ± 1.84</td>
<td>11.44</td>
<td>39.14</td>
</tr>
<tr>
<td>Exploration of enrichment material</td>
<td>2.58 ± 0.56</td>
<td>4.27 ± 0.55</td>
<td>3.16 ± 0.61</td>
<td>0.00</td>
<td>9.88</td>
</tr>
</tbody>
</table>

\( \text{a, b}\) Different letters within rows indicate significant differences \((P < 0.05)\).
**Human-Animal Relationship**

In tendency (P < 0.10), the panic response observed in 10% of the pens in large herds was lower than the 15 and 20% found in medium and small herds. In small farms, the maximum prevalence of groups with a panic response reached 70% of the observed pens, while in medium and large farms at most 40% of the pens showed this response.

**Discussion**

In general, behaviour is an important component of animal welfare as it reflects the animal's feeling. Therefore, it is of utmost importance to include both psychological and physiological parameters for its assessment (Duncan & Petherick, 1991). The evaluation of behaviour has become of sustainable interest in the last years, whereby the emotional state is difficult to assess (Boissy et al., 2007). Independent of the herd size, farms in this study reached only 32 of 100 points for this principle, which has to be considered as low. Generally, intensive systems are often criticised with respect to species-specific behaviour (Van de Weerd & Day, 2009). Comparable studies on fattening pigs using measures of the WQP to evaluate pigs' behaviour are not widely available, yet. Studying only three intensive fattening pig farms, Otten et al. (2013) found values for “appropriate behaviour” for each farm slightly better (approximately 45 points) than in our study. The present findings also coincide with results of Knage-Rasmussen et al. (2013), who did not find any relationship between the number of pigs per farm (120 to 7,825 pigs/farm) and behavioural measurements such as aggression, exploration and fear of humans.

**Qualitative behaviour assessment**

Several studies clearly identify QBA as one of the most appropriate methods for the assessment of emotions in animals (Rutherford et al., 2012; Phythiana et al., 2013). First of all, there was no significant difference between the three farm
size categories when comparing the millimetre lengths assigned to each adjective in the QBA. In literature, however, millimetre scores are not often compared, although it was also carried out in some studies (Temple et al., 2011a; Otten et al., 2013). Comparable to the present study, only a low proportion of pigs showed behavioural patterns such as frustrated, indifferent and distressed (Otten et al., 2013). Regarding behavioural patterns that are negatively connoted (tense, agitated, irritable), previous findings indicated a high level of disturbance present in the animals (Temple et al., 2011a).

For further interpretation of the QBA results the Principle Component Analysis (PCA) was proposed (Temple et al., 2011b). There might be some agreement which is not taken into account when analysing the adjectives separately warranting the use of PCA (Wemelsfelder & Millard, 2009; Phythiana et al., 2013). The PCA showed a high variation for most of the adjectives included in the QBA between medium and both other herd size classes in terms of the factor loadings. The differences between herd sizes were secured by the Spearman Rank correlation coefficients.

In the study of Wemelsfelder & Millard (2009), Factor 1 distinguished between positive and negative mood and Factor 2 differentiated this mood in low and high levels of arousal. In the present study, Factor 1 of the small and large herd sizes have highly positive values in adjectives describing active behaviour with a positive connotation. Factor 1 of the medium herd sizes has adjectives expressing negative behaviour. The contrasting findings of the QBA are complicated to interpret due to the complex physiological system involved with emotions (Temple et al., 2011b).

Differences found between medium and the other two herd size classes can, in general, not be explained by differences between the 60 farms regarding their husbandry system or management procedures. However, there might be unknown and unpredictable time effects (e.g. disease outbreak or extreme weather events). In order to minimize errors related to the assessment procedures, all farms were assessed by the same observer after intensive training on the use of the adjectives. Nevertheless, there might be influences on
the outcomes due to the mood of the observer (Temple et al., 2013). The observer might transfer his own feelings and expectations to the animals, which is often the problem when subjective behavioural observations are conducted (Tuyttens et al., 2014). But Temple et al. (2011b) also noticed, that the QBA appears to be useful to differentiate and is sufficiently robust to distinguish between intensive farms. However, it was not possible to identify factors that could explain the differences between the PCAs of the medium and the other two herd size classes.

It has to be mentioned, that none of the factors explained more than 39% of the total variance in the different PCAs. In general, the interpretation of the QBA may gain in stability when applied to farms with a higher variation of production systems then in this study, while more than one visit seems to be necessary when a comparably low variation exists (Temple et al., 2013).

*Expression of social and exploratory behaviour*

In general, the scan sampling method allows a short time of observation. It is a good techniques for measuring states (Mann, 1999) and is accurate and precise for measuring durations of standing, lying, and feeding behaviours but were less precise for drinking and walking behaviors (Mitlöchner et al., 2001). Brief events can also be missed and the method can be problematic, when sporadic behaviour occurs.

The results for the social behaviour observed in the present study were similar to findings of Temple et al. (2011a), who reported values of 12.2% for positive and 5.4% for negative social behaviour. These similar values highlight the reliability of the scan sampling methodology.

Negative social behaviour is a clear indicator of insufficient welfare, because it correlates with a high number of stressful situations and competition for resources like feeding places. It has to be noted that differences between herd sizes were not significant. Other authors (Temple et al., 2011a) found significant variability among conventional farms for positive and negative social behaviours.
and explained the variation as a result of the interaction of several factors. The most important factors that have been reported in the literature are management-related factors (mixing of animals and growing stage (Courboulay et al., 2009), castration status (Fredriksen et al., 2008), genetics (Breuer et al., 2003) or housing systems like limited available space, limited resource, mixing of animals (Ewbank & Bryant, 1972). Again, variation between the studied farms of this study was low, so that none of these factors could be related to the expression of social behaviour. Furthermore the overall occurrence of negative social behaviour was quite low. If more than 7% of the animals on a farm are observed with this behaviour, it should be considered as having a welfare problem with regard to social negative behaviour (Temple et al., 2011a). In the present study for two of the 60 farms this threshold was exceeded (8% and 9%).

The proportion of investigation of the pen and exploration of enrichment material in our as well as previous studies (Temple et al., 2011b) clearly indicates that under intensive fattening conditions the behavioural needs are not fulfilled. This becomes obvious with regard to extensive housing conditions where exploratory behaviour is performed at much higher rates (40%) (Temple et al., 2011b). Although all of the observed pens in the present study were provided with toys, the occurrence of exploration of enrichment material was low (around 3%). An explanation might be caused by the fact that the provided material is not sufficiently interesting for stimulation the pigs to manipulate them. An attractive and appropriate enrichment material should frequently be renewed and never be spoiled with manure (Studnitz et al., 2007).

