Scientific Papers. Series D. Animal Science. Vol. LXV, No. 1, 2022
ISSN 2285-5750; ISSN CD-ROM 2285-5769; ISSN Online 2393-2260; ISSN-L 2285-5750

ANIMAL WELFARE AND ITS ASSOSSIATIONS WITH FARM SIZE AND STOCKMANSHIP CHARACTERISTICS ON EUROPEAN BREEDING-TO-FINISHING PIG FARMS

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Abstract

Animal health and welfare (AHW) has become an important aspect for sustainable development in livestock farming. Therefore, this paper aims to analyse the AHW performance of 27 breeding-to-finishing pig farms across six European countries and to investigate associations with number of sows in production, number of sows per worker and percentage of family labour. AHW indicators were aggregated to themes, namely "Hunger and thirst", "Comfort", "Injuries and disease", "Pain by management", "Appropriate behaviour" and "Human-animal relationship". On a scale from 0 to 100 (worst to best AHW), lowest median theme score was found for "Comfort" (39) and highest for "Human-animal relationship" (78). AHW performance varied considerably between farms, indicating a potential for improvement, especially regarding "Comfort". Number of sows per farm in production correlated negatively with "Hunger and thirst" (r_s = -0.81), "Comfort" (-0.44) and "Appropriate behaviour" (-0.61). Number of sows per worker also correlated negatively with "Hunger and thirst" (-0.56). Family labour did not correlate with any of the themes. We conclude that some aspects of animal welfare especially regarding comfort (e.g., space allowance and enrichment material), require improvement measures across these six European countries. These problems may increase with farm size and number of sows per worker. Therefore, incentives to implement animal welfare improvement measures are needed for all farms to encourage farmers to construct housing systems above the minimum legal requirements.

Key words*: animal-based indicators, comfort, family labour, farm size, multi-criteria analysis.*

INTRODUCTION

Due to the competitive forces of the market farmers will also need to produce in an efficient way. This have led to the development of husbandry systems which might compromise the animals' health and welfare, as in the case of the pig sector (e.g., fully slatted floor systems). In such systems, pigs are not able to fulfil their natural behavioural needs which may result in abnormal behaviour such as tail biting and stereotypies (Terlouw et al., 1991, Valros and Heinonen, 2015). Therefore, animal health and welfare (AHW) has increasingly become a concern of society (European Commission, 2016, Bozzo et al., 2019) and is seen by some scholars as an important component of the concept of sustainability (Tucker et al., 2013).

Furthermore, an intensification of pig production took place with an increase in farm size (Robbins et al., 2016) and number of sows per worker (Martel et al., 2008). Even though farm size has increased, family farms remain predominant in the EU (Eurostat - Statistics Explained, European Commission). However, with increasing farm size, family farms depend also on external workers. There is also evidence, that with increasing farm size the number of animals per worker may increase and therefore less time might be spent per animal so AHW may be compromised (Robbins et al., 2016). On the other hand, others found no impact (Moinard et al., 2003; Meyer-Hamme et al., 2018) or even positive effects in dairy farms due to a professional management (Robbins et al., 2016).

As part of the Era-Net project SusPigSys (Sustainable Pig Production Systems) we aimed at developing a multi criteria assessment tool to analyse sustainability of pig farms with AHW as a separate dimension beside the three commonly used dimensions, namely economy, environment and social well-being (Hörtenhuber et al., 2021).

The aims of this paper are to describe the integrated AHW performance of breeding-to-finishing pig farms across six European countries and to analyse the correlations between size, number of sows per worker and percentage of family labour.

We hypothesised that farm size might not have a strong effect on AHW, whereas number of sows per worker might correlate negatively and family labour might correlate positively with the AHW performance.

MATERIALS AND METHODS

Development of the AHW component within the SusPigSys Multi-Criteria Assessment Tool

The SusPigSys assessment tool was developed in an iterative process, resulting in a multi-criteria assessment tool, which summarises indicator scores into subtheme and theme scores in several steps (Munsterhjelm et al., 2021).

First, AHW indicators were selected from previous projects, including ProPig (Leeb et al., 2015) and Welfare Quality® (Welfare Quality®, 2009). A detailed protocol was refined in iterative discussions within the consortium and stakeholder workshops, as well as by including pilot farm visit experiences (Munsterhjelm et al., 2021). As a result, the protocol consisted of indicators that can be assessed through an interview including records and management-based indicators (e.g. productivity data, castration method) as well as direct observations to assess resource- (e.g. amount of bedding) and animal-based indicators (e.g. tail lesions).

