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# Producers' valuation of animal welfare practices: Does herd size matter?

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## Abstract

It is alleged that larger farms are less willing to adopt animal welfare-friendly production systems, though empirically-based knowledge on this issue is still lacking. Therefore, the aim of this study is to analyze pig and sow producer preferences for the adoption of animal welfare standards (AWS), with primary interest in herd size effects on producers' adoption behavior. A survey was carried out with pig (n = 103) and sow (n = 63) producers in Germany. A discrete choice experiment (DCE) was conducted to analyze herd size effects on producer adoption of AWS. Producers' attitudes about the economic feasibility of animal welfare are affected by the herd sizes. The results of the DCE indicate that larger herd sizes in pig production are correlated with lower adoption of outdoor yards and bedding material, while adoption of the remaining AWS is unaffected by herd size. Sow producers show no herd size-related differences in acceptance of the analyzed AWS. The standard criticism regarding the lack of animal welfare adoption on large farms was not supported by this study. Identifying herd-size effects on the producers' adoption behavior for AWS may be an important step in clarifying the discussion about animal welfare in intensive production systems. Furthermore, the identified heterogeneity in the producers' preferences underlines the need for identification of the most effective animal welfare strategies for farms of various structures without endangering profitability. In this regard, policy is suggested to support strategies that directly improve animal welfare on farms of all sizes instead of targeting a decrease in farm size. The study is the first to demonstrate empirically based knowledge about herd size effects on the farmers' adoption of AWS.

**Keywords:** animal welfare, herd size, pig production, discrete choice experiment

## 1. Introduction

The intensification of animal production is a key factor in the public debate on farm animal welfare (Mench, 2008; Vanhonacker and Verbeke, 2014; Robbins *et al.*, 2016). Intensification is characterized as production on fewer but larger units, which is believed to provide lower animal welfare than smaller and less-intensive production systems (Fraser, 2005). This is because intensive production systems are assumed to pursue profit maximization by saving costs and reducing the working time per animal (Hess *et al.*, 2014), which has been determined to be incompatible with the maximization of farm animal welfare (Fraser, 2005; Lusk and Norwood, 2012; Robbins *et al.*, 2016). This "standard criticism" regarding animal welfare in intensive production systems is linked to the hypothesis that large farms are less willing to adopt animal welfare-friendly production systems (Hess *et al.*, 2014). However, producers seem to assess the relation between farm size and animal welfare as weak (Vanhonacker *et al.*, 2008).

Empirically-based knowledge on size-dependent differences in the adoption of specific animal welfare practices is still lacking. Therefore, this paper aims to analyze whether farm size has an impact on the willingness of pig and sow producers to adopt specific animal welfare standards (**AWS**). It thereby contributes new information to the debate on lacking animal welfare adoption in intensive production systems.

Many different animal welfare assurance programs have emerged in food production and were initiated by various players, such as animal producers, retailers, civil organizations and governments, in order to ensure higher animal welfare standards in the meat supply chain (Fraser, 2005). By participating in these schemes, producers may benefit by receiving bonus payments for adopting specific animal welfare standards. Based on such schemes, our analysis uses a discrete choice experiment (**DCE**) that allows us to analyze the preferences of producers for specific AWS in general as well as potential herd size effects.

## 2. Material and Methods

### *2.1 Data Collection*

For the empirical analysis, primary data was collected from German pig and sow producers. An anonymous online survey was developed and available for participants from November 2014 to January 2015. Producers were invited to participate in the survey through a mailing list of the university, newsletters of regional associations and social media channels. The surveys of 209 pig and sow producers were included in the evaluation, while 43 surveys could not be used since they lacked important data for the econometric evaluation.

The questionnaire was structured as follows: firstly, participating producers were asked to provide general operating data related to their farms. Secondly, the DCE was conducted. Next, questions were raised to identify the producers' perceptions of different aspects of animal welfare. Finally, the fourth part of the survey was dedicated to collecting socio-demographic data. The producers needed 21 minutes on average to complete the experiment.

### *2.2 The Discrete Choice Experiment*

DCEs underlie the stated preference approach, which allows for conclusions to be drawn from previously unarticulated preferences about real choice decisions (Louviere et al., 2000). The attribute-based measure of respondents' preferences is thereby possible through a series of hypothetical decision-making situations (List *et al.*, 2006). In a DCE, participants are confronted with a number of choice sets consisting of different alternatives and are asked to select one of the given alternatives. Each presented alternative is characterized by pre-defined attributes and their associated levels. By systematically varying the attribute levels, the respective influence on the selection decision can be determined (Louviere *et al.*, 2000).