Positive social behaviour was observed at higher frequencies than negative social behaviour, again without any difference between herd sizes. Positive social behaviour reduces the negative effects of stressful events, and hence, is related to good welfare (Temple et al., 2011b). However, a social interaction may begin as a positive one (i.e. licking) and end up in a negative (i.e. biting). Therefore, high levels of positive social activity may not necessarily reflect a positive mood of the animal (Boissy et al., 2007). In consequence, the
interpretation of high frequencies of positive social behaviour should be interpreted carefully (Temple et al., 2011b). Active behaviour was significantly more often observed in larger herd sizes. The increase of active behaviour is probably due to a higher level of other active behaviour like eating, drinking, sitting or watching the surroundings, so that the whole active behaviour increases with increasing herd size. However, ranges of active behaviour were wide, thus indicating that some farms differed from the others regarding active behaviour. A high variability of active behaviour between farms was also observed by Temple et al. (2011a).

*Human-animal relationship*

The human-animal relationship is largely affected by the way farmers interact with their animals (Hemsworth et al., 1993). With the help of this parameter it is possible to detect the fear response of the pigs toward the stockman, which is a major welfare problem and alters not only the well-being, but also the productivity, product quality and profitability of farm animals (Waiblinger et al., 2006). On average, a panic response was observed in 14% of the farms, which was in tendency higher in small farms (20%). When a small farm was recorded with a panic response up to 70% of the single pens were affected, while for medium to large farms at most 40% of the pens showed this behaviour. According to Temple et al. (2011b), a maximum of 30% of the pens showing a panic response can be considered as having a good welfare status in terms of the relationship between animal and farmer. Apart from an adequate interaction, there are other important factors influencing the human-animal relationship such as genetics, growing stage, rearing system (Waiblinger et al., 2006), feed supply (Hemsworth et al., 1993) or group size (Meyer-Hamme et al., 2015). However, it was not possible to associate any of these factors with the human-animal-relationship because of the limited number of studied farms and a limited variation.
Conclusion

In conclusion, findings of this preliminary study showed that none of the herd sizes proved to be clearly superior to others in terms of species-specific behaviour. Nevertheless, findings clearly indicate limitations of the current production systems. Further studies are warranted to study the effects of other factors like the management (e.g. care of animals, health management, expertise of the stockman), feedings system or the floor type in combination with the farm size on the species-specific behaviour of fattening pigs.

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BEHAVIOURAL INDICATORS OF WELFARE IN FATTENING PIGS: DOES HERD SIZE MATTERS?


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KAPITEL 5

Does group size have an impact on welfare indicators in fattening pigs?

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Does group size have an impact on welfare indicators in fattening pigs?

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Short title: Effect of group size on welfare in fattening pigs
Abstract

Production systems for fattening pigs have been characterized over the last two decades by rising farm sizes coupled with increasing group sizes. These developments resulted in a serious public discussion regarding animal welfare and health in these intensive production systems. Even though large farm and group sizes came under severe criticism, it is still unknown whether these factors indeed negatively affect animal welfare. Therefore, the aim of this study was to assess the effect of group size (< 15 vs. 15 to 30 vs. > 30 pigs/pen) on various animal-based measures of the Welfare Quality® protocol for growing pigs under conventional fattening conditions. A total of 60 conventional pig fattening farms with different group sizes in Germany were included. Moderate bursitis (35%) was found as the most prevalent indicator of welfare-related problems, while its prevalence increased with age during the fattening period. However, differences between group sizes were not detected (P > 0.05). The prevalence of moderately soiled bodies increased from 9.7% at the start to 14.2% at the end of the fattening period, whereas large pens showed a higher prevalence (15.8%) than small pens (10.4%; P < 0.05). With increasing group size, the incidence of moderate wounds with 8.5 and 11.3% in small- and medium-sized pens, respectively, was lower (P < 0.05) than in large-sized ones (16.3%). Contrary to bursitis and dirtiness, its prevalence decreased during the fattening period. Moderate manure was less often found in pigs fed by a dry feeder than in those fed by a liquid feeding system (P < 0.05). The human-animal relationship was improved in large in comparison to small groups. On the contrary, negative social behaviour was found more often in large groups. Additionally, with increasing live weight, the prevalence of exploration of enrichment material decreased. Given that all animals were tail-docked, tail biting was observed at a very low rate of 1.9%. In conclusion, the results indicate that body weight and feeding system are determining factors for the welfare status, while group size was not proved to affect the welfare level under the studied conditions of pig fattening.
Keywords: animal-based measures; fattening pigs; group size; welfare indicators

Implications

Production systems for fattening pigs have been characterized over the last two decades by rising farm sizes coupled with increasing group sizes, in order to optimize management and efficiency. Concerns about animal welfare in these systems are under intensive discussion. Lack of scientifically-proven studies contributes to the negative image of modern livestock farming. Therefore, the welfare level of 60 fattening pig farms in Germany was assessed and the effect of group size on welfare indicators was evaluated to identify an optimal group size proved to be superior to others in terms of animal welfare. This will be an important contribution for the future discussion as group size is one of the most criticized aspects among the welfare debate.

Introduction

During the last decades, the pig fattening industry has shifted towards larger farm sizes mainly due to limited profits (FAWC, 2012). At the same time, some farmers changed the housing system from small groups of 12-15 pigs to large (> 50 pigs) (Turner & Edwards, 2004) and even mega groups (> 100 pigs) (Samarakone & Gonyou, 2008) in order to optimize management and labour efficiency (Schmolke et al., 2003). Common group sizes for growing pigs in Germany range between 10 and 30 animals, even though groups of 40 to 100 or even more animals were proposed by a few farms as a management strategy to improve overall profitability (Schmolke et al., 2003). In Germany, pigs under conventional production conditions, are generally fattened indoors and barns are generally characterized by fully slatted floors, forced ventilation and automatic feeding systems (Hoy et al., 2006). Recently, these production systems, particularly under conditions of large farms and group sizes, have been under serious discussion mainly due to animal welfare concerns (Schröder & McEachern, 2004; Kayser et al., 2012; Velarde et al., 2015).
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Studies using various welfare-related measures indicate negative impacts when group sizes exceed those found in the wild, which are usually comprised of two to four sows with their most recent litters and juvenile offspring of previous litters (Gonyou, 2001). McGlone & Newby (1994) found that injury and morbidity rates were greater for pigs in groups of 40 than of 10 or 20 animals. In contrast, Samarakone & Gonyou (2008) did not find differences for mortality, morbidity or behavioural vices, such as tail biting, when comparing groups of around 20 and 100 pigs. The meta-analysis of Averós et al. (2010) did also not provide any evidence that group size affects the lying behaviour.