Second, indicators were scaled from 0 (= worst) to 100 (= best) to obtain a uniform scale across all indicators. This was done based on literature, own project data and expert opinion (Hörtenhuber et al., 2021).

Third, indicators were attributed to subthemes and subthemes further to themes. The AHW dimension consisted of six themes:

1. Hunger and thirst (AHW1)
2. Comfort (AHW2)
3. Injuries and disease (AHW3),
4. Pain by management (AHW4)
5. Appropriate behaviour (AHW5)
6. Human-animal relationship (AHW6).

Fourth, weights were allocated to indicators within themes and subthemes within themes through a Delphi-like approach (Mukherjee et al., 2015), similar to the methodology of Averos et al. (2013).

Data collection

The tool was then applied on 27 breeding-to-finishing farms in six countries: Austria (7 farms), Finland (2), Germany (4), Netherlands (4), United Kingdom (6), and Poland (4). One national contact person conducted the interview in the local language and one out of two trained observers performed direct observations on the pigs. Before the visit started, an inter-observer reliability test with sufficient agreement was carried out (Ruckli et al., submitted).

It has to be kept in mind that our sample is not representative for all pig farms in the EU, since the main aim was to include a large range of different farm types so to develop and test the assessment protocol.

Statistical analysis

Statistical analyses were undertaken in SAS 9.4 (SAS Institute Inc., 2016). Spearman correlation coefficients (r_s) were calculated to investigate associations between farm characteristics (e.g., size, number of sows per worker, percentage of family labour) and AHW theme scores.

Furthermore, correlations were calculated between the indicators which contributed most to the theme (Ruckli et al., submitted) with the farm characteristics. Absolute r_s values greater than 0.4 and p-value smaller than 0.05 were regarded as indicating a relevant association and highlighted in bold in Table 2.

RESULTS AND DISCUSSIONS

Farm characteristics

Table 1 summarizes farm management characteristics of the 27 breeding-to-finishing pig farms. The sample included a variety of production systems including 8 conventional, 5 organic and 14 farms certified according to other

labels. Productivity, as well as feed and bedding characteristics show the large variation across farms and can be used to understand the different AHW theme scores.

Number of sows in production (farm size) correlated positively with number of sows per worker (r_s = 0.55) and negatively with family labour (r_s = -0.49). Number of sows per worker and percentage of family labour did not correlate.

Table 1. Farm management-characteristics of 27 breeding-to-finishing pig farms in Austria (7 farms), Finland (2), Germany (4), Netherlands (4), United Kingdom (6), and Poland (4)

	Min	M	Max
Sows in production (n)	17	150	1022
Number of sows per worker	31	80	263
Percentage of family labour	0	50	100
Productivity			
Litters sow^{-1} y^{-1} (n)	1.5	2.3	2.4
Piglets born alive sow^{-1} y^{-1} (n)	14	29	39
Piglets weaned sow^{-1} y^{-1} (n)	14	25	33
Lactation length (d)	25	28	49
Mortality suckling piglets (%)	0	13.4	26
Mortality weaners (%)	0	2.9	18
Mortality finishers (%)	0	2.0	6
Feed			
FCR BU (kg feed kg^{-1} BM^{-1})	1.7	3.6	6.6
FCR FU (kg feed kg^{-1} BM^{-1})	1.8	2.9	5.2
Bedding, manure management system and electricity			
Bedding (kg sow^{-1} year^{-1})	0	76	248
Bedding (kg weaner^{-1} year^{-1})	0	0	55
Bedding (kg finisher^{-1} year^{-1})	0	0	37

n = number. Min = minimum, M = median, Max = maximum. FCR = feed conversion ratio. BU = breeding unit, FU = finishing unit. BM = body mass, FW = fresh weight.

Theme scores

AHW theme scores of the 27 breeding-to-finishing farms are presented in Figure 1. Overall, only a few farms scored between 0 and 20 and between 80 and 100, except for one theme, i.e. "Human-animal relationship" (AHW6). This is in line with Meyer-Hamme et al. (2018) and indicates that most farms still have a potential for improvement, especially regarding the "Comfort" (AHW2), which was found to have the lowest median score (39). This theme covers aspects such as *Space allowance, Proper sick pen* and *Proper creep area*. Detailed analysis can be found in Ruckli et al. (2016).