In the DCE utilized in this investigation, the following decision situation was presented to the participating producers: the producer had to choose one of two hypothetical animal welfare programs or had the option not to participate in either (opt out). The opt-out alternative was included because program participation is voluntary in reality. A forced choice could lead to inaccuracy and inconsistency with demand theory (Hanley *et al.*, 2001). Each decision situation (choice set) provided two different and mutually-exclusive program alternatives. The programs were neutrally referred to as "Animal welfare program A" and "Animal welfare program B", so as not to reveal any differences with the name of the program. In each decision situation, the participating producers chose between two program alternatives that were described by specific AWS and bonus payments to producers for program participation. We conducted a separate DCE for pig and sow farms, with different AWS implemented in the DCE of each group. The AWS and their levels, which are shown in Table 1, were chosen based on a literature review, analysis of existing animal welfare programs, and the results of expert discussions with producers, farm consultants and animal researchers.

**Table 1.** Animal welfare practices and their levels for the DCE with pig and sow farmers.

| Animal Welfare Attributes | Levels | |
|---|---|---|
| | Pig farms | Sow farms |
| Additional space | - +10 %<br>- +20%<br>- +30%<br>- +40% | - +10 %<br>- +20%<br>- +30%<br>- +40% |
| Roughage and Manipulatable material | - None<br>- Manipulatable material<br>- Roughage<br>- Both materials | - None<br>- Manipulatable material<br>- Roughage<br>- Both materials |
| Outdoor yard | - No outdoor yard<br>- Outdoor yard | — |
| Lying area | - Fully slatted floor<br>- Partially slatted floor<br>- Soft mat<br>- Bedding | — |
| Suckling period | — | - 4 weeks<br>- 5 weeks |
| Farrowing | — | - 5.0m², permanent fixation<br>- 7.5m², permanent fixation<br>- 7.5m², no permanent fixation<br>- Group farrowing |
| Bonus payment per pig/piglet | - €5<br>- €10<br>- €15<br>- €20 | - €4<br>- €8<br>- €12<br>- €16 |

The software Ngene 1.1.2. (Choice Metrics, 2016) was used to produce the experimental design for this study. As recommended by Sandor and Wedel (2001) and Scarpa *et al.* (2008), an efficient Bayesian design was generated. This design makes it possible to take into account preliminary information about the utility parameters of the population and the associated uncertainty in terms of random distributions for the prospective utility parameters. This preliminary data was collected in a pilot study with 30 pig and sow producers using a D-optimal choice design (Bliemer *et al.*, 2009). As a result, each producer had to complete 12 choice sets in the final experiment. Producers who had both pigs and sows were randomly assigned either to the experiment for pig or sow farmers so that each producer conducted only one experiment. One of the choice sets presented to pig producers is shown in Table 2.

Before starting the experiment, we presented an introductory text consisting of the description of the experimental procedure and a cheap talk script as suggested by Cummings and Taylor (1999) and Carlsson *et al.* (2005) (available in Appendix A1) to reduce the occurrence of choices in the hypothetical situations differing significantly from choices in reality.

**Table 2.** Sample choice set of an animal welfare program for pig producers

| Animal welfare package | Animal welfare program A | Animal welfare program B | No animal welfare program (opt-out) |
|---|---|---|---|
| **Additional space** | +10% | +30% | Unchanged housing conditions and no bonus payments |
| **Roughage and manipulatable material** | Manipulatable material | Roughage | |
| **Outdoor yard** | No outdoor yard | No outdoor yard | |
| **Lying area** | Soft mat | Fully slatted floor | |
| **Bonus payment per pig** | €10 | €15 | |
| **Which alternative do you choose?** | O | O | O |

*2.3 Statistical Analysis*

All data were analyzed with STATA 15. Mixed logit models were estimated to detect differences in AWS evaluations between farm sizes. Mixed logit models allow random taste variations, meaning that the choice probability of each individual can be identified (Train, 2009; Hensher *et al.*, 2015). To enable this, all animal welfare attributes were modeled as random parameters. By entering individual-specific attributes via interaction terms in the model estimation process, factors influencing the choice of farmers could be analyzed (Hanley *et al.*, 2001; Boxall and Adamowicz, 2002).

## 3. Results and discussion

*3.1 Descriptive statistics*

Table 3 presents the descriptive statistics of our sample of 103 pig and 63 sow producers. The average pig and sow producer was 31 years old. In the German farmer population, the average farmer is 53 (AgriDirect, 2013) and therefore older than the producers in our sample. The majority of respondents were male producers. About 90% in both groups were farm managers or farm successors and therefore the current or future decision-makers on the farm. 35 % in both groups held a university degree. Therefore, the share of farmers with an academic education in our sample was higher than the German farmer population, in which only 10 % have a university degree (