Because the welfare status of animals is multi-factorial, a combination of various parameters is necessary for its evaluation. The Welfare Quality® assessment protocol (WQP) for growing pigs (Welfare Quality®, 2009) is an adequate tool to address the effects of group size on farm. As a multidimensional concept, it integrates the absence of thirst, hunger, discomfort, disease, pain and injuries, stress and the expression of normal behaviour. Recent studies on the welfare status of growing pigs raised under intensive conditions reported only minor differences between farms (Temple et al., 2011a; Temple et al., 2012). However, group size effects on the animal-based indicators of the protocol were not assessed, yet. Therefore, the aim of this study was to compare different group sizes under conventional fattening conditions in terms of welfare-related indicators of the WQP.

Material and methods

Farm selection and housing system

A total of 60 conventional pig fattening farms with herd sizes between 250 and 11,000 pigs, located in Northern Germany, were assessed. The assessments were conducted between September 2013 and June 2014 by the same observer, who received intensive training on the correct application of the WQP beforehand. Farms were selected based on farm size and management (intensive production conditions, forced ventilation, “all in all out” management). Eighty% of the farms only raised growing pigs, while 20% had a closed system
Does group size have an impact on welfare indicators in fattening pigs?

raising sows, piglets and growing pigs. Farm-related data (feeding and hygiene management, prevention of diseases, mortality rate, castration and tail docking routines and procedures) were gathered. All barns were insulated and equipped with mechanical ventilation systems. Liquid feeding was used in 62% and dry feeding automatns in the other farms.

Animal and pen characteristics

On each farm, 10 randomly selected pens were assessed. In pens with less than 15 pigs, all pigs were included, while in larger pens 15 animals were randomly selected and assessed for the animal-based measures. Hospital pens were excluded and the sex of each individual was recorded. The total number of 600 pens housed 32,723 pigs, of which 8,214 were included in the individual observations. The group size of the selected pens ranged from 10 to 350 animals, which were classified into the following three categories: 1) small: < 15 pigs/pen; 2) medium: 15 to 30 pigs/pen; and 3) large: > 30 pigs/pen.

Animals were crossbreds of various genetic lines from the following breeding companies: DanZucht (Copenhagen, Denmark) (45%), German Federal Hybrid Breeding Program (BHZP, Ellringen, Germany) (15%), Topigs (Senden, Germany) (12.8%), Pig Improvement Company (PIC) (Schleswig, Germany) (8.3%), Hypor (Sittensen, Germany) (6.6%) or JSR Hybrid (Ahaus, Germany) (3.3%). Sows were bred by AI either with Pietrain (73%) or Duroc (27%) semen. Tail docking was routinely practiced for all pigs.

The fattening period started at an initial body weight of 29.9 ± 2.8 kg and pigs were slaughtered at 120.8 ± 3.5 kg. The age of the pigs at the assessment ranged from 12 to 30 weeks. On the assessment day, the actual body weight was calculated based on the initial weight and under the assumption of 800 g daily weight gain. The respective body weight was classified into the following groups: 1) < 50 kg; 2) 50 to 80 kg; and 3) > 80 kg.

The length and width of the individual pens was measured to calculate the space allowance. On average, 0.83 m² were available per pig (range 0.31 to 2.5 m²). In accordance with the German farm animal welfare regulations
DOES GROUP SIZE HAVE AN IMPACT ON WELFARE INDICATORS IN FATTENING PIGS?

(Tierschutz-Nutztierhaltungsverordnung, 2006) the space allowance was defined as 1) = legally justified: 30 to 50 kg = > 0.5 m²/pig; 51 to 110 kg = > 0.75 m²/pig; > 111 kg = > 1 m²/pig or 2) = not legally justified: space allowance below the thresholds stated under 1).

Assessment of animal-based measures

At the individual level, body condition, bursitis, manure, wounds, tail biting, lameness, laboured breathing, scouring, skin condition (inflammation or discoloration), hernias, twisted snouts and rectal prolapse were assessed according to the WQP (Welfare Quality®, 2009), which includes detailed information on the overall assessment methodology. Only one side of the animals was inspected. Individual animal-based measures are either categorised by a three-point scale (0 = absent, 1 = moderate, 2 = severe), such as bursitis, manure on the body, shivering, panting, huddling, lameness, wounds on the body, skin condition and ruptures or else by a two-point scale (0 = absent, 2 = present), such as body condition score, tail biting, twisted snouts and rectal prolapse. In brief, score 2 for tail lesions describes the presence of any animal with fresh blood visible on the tail and/or evidence of some swelling and infection, and/or part of the tail tissue missing and presence of crust. For pig dirtiness, score 0 is defined as <20%, score 1 as 20-50% and score 2 as >50% of the body surface being soiled with faeces. The accordant definitions for bursitis are no evidence of bursa/swelling (score 0), one or several small bursa (1.5 to 2.0 cm) or one large bursa (3.0 to 5.0 cm) (score 1) and several large bursa, or one extremely large bursa (5.0 to 7.0 cm), or any eroded bursa (score 2). Wounds are scored 0 if the different regions of the body (ears, front, middle, hind-quarters and legs) have less than five lesions. Score 1 is given if 5 to 10 lesions are visible and 2 if more than 11 lesions are observed on at least two body regions or if any zone is found with more than 15 lesions.

At pen level, huddling, shivering, panting, the human-animal relationship and the water supply (number of drinkers, functioning and cleanliness) were assessed. Huddling, shivering and panting were the first measures assessed.
visually from the corridor and only observed in resting animals, just before the animals began to stand up. The human-animal relationship test was performed using score 0 for no panic towards the human present and score 2 for more than 60% of the pigs with panicking behaviour. Panic was defined as animals fleeing, facing away from the observed or huddling in the pen corner. For the human-animal relationship test, the amount of pens with a panic response from the total pens observed per farm expressed in percent was used for further analysis.

The social and explanatory behaviour was assessed at three different observation points of the farm. At each point 50 to 60 animals from up to four different pens were observed for a total period of 10 minutes with a scan made every 2 minutes. First, the animals were forced to stand up, if necessary hands were clapped, and then they had 5 minutes time to calm down. Firstly, pigs were scored as active or inactive (resting). Active behaviour were differentiated into positive social, negative social, pen investigation, use of enrichment material and other active behaviour. Negative social behaviour is defined as aggressive interaction, including any social behaviour with a response from the disturbed pig. Positive social behaviour is described as sniffing or nosing and moving gently away from the pig without an aggressive reaction. Investigation of the pen is defined as sniffing, nosing or licking all features of the pen, whereby use of enrichment material is described as play or exploring towards enrichment materials. Other active behaviour can be eating, drinking or air sniffing.

Statistical analyses

All analyses were conducted using SAS version 9.3 (Statistical Analyses System, 2011). Pen was defined as the statistical unit. Results were considered statistically significant at $P > 0.05$. For indicators that were recorded at individual level, the number of animals per pen scored either 1 or 2 was divided by the total number of animals observed in the pen and then transformed into frequencies. Data of the social and exploratory behaviour were expressed as the proportion of animals performing the respective behaviour in relation to the
total number of active animals observed per viewpoint. From seven observation points data could not be included, because pens from more than one group size category were observed at these points.