"Human-animal relationship" (AHW6) had the highest median score (78). This theme focused on the perception of the farmer regarding his/her relationship with the pigs. It included questions such as how important it is for animal welfare to avoid force when moving pigs, or whether good overall farm performance is directly linked to good pig welfare. We assume that answers to this questions can partly be explained by "social desirability bias" (King & Bruner, 2000) and should be carefully interpreted. This means that assessors might have inadvertently influenced the farmers, who may have felt obligated to agree with e.g., not using force when moving pigs, since that would be considered to be expected of them by society as the 'right answer'. However, Scott et al. (2001) (cited in Hubbard et al., 2007) points out that there is an inexorable link between the economic wellbeing of the farmers and the welfare of animals.

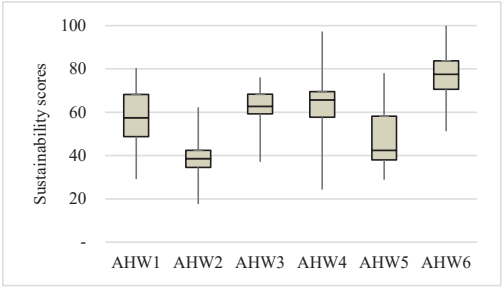

Figure 1. Boxplot of AHW theme level sustainability scores of 27 breeding-to-finishing farms.

Scores of 0 represent worst and scores of 100 represent best sustainability scores. The horizontal bold line denotes the median. The box denotes the first and third quartile. The vertical line denotes the maximum and minimum value.

AHW1 (Hunger and thirst), AHW2 (Comfort), AHW3 (Injuries and disease), AHW4 (Pain by management) AHW5 (Appropriate behaviour), AHW6 (Human-animal relationship).

Hunger and thirst (AHW1)

Both, the size of the farm expressed as the number of sows in production (r_s = -0.81) and the number of sows per worker (-0.56) correlated negatively with "Hunger and thirst" (AHW1; Table 2). In contrast, no correlation was found with the percentage of family labour. We explain the correlations of this theme with size and number of sows per worker by the high contribution of the indicator *Quality of roughage* (Ruckli et al., submitted). We found that farm size correlated negatively with the indicator *Quality of roughage* (r_s = -0.59, p < 0.00). Roughage is very beneficial for pigs (Olsen et al., 2000) since they are used to explore, root and graze several hours a day in a

semi-natural environment (Stolba and Wood-Gush, 1989). However, one of the reasons for not providing roughage is related to the extra labour needed which in turn leads to an increase in the production costs. This is in line with Czekaj et al. (2013) who found that there is a slight tendency that relatively large farms are less likely to provide any rooting substrate for pigs since it leads to additional labour and therefore higher production costs. Furthermore, slatted floors can get clogged and slurry-based systems do not allow a lot of structure (e.g., leftover from the roughage or bedding material) in the slurry. Providing roughage is not yet mandatory on most EU farms except on organic ones (Council Directives 2007/834/EC and 2008/889/EC).

Comfort (AHW2)

Farm size correlated negatively with the theme "Comfort" (AHW2; r_s=-0.44), but neither number of sows per worker or percentage of family labour correlated with this theme. We found that space allowance, which contributes to a high degree to this theme score, was decreasing with increasing farm size (r_s = -0.51, $p < 0.00$). Space allowance, however, is crucial for pigs to separate their functional areas such as resting, feeding and defecating (Stolba and Wood-Gush, 1989) and therefore presents an important aspect for "Comfort". Larger farms might have often just followed the legal minimum requirements of the EU (Council Directive 2008/120/EC) when constructing a farm. Interestingly, no correlation was found with number of sows per worker even though farms with higher animal welfare level e.g. organic farms (Council Directives 2007/834/EC and 2008/889/EC) are usually more labour intensive (Tuyttens, 2005) and therefore the number of sows per annual working unit is usually lower compared to conventional farms. One explanation could be that other indicators such as the *Presence of a proper sick pen* might have overruled this effect. A proper sick pen with a soft floor (e.g., bedding) as well as easy access to feed and water is highly relevant for the comfort of sick pigs since they are more vulnerable, climate sensitive and need a soft lying area. Many farms did not have a proper sick pen independent of the farm size, number of sows per worker or percentage of family labour: We assume that sick pigs are often seen as not profitable and therefore sick pens are often used as additional pens. We suggest that farmers need to be more aware of this highly relevant topic.

Injuries and disease (AHW3)

No correlation was found between the theme "Injuries and disease" (AHW3) with farm size, number of sows per worker or percentage of family labour. This was at first surprising, since we were expecting better performance on farms with less sows per worker, since they might be able to spend more time per pig. It could be that farms with more sows per worker might have been able to afford more technology (e.g. automatic feeding) (Robbins et al., 2016) in order to replace manual labour and were therefore able to spend a similar amount of time with observation of pigs. Furthermore, highest influence on this indicator had mortality (Ruckli et al., submitted), which did not increase with increasing farm size or number of sows per worker.