Multiple Generalized Linear Mixed Models were performed separately for moderate bursitis, manure and wounds as well as for the social and exploratory behaviour using the GLIMMIX procedure. A Poisson distribution and a logarithmic link function were assumed. Apart, scores other than 0 were observed at such low rates that group size effects could not be verified. The statistical model included the fixed effects group size (small, medium and large), live weight group (1, 2 and 3), space allowance (legally justified, not legally justified), and feeding system (liquid feeding, dry feeding) were included. The farm served as random effect to account for the possible dependence between observations of pens from the same farm. Space allowance was excluded because it did not have a significant effect on any of the measures.

For human-animal relationship, which was recorded as binomial variable, odds ratios were calculated using the GLIMMIX procedure including group size as fixed and farm as random effect.

**Results**

*Farms and animals*

Females and castrates were housed together in mixed pens in more than 60% of the studied pens, whereas pens with boars and females (6%) and boars only (4%) were exceptions. Sexes were raised separately in all other pens. The vast majority of the pens had a fully and only 8% a partly slatted floor (Table 1). More than 40% of the pens had a space allowance below the German legal requirements independent of the group size (Table 1). The mean and median number of pigs per drinker was 6 and 7, respectively, for liquid feeding (range 2 to 43) and 9 and 10 for dry feeding (range 2 to 23). In 22% of the pens the ratio was larger than 10; and 7% of the pens were only equipped with one drinker. Three farms using liquid feeding even had no additional drinker in the pen or
turned them off after a certain period of the fattening period. The mortality rate averaged 2.5% and ranged from 0.9 to 5.2%.
Does group size have an impact on welfare indicators in fattening pigs?

| Table 1: Distribution (in % of pens) of floor type (fully-slatted and partly slatted), space allowance (legally justified and not legally justified) and live weight group (1, 2 and 3) in dependence of three different group sizes (small, medium and large) evaluated in 600 pens for growing pigs |
|---------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Group size¹                    | n               | Floor type      | Space allowance² | Live weight group³ |
|                                 |                 | Fully-slatted   | Partly-slatted   | Legally justified | Not legally justified | 1              | 2              | 3              |
| Small                          | 207             | 28.8            | 5.7             | 23.0             | 12.1             | 5.9             | 12.1           | 17.0           |
| Medium                         | 257             | 41.3            | 1.5             | 23.9             | 18.2             | 8.3             | 17.1           | 16.5           |
| Large                          | 136             | 22.0            | 0.7             | 12.4             | 10.4             | 5.3             | 10.0           | 7.8            |
| Total                          | 600             | 92.2            | 7.8             | 59.3             | 40.7             | 19.5            | 39.2           | 41.3           |

¹ Group size: Small: < 15 pigs/pen; medium: 15 to 30 pigs/pen and large: > 30 pigs/pen.

² Space allowance: legally justified = 30 to 50 kg = > 0.5 m²/pig; 51 to 110 kg = > 0.75 m²/pig; > 111 kg = > 1 m²/pig; not legally justified = space allowance below the thresholds stated under legally justified.

³ Live weight group: 1 = < 50 kg; 2 = 50 to 80 kg; and 3 = > 80 kg.
Animal-based measures

Among the animal-based measures, highest prevalence was determined for moderate bursitis (35%), moderate manure (15.5%) and moderate wounds (10.5%), whereas severe bursitis, manure and wounds were only detected exceptionally (Table 2). For all other indicators recorded at the individual level including tail biting, scores other than 0 were recorded at very low frequencies. In Table 3, rates of the most prevalent measures are presented by group size and live weight class. For moderate bursitis, group sizes did not differ (P > 0.05), while the prevalence was higher in the two upper live weight classes when compared with the lowest class (P < 0.05). In medium and large groups moderately soiled bodies were found more often than in small groups (P < 0.05). Moderate manure was found at higher rates on pigs fed by a liquid (22%) than a dry feeding system (12%; P < 0.05). Pigs in the upper two live weight classes were dirtier than in the lowest class (P < 0.05). Moderate wounds increased from less than 9% in small to almost 16% in large groups (P < 0.05). In comparison to pigs in the medium live weight category, moderate wounds were less often observed in pigs of the upper one (P < 0.05).
### Table 2: Prevalence (%) of the animal-based measures of the Welfare Quality® assessment protocol for growing pigs evaluated in 600 pens

<table>
<thead>
<tr>
<th>Measure</th>
<th>Mean</th>
<th>SD</th>
<th>Median</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor body condition</td>
<td>0.2</td>
<td>0.7</td>
<td>0</td>
<td>0</td>
<td>17</td>
</tr>
<tr>
<td>Moderate bursitis</td>
<td>34.7</td>
<td>8.9</td>
<td>33</td>
<td>0</td>
<td>93</td>
</tr>
<tr>
<td>Severe bursitis</td>
<td>2.7</td>
<td>3.3</td>
<td>0</td>
<td>0</td>
<td>47</td>
</tr>
<tr>
<td>Moderate manure</td>
<td>15.5</td>
<td>9.8</td>
<td>13</td>
<td>0</td>
<td>88</td>
</tr>
<tr>
<td>Severe manure</td>
<td>6.2</td>
<td>6.5</td>
<td>0</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Moderate lameness</td>
<td>0.4</td>
<td>0.6</td>
<td>0</td>
<td>0</td>
<td>13</td>
</tr>
<tr>
<td>Severe lameness</td>
<td>0.1</td>
<td>0.3</td>
<td>0</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>Moderately wounded</td>
<td>10.5</td>
<td>7.5</td>
<td>7</td>
<td>0</td>
<td>64</td>
</tr>
<tr>
<td>Severely wounded</td>
<td>1.5</td>
<td>2.8</td>
<td>0</td>
<td>0</td>
<td>50</td>
</tr>
<tr>
<td>Tail biting</td>
<td>1.9</td>
<td>2.8</td>
<td>0</td>
<td>0</td>
<td>90</td>
</tr>
<tr>
<td>Pumping</td>
<td>0.0</td>
<td>0.1</td>
<td>0</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>Twisted snouts</td>
<td>0.0</td>
<td>0.0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Rectal prolapse</td>
<td>0.0</td>
<td>0.1</td>
<td>0</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>Moderate skin</td>
<td>0.6</td>
<td>0.8</td>
<td>0</td>
<td>0</td>
<td>13</td>
</tr>
<tr>
<td>Severe skin</td>
<td>0.0</td>
<td>0.1</td>
<td>0</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>Moderate hernia</td>
<td>0.6</td>
<td>0.7</td>
<td>0</td>
<td>0</td>
<td>13</td>
</tr>
<tr>
<td>Severe hernia</td>
<td>0.0</td>
<td>0.0</td>
<td>0</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>Panic response</td>
<td>14.5</td>
<td>17.8</td>
<td>0</td>
<td>0</td>
<td>100</td>
</tr>
</tbody>
</table>
Table 3: Prevalence (%) (standard error) of selected animal-based measures of the Welfare Quality® protocol for growing pigs separated by group size (small, medium and large) and live weight group (1, 2 and 3) evaluated in 600 pens

<table>
<thead>
<tr>
<th>Measures</th>
<th>Group size</th>
<th>Live weight group</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Small</td>
<td>Medium</td>
<td>Large</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Moderate bursitis</td>
<td>32.6 (1.6)</td>
<td>33.1 (1.6)</td>
<td>34.7 (2.0)</td>
<td>25.8&lt;sup&gt;a&lt;/sup&gt; (1.9)</td>
<td>36.5&lt;sup&gt;b&lt;/sup&gt; (1.7)</td>
</tr>
<tr>
<td>Moderate manure</td>
<td>10.4&lt;sup&gt;a&lt;/sup&gt; (1.4)</td>
<td>13.1&lt;sup&gt;ab&lt;/sup&gt; (1.5)</td>
<td>15.8&lt;sup&gt;b&lt;/sup&gt; (1.8)</td>
<td>9.7&lt;sup&gt;a&lt;/sup&gt; (1.7)</td>
<td>15.4&lt;sup&gt;b&lt;/sup&gt; (1.5)</td>
</tr>
<tr>
<td>Moderate wounds</td>
<td>8.5&lt;sup&gt;a&lt;/sup&gt; (1.2)</td>
<td>11.3&lt;sup&gt;a&lt;/sup&gt; (1.2)</td>
<td>16.3&lt;sup&gt;b&lt;/sup&gt; (1.5)</td>
<td>14.4&lt;sup&gt;a&lt;/sup&gt; (1.4)</td>
<td>12.5&lt;sup&gt;a&lt;/sup&gt; (1.3)</td>
</tr>
</tbody>
</table>

<sup>a,b,c</sup> Different letters within rows indicate significant differences ($P < 0.05$).

<sup>1</sup> Group size: Small: < 15 pigs/pen; medium: 15 to 30 pigs/pen and large: > 30 pigs/pen.

<sup>2</sup> Live weight group: 1 = < 50 kg; 2 = 50 to 80 kg; and 3 = > 80 kg.
The effects of group size and live weight group on the social and exploratory behavior are presented in Table 4. At a rate of 4.3%, negative social behaviour was recorded more frequently in large groups \((P < 0.05)\) than in small (2.2%) and medium groups (2.4%). Without differences between groups, a positive social behaviour was observed at rates of around 10%. Also not different between groups, rates of 22 to 25% were found for investigation of the pen and 3 to 4% for exploration of enrichment material. Pigs in large groups showed active behaviour less frequent than those in small and medium groups \((P < 0.05)\). Regarding live weight groups, differences were only found for investigation of the pen, which was recorded more often in group 1 and 2 than in group 3 \((P < 0.05)\).

The prevalence of a panic response assessed via human-animal relationship was higher in small (20.3%) than in medium (14.0%) and large groups (6.6%; Table 5). Thereby, the odd of having a panic response was 0.329 and 0.497 for pigs in small and medium groups, respectively, when compared to large groups.
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Table 4: Prevalence (%) (standard error) of the social and exploratory behaviour separated by group size (small, medium and large) and live weight group (1,2 and 3) evaluated in 600 pens

<table>
<thead>
<tr>
<th>Measures</th>
<th>Group size¹</th>
<th>Live weight group²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Small</td>
<td>Medium</td>
</tr>
<tr>
<td>Negative social</td>
<td>2.2ᵃ (0.3)</td>
<td>2.4ᵃ (0.3)</td>
</tr>
<tr>
<td>Positive social</td>
<td>9.2 (0.6)</td>
<td>10.1 (0.6)</td>
</tr>
<tr>
<td>Investigation of the pen</td>
<td>24.5 (1.3)</td>
<td>23.4 (1.2)</td>
</tr>
<tr>
<td>Exploration of enrichment material</td>
<td>3.4 (0.5)</td>
<td>3.6 (0.5)</td>
</tr>
<tr>
<td>Active behaviour</td>
<td>60.5ᵃ (1.7)</td>
<td>60.3ᵃ (1.6)</td>
</tr>
</tbody>
</table>

ᵃ,ᵇ,ᶜ Different letters within rows indicate significant differences (P < 0.05).

¹ Group size: Small: < 15 pigs/pen; medium: 15 to 30 pigs/pen and large: > 30 pigs/pen.
² Live weight group: 1 = < 50 kg; 2 = 50 to 80 kg; and 3 = > 80 kg.
Table 5: Probability of occurrence of a panic response to the observer depending on group size (small, medium and large) evaluated in 600 pens

<table>
<thead>
<tr>
<th>Variable</th>
<th>Prevalence of a panic response (%)</th>
<th>Odds Ratio¹</th>
<th>Confidence intervals (95%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group size²</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>20.3</td>
<td>0.329</td>
<td>0.119  0.908</td>
</tr>
<tr>
<td>Medium</td>
<td>14.0</td>
<td>0.497</td>
<td>0.188  1.313</td>
</tr>
<tr>
<td>Large</td>
<td>6.6</td>
<td>Reference</td>
<td>-                   -</td>
</tr>
</tbody>
</table>

¹Intercept coefficient = 2.9466.

² Group size: Small: < 15 pigs/pen; medium: 15 to 30 pigs/pen and large: > 30 pigs/pen.

Discussion

Among the various indicators that were assessed using the WQP bursitis, wounds and manure on the pigs showed the highest incidences. In large groups of more than 30 animals, the presence of both wounded and soiled pigs was higher compared to small- and medium-sized groups. Additionally, negative social behaviour was found more often in large groups, in which, on the contrary, a better human-animal relationship was noted. With increasing live weight, the occurrence of bursitis and manure on the body increased, while the prevalence of wounds and exploration of enrichment material decreased.

Feeding

Under conventional fattening conditions where animals are commonly fed ad libitum, pigs with a poor body condition are the exception. Expectedly, values in our study were similar to those observed by Temple et al. (2012) who recorded a prevalence of only 0.4% in conventional production systems. Even though previous studies showed that access to feeders and feed intake is impacted by group size (Spoolder et al., 1999; Wolter et al., 2001), changes are not as
pronounced as to translate directly into body condition changes. In general, a poor body condition is the result of deficits in health management and consequently in feed intake (Velarde & Geers, 2007). However, it has to be mentioned here that hospital pens are not assessed by the WQP, thus the actual prevalence in the studied farms might have been greater.