Table 2. Spearman correlations (r_s) of farm management characteristics (rows) with AHW theme scores (columns). Correlations with an absolute $r_s \geq 0.4$ and p-value ≤ 0.05 are shown in bold font

Farm characteristic	**AHW1**	**AHW2**	**AHW3**	**AHW4**	**AHW5**	**AHW6**
Number of sows in production	**-0.81**	**-0.44**	0.21	-0.38	**-0.61**	0.26
Number sows per worker	**-0.56**	0.01	0.01	0.06	-0.23	0.01
Percentage of family labour	0.22	0.04	0.09	0.20	0.13	-0.35

AHW1 (Hunger and thirst), AHW2 (Comfort), AHW3 (Injuries and disease), AHW4 (Pain by management) AHW5 (Appropriate behaviour), AHW6 (Human-animal relationship).

Pain by management (AHW4)

No correlation of farm size, number of sows per worker and percentage of family labour was found with "Pain by management" (AHW4). Highest contribution to this theme had the indicator *Hospitalisation* (= pigs present in pens that should have been separated), *Castration, Tail docking* and *Nose rings* (Ruckli et al.,

submitted). Overall, pigs needing hospitalisation were only observed on few farms and this was irrespective of farm size, number of sows per worker or proportion of family labour. Also, none of the farms used nose rings for sows

Appropriate behaviour (AHW5)
Farm size correlated negatively with the theme "Appropriate behaviour" (AHW5; -0.41). However, no correlations were found with number of sows per worker and percentage of family labour.
The negative correlation between size and "Appropriate behaviour" (AHW5) can be partly explained by the highest contributing indicator *Space allowance,* as it negatively correlated with the size of the farm, as described for "Comfort". Furthermore, we found that larger farms were less likely to provide other enrichment measures (e.g. roughage, objects). However, an enriched environment is crucial for pigs to fulfil their internal needs (e.g. rooting) and thus to reduce the risk for tail biting (Schroder-Petersen & Simonsen, 2001) and other abnormal behaviour (Terlouw et al., 1991).

Human-animal relationship (AHW6)
No correlations of farm size, number of sows per worker and percentage of family labour were found with the theme "Human-animal relationship" (AHW6).
At first, it was surprising that we did not find any correlation with size and number of sows per worker. Other studies found that with increased farm size, farmers might be more profitability-orientated and therefore other values might replace animal welfare (Robbins et al., 2016). This seems not to be the case in our study. Furthermore, with increasing number of sows per worker, less time is spent per animal (Robbins et al., 2016). This can result in less positive interactions with humans but also in less negative interactions (Robbins et al., 2016). However, one explanation could be the "social desirability bias" as discussed above.
We were also expecting that the percentage of family labour would positively correlate since with an increasing intensification and therefore more animals per worker, family farms might be replaced by companies, which may threaten AHW (Fraser, 2005). However, even though some farms did not have any family internal labour, we only included farms that are a family owned business and no farms owned by companies. Moreover, we interviewed the farm manager who was not necessarily the person working with the pigs. It would be interesting to interview not only the farm manager but all employees working with pigs about their perception on the human-animal relationship in order to receive a more comprehensive picture.
Nevertheless, when working with family and hired labour, one important aspect is to train people in order to improve the welfare on the farm (Boivin et al., 2003). Therefore, training of workers, hence high quality husbandry and skilled labour might be more important than the percentage of family internal labour.

CONCLUSIONS

Our findings indicate that there is still room for AHW improvement on most of the breeding-to-finishing pig farms in our sample, especially aspects such as comfort (space allowance) and appropriate behaviour (enrichment). On one hand, relatively large farms in our sample provided less roughage and space allowance, which might be partly due to lower number of sows per worker. On the other hand, the proportion of family labour did not to have an impact on the AHW performance. Therefore, we conclude that the size of the farm and the number of sows per worker could be considered as risk factors for impaired animal welfare, whereby the percentage of family labour seems not to play an important role.

ACKNOWLEDGEMENTS

This research was made possible by funding from SusAn, an ERA-Net co-funded under European Union's Horizon 2020 research and innovation programme (www.era-susan.eu), under Grant Agreement n°696231.
Direct observation data were collected by Juliane Helmerichs (in DE, IT, NL and UK) and Antonia Ruckli (in AT, FI and PL). Interview data were collected by Rachel Chapman (UK), Monika Gebska and Agata Malak-Rawlikowska (PL), Juliane Helmerichs (DE), Antonia Ruckli (AT), Kirsi Swan (FI), and Herman Vermeer (NL).

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