Contrary to feeding, the water supply was regularly insufficient in terms of animal to drinker ratio and functionality. In accordance with article 28 (2) No 5 (Tierschutz-Nutztierhaltungsverordnung, 2006) one drinker should be offered per 12 pigs and article 26 (1) No 2 regulates that every pig should have permanent access to a drinker with water in sufficient quality and quantity and which is separated from the feeding spaces. Nevertheless, the ratio should be adjusted to the group size. As the interaction between group size and drinker ratio on daily time at the drinkers found by Turner et al. (2000) indicated. Consequently, the larger the group the more drinkers per pig should be available, although pigs in larger groups (60 pigs) spent less time drinking per day than pigs in smaller groups (<20 pigs). Furthermore, the frequency of visits to the drinkers, drinking bout duration and daily drinking time increased in the mentioned study when the pig to drinker ratio increased (Turner et al., 2000). However, a sufficient quantity is more often a problem than the water quality (Kamphues & Schulz, 2002).

*Bursitis*

Bursitis arises as one or more fluid-filled sacs at the fore or hind leg, where normally no swelling is present. The swelling occurs whenever skin covering a bony structure is exposed to pressure and is not related to an infection. As a result, the fluid exudates from traumatized capillaries and lymphatic vessels. Bursitis can persist or vanish after a certain period of time (Mouttotou et al., 1999). In the present study moderate bursitis (35%) was found as the most prevalent animal-based measure. As shown in previous studies, this is a sensitive indicator to compare different production systems and differentiate farms, because of high between-farm variability and low within-farm variability.
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(Temple et al., 2012). When bursitis was present on a farm, a large number of animals were affected. The different prevalence of bursitis and the high between-farm variability can be explained by several causal factors such as the environment, especially the floor type. A concrete floor increases pressure on the pigs’ limbs and intensifies the severity of bursitis (Smith, 1993; Mouttotou et al., 1999). The high bursitis prevalence in the present study can be explained by the vast majority of pens with fully slatted floors. However, differences between fully and partly slatted floors could not be verified. The prevalence of bursitis increased with age during the fattening period, mainly due to the fact that the greater body weight exerts additional pressure on the limbs (Mouttotou et al., 1999). Although Smith (1993) reported that pigs kept at high stocking densities tended to have an increased prevalence and severity of bursa lesions, the stocking density and group size in our study did not have an effect. Although we observed that more than 40% of the farms had a space allowance below the German farm animal welfare regulations (Tierschutz-Nutztierhaltungsverordnung, 2006), this did not affect the prevalence of bursitis. Severe bursitis was only recorded exceptionally and at lower rates than under comparable production conditions with concrete flooring in previous studies (Temple et al., 2011a).

Pig dirtiness

The prevalence of moderately (15.5%) and severely (6.2%) soiled bodies are similar to the values of 16.6% and 3.7%, respectively, reported by Temple et al. (2011a). This emphasizes that the prevalence of soiled bodies is consistent within the same production system independent of the geographic region. The highest prevalence of moderate dirtiness was registered for pigs kept in large groups (15.8%), compared to the lowest in small groups (10.4%). Comparable values are not available in the literature, yet. Pig dirtiness is influenced by multiple factors (Velarde & Geers, 2007) with the floor type being one of the most causal factors in conventional housing systems (Temple et al., 2011a). Thereby, the risk for manure on the body is higher for partly than for fully slatted
floors (Temple et al., 2012). However, this could not be verified in our study. Similar to bursitis, pig dirtiness increased during the fattening period, which can be mainly explained by the fact that the effective stocking density increases. Furthermore, older pigs spend more time lying compared to younger animals in order to dissipate metabolic heat (Aarnink et al., 2006). This was supported by the current finding that older pigs were found less often investigating the pen compared with younger animals. As another determining factor, the feeding system plays a role. The findings that liquid-fed pigs were dirtier than dry-fed ones was previously described by Hyun (2001). In summary, the feeding system and floor type seem to have a much larger effect on pig dirtiness than group size.

Wounds

The prevalence of severely wounded pigs (1.5%) was similar to the mean prevalence found by Temple et al. (2011a). The occurrence of moderate wounds was about 10.5%. With increasing group size, the amount of observed moderate wounds rose. It remains questionable whether these wounds are a consequence of social interactions between animals (fights) or deficiencies in the physical environmental (inappropriate design of facilities). Moreover, negative social behaviour occurred more often with increasing group size in the present study. In general, negative social behaviour is a clear indicator of poor welfare, whereas the occurrence in the present study was found at a level as low as reported by Temple et al. (2011b). The number of possible encounters increases with increasing group size and consequently the risk for agonistic behaviour and injures increases (Velarde & Geers, 2007). Similar to our findings, McGlone & Newby (1994) observed the highest injury and morbidity rate in groups of 40 compared with 20 or 10 pigs. The decreasing prevalence of wounds with increasing age during the fattening period is probably due to the fact that wounds are usually achieved at the beginning of the fattening period as a result of fights during the establishment of the rank order. These fights can be of differing severity and length depending
Does group size have an impact on welfare indicators in fattening pigs?

on the aggressiveness of individual group members (Bryant & Ewbank, 1972). Furthermore, competition for food leads to more wounds (Botermans & Svendsen, 2000). In fact, dry feeding with limited feeding places compared with liquid feeding using communal troughs led to an increase in skin injuries, most pronounced when the pigs were fed restrictively. In agreement, pigs fed by a dry feeder with a reduced number of feeding places, showed a higher incidence of moderate wounds in our study. Though the incidence of wounds is highly dependent on whether pigs are fed ad libitum or restricted, lesion patterns on the skin do act as indicators for welfare and reflect the quality of pigs’ social and physical environment. This is particularly valid under the consideration that fattening pigs are most commonly fed ad libitum.

Behaviour

In general, behaviour is an important component of animal welfare because it reflects the animal’s feeling. Therefore, it plays a major role in the WQP. To the author’s knowledge this is the first study, revealing the relationship between group size and social and exploratory behaviour. The fact that large groups showed more negative social behaviour, which is a clear indicator of insufficient welfare, emphasizes the increased number of stressful situations and competition for resources in these groups. Nevertheless, it has to be noted that differences between groups were relatively low and the overall presence of this indicator was lower than observed by other studies under comparable production systems (Temple et al., 2011b). For investigation of the pen, differences between groups sizes were not observed, so the proposed increase in negative social behaviour associated with a decrease of exploratory behaviour by Temple et al. (2011b) could not be substantiated. The proportion of exploratory behaviour including investigation of the pen and exploration of enrichment material in our as well as previous studies (Temple et al., 2011b) clearly indicates that under intensive fattening conditions the behavioural needs are not fulfilled. This becomes obvious when comparisons to extensive housing conditions where exploratory behaviour is performed at much higher rates.
DOES GROUP SIZE HAVE AN IMPACT ON WELFARE INDICATORS IN FATTENING PIGS?

(40%) are drawn (Temple et al., 2011b). The decrease of the exploration behaviour during the fattening period is probably due to a lower level of curiosity and higher level of lethargy (Studnitz et al., 2007). In contrast to negative, positive social behaviour was observed at higher frequencies without any difference between group sizes. It reduces the negative effects of stressful events and hence is related to good welfare (Temple et al., 2011b). However, a social interaction may begin as a positive one (i.e. licking) and end up in a negative one (i.e. biting). Therefore, high levels of positive social activity may not necessarily reflect a positive mood of the animal (Boissy et al., 2007). In consequence, the interpretation of high frequencies of positive social behaviour should be carefully interpreted (Temple et al., 2011b).

The human-animal relationship is largely affected by the way farmers interact with their animals (Hemsworth et al., 1993). With the help of this parameter it is possible to detect the fear response of the pigs toward the stockman. Fear is considered as a major welfare problem and alters not only the well-being, but also the productivity, product quality and profitability of farm animals (Waiblinger et al., 2006). Without changes in husbandry conditions, human-animal relationship is consistent for a prolonged period on the farm (Temple et al., 2011b). In total, a panic response was observed in 14.5% of the pens in the present study. According to Temple et al. (2011b), a farm with maximum 30% of the pens showing a panic response can be considered having a good welfare status for the relationship between animal and farmer. Apart from an adequate interaction, there are other important factors influencing the human-animal relationship such as the genetics, growing stage, rearing system (Waiblinger et al., 2006) or feed supply (Hemsworth et al., 1993). Indeed, results might be biased by the fact that in small pens pigs cannot escape from the observer as easily as in large pens. Another explanation might be that in large pens farmers have to walk through the pens for their routine controls, and thus pigs might receive more frequent human contact.
**Tail biting and other indicators**

As one of the most common welfare problems in the pig industry (Schrøder-Petersen & Simonsen, 2001), tail biting has welfare implications not only for the bitten pigs suffering from pain, but also for the biters being unable to cope with their environment (D'Eath et al., 2014). Economic losses are caused by reduced weight gain, extra handling and medication costs, whereas determining factors are complex and can vary over time (Taylor et al., 2010). When pigs are tail-docked and tail biting is occurring as rarely as observed in this as well as the study of Temple et al. (2011a), group size does not seem to be a risk factor. Nevertheless, it has to be emphasized that docked pigs are less bitten than undocked pigs, even though it does not prevent tail biting behaviour completely (Moinard et al., 2003).

The low occurrence (<2%) of the indicators lameness, hernia, panting, laboured breathing, shivering, huddling, and scouring in growing pigs kept under intensive conditions found here and by Temple et al. (2011a), limited the potential of these measures to differentiate group sizes. Again, it has to be mentioned that hospital pens were not observed and this might have affected the prevalence. However, the prevalence of these indicators not only reflects health problems but also problems in the management of the hospital pens (Temple et al., 2011a).

**Conclusion**

Findings of the present study showed the effects of different group sizes in fattening pigs on several animal-based measures. However, none of the group sizes proved to be superior to others. In pens with more than 30 animals the presence of wounded and dirty pigs and of negative social behaviour was greater. On the contrary, a better human-animal relationship was noted in these large groups.
Acknowledgements

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KAPITEL 6

Allgemeine Diskussion


6 Allgemeine Diskussion

6.1 Einleitung

Im Rahmen der vorliegenden Dissertation sollten Ergebnisse erarbeitet werden, um die in der Öffentlichkeit zunehmend emotional geführte Diskussion um Defizite im Tierschutz bei wachsenden Bestandsgrößen zu verschärfen.


Abschließend wurde überprüft, ob es einen Zusammenhang zwischen der Gruppengröße und ausgewählten Tierwohlindikatoren des Welfare Quality® Protokolls gibt.

Die Betriebsakquise fand in erster Linie über den ISN (Interessengemeinschaft Norddeutscher Schweinhalter e.V.) statt. Die teilnehmenden Betriebe waren in verschiedenen Erzeugergemeinschaften bzw. Beratungsringen organisiert und wurden von ihrem jeweiligen Berater akquiriert. Die Teilnahme an der Studie erfolgte auf freiwilliger Basis, wobei die Respons-Rate 100% betrug. Inwiefern die Auswahl der Betriebe durch den zuständigen Berater einen Effekt auf das Ergebnis dieser Untersuchung hat, ist schwer abzuschätzen.

Haltungsverfahren waren Voll- (92%) und Teilspaltenböden (8%). 2010 wurden in Deutschland 67% der Schweine auf Voll- und 25% auf Teilspaltenböden, die restlichen auf planbefestigten Boden mit Einstreu (6%) und anderen Stallhaltungsverfahren (2%) (WBA, 2015) gehalten. Damit sind die Betriebe mit Vollspaltenböden in dieser Studie überrepräsentiert.
6.2 Zusammenhang zwischen Bestandsgröße und Tierwohl


Die Bestandsgröße hatte keinen signifikanten Effekt auf die Ausprägung des Gesamtscores sowie des Durchschnittsscores. Knage-Rasmussen et al. (2013)


Der Verschmutzungsgrad der Tiere nahm signifikant mit steigender Bestandsgröße zu (p < 0,05). Kontakt zwischen den Exkrementen und den Schweinen ist zu vermeiden, da ein hoher Verschmutzungsgrad mit Kot sich negativ auf die Gesundheit der Tiere auswirken kann. Vergleichbare Verschmutzungsgrade wurden von Temple et al. (2011a) dokumentiert. Das Fütterungssystem und die Art des Bodens werden in der Literatur als mögliche

Gar nicht oder sehr selten (<1%) wurden Zittern, Hecheln, die Bildung von Haufenlage und schwere Atmung dokumentiert. Andere Studien (Temple et al., 2011a; Temple et al., 2012a) bestätigen diese geringe Prävalenz. Nach Geers et al. (1990) hat die Stalltemperatur den größten Einfluss auf Zittern, Hecheln und die Bildung von Haufenlage. In einem konventionellen Haltungssystem mit vollklimatisierter Stalltemperatur und Luftführung treten die genannten Probleme kaum auf, so dass das Kriterium „Klimakomfort“ als sehr gut bewertet wurde.


aller Mastschweine die Schwänze routinemäßig kupiert. Tatsächlich werden Schweine mit kупierten Schwänzen weniger stark gebissen (Sutherland et al., 2008). Allerdings verhindert das Kupieren nicht komplett das Schwanzbeißen (Moinard et al., 2003). Ausgehend von der hohen Anzahl routinemäßig kупierter Schweine scheinen die in Deutschland vorhandenen Haltungsbedingungen so gestaltet zu sein, dass die Tiere ohne kurative Eingriffe nicht gehalten werden können (Kastrieren, Schwänze kupieren). Bei der Diskussion um das Verzichten von Amputationen geht es v.a. darum, dass die Tiere nicht an die Haltungssysteme angepasst werden sollen, sondern die Haltungsbedingungen so gestaltet sein sollten, dass intakte Tiere mit ihnen gut zurechtkommen (WBA, 2015). Grundsätzlich gilt, dass es bei dem Verzicht auf das Schwänzekupieren Probleme in der Haltung und im Management wesentlich deutlicher und schneller erkennbar werden, was als wichtiges Alarmsignal verstanden werden kann (Keeling et al., 2012).


beläuft sich in großen Betrieben auf 2,7% und war damit leicht höher als die vom Welfare Quality® Protokoll vorgegebene Warnschwelle von 2,6%.


als 39% der Varianz der verschiedenen PCAs erklären kann. Somit sind die Unterschiede zwischen den Betrieben bezüglich der qualitativen Verhaltensbeobachtung eher zu vernachlässigen.


6.3 Zusammenhang zwischen Gruppengröße und Tierwohl


Wie bereits im vorigen Kapitel beschrieben, waren 40% der untersuchten 600 Buchten überbelegt. Ein signifikanter Effekt der Überbelegung auf verschiedenen Tierwohl-Indikatoren konnte nicht festgestellt werden. Es wurden nur Tendenzen beobachtet, die darauf hindeuten, dass das Tierwohl bei Überbelegung negativ beeinflusst wird.

6.4 Schlussfolgerungen

Die Auswahl der Betriebe über die Beratungsringe und die Einteilung in die drei Bestandsgrößen- sowie Gruppengrößen Kategorien sind limitierende Faktoren bezüglich der generellen Aussagekraft dieser Studie. Gleichzeitig ist diese Untersuchung eine der ersten, die sich mit dem Zusammenhang zwischen Bestands- und Gruppengrößen sowie dem Tierwohl niveau von konventionellen Schweinemastbetrieben beschäftigt.
Aus den Ergebnissen dieser Arbeit können folgende Schlussfolgerungen abgeleitet werden:

• Bezüglich der Einstufung der Betriebe hinsichtlich ihres Tierwohl-Niveaus ist die Gesamtsituation nach dem Welfare Quality® Protokoll als unbefriedigend einzustufen.

• Der Gesamtscore und die beiden Grundsätze Verhalten und Gesundheit erreichten nach dem Welfare Quality® Protokoll ein kritisch niedriges Niveau.

• Nicht akzeptabel sind der hohe Anteil überbelegter Buchten sowie die teilweise gravierenden Mängel in der Wasserversorgung. Hintergründe und Ursache dieser Verstöße konnten nicht untersucht werden, wobei sicherlich ein höheres Maß an Kontrollen hilfreich wäre, um diese Missstände zu beheben.

Bei der Interpretation der Ergebnisse muss die Nicht-Einhaltung der Richtlinien der Nutztierhaltungsverordnung berücksichtigt werden. Es kann nicht ausgeschlossen werden, dass bei den Untersuchungen des Einflusses der Bestandsgröße bzw. Gruppengröße auf das Tierwohl bei Einhaltung der Vorgaben der Verordnung womöglich andere Ergebnisse herausgekommen wären.

• Im Mittel waren fast 35% der Schweine von moderater Bursitis betroffen. Die Haltung auf Betonspaltenböden ist als Hauptursache zu diskutieren und muss demnach kritisch hinterfragt werden.


• Grundsätzlich positiv zu bewerten sind die geringen Inzidenzen einiger Indikatoren (zittern, hecheln, lahme Tiere und Schweine mit veränderter Hautkondition).

ALLGEMEINE DISKUSSION

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Burchard Möllers haben dafür gesorgt, dass die Promotionszeit nicht nur Arbeit, sondern auch ein Vergnügen war. Meine beiden Mitdoktorandinnen Steffi und Anna haben den größten Anteil daran, dass ich immer wieder gerne an die Zeit in Göttingen zurückdenken werde.


Eidesstattliche Erklärung

1. Hiermit erkläre ich, dass diese Arbeit weder in gleicher noch in ähnlicher Form bereits anderen Prüfungsbehörden vorgelegen hat.

Weiter erkläre ich, dass ich mich an keiner anderen Hochschule um einen Doktorgrad beworben habe.

Göttingen, den ..........................................

.......................................................... (Unterschrift)


Göttingen, den ..........................................

.......................................................... (Unterschrift)
Curriculum Vitae

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Geburtsort            Sulingen, Deutschland
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Ausbildung

Seit 02/2013 Promotionsstudium
Georg-August-Universität Göttingen, Department für Nutztierwissenschaften, Produktionssysteme der Nutztiere
Promotionsprogramm “Animal Welfare in Intensive Livestock Production Systems” gefördert vom Niedersächsischen Ministerium für Wissenschaft und Kultur

Masterabschlussnote: 1,4

10/2006-07/2009 Studium, Bachelor of Science Agrarwissenschaften (Schwerpunkt: Nutztierwissenschaften) an der Georg-August-Universität Göttingen
Bachelorabschlussnote: 1,8

08/1996-06/2005 Hochschulreife
Abitur am Städtischen Gymnasium Petershagen/Weser (Abschlussnote: 2,3)

Praktische Erfahrungen

07/2012 – 12/2012 Hochschulpraktikum im Bundesamt für Veterinärwesen, Zentrum für tiergerechte Haltung: Wiederkäuer und Schweine, Tänikon, Schweiz

03/2012 – 04/2012 Praktikum auf zwei Milchviehbetrieben in Neuseeland (Plantation Road Dairies Ltd, Waipawa und Galloway Enterprises Ltd, Takapau)

07/2010 – 09/2010 Praktikum bei Topigs (Hoppenbrock Tierzucht GmbH), Melle
02/2009 – 05/2009 Praktikum und Bachelorarbeit im Institut für Tierernährung, FLI Braunschweig
08/2008 – 09/2008 Praktikum am Scottish Agriculture College, Hill and Mountain Research Centre, Crianlarich, Schottland
08/2005 – 07/2006 Einjähriges Praktikum im Landwirtschaftszentrum Haus Düsse, Soest (Praktikantenprüfung: 2,1)

Auslandserfahrungen
12/2011 – 04/2012 Work & Travel in Neuseeland
08/2008 – 09/2008 Praktikum am Scottish Agriculture College, Hill and Mountain Research Centre, Crianlarich, Scotland

Publikationen

Bericht, Fachzeitung:

Konferenz, Präsentation:
Meyer-Hamme, Sophie / Lambertz, Christian / Gauly, Matthias: Does group size have an impact on welfare indicators in fattening pigs? EAAP - European Federation of Animal Science; 31.08.2015 – 03.09.2015, Warschau, Polen

Göttingen, Dezember 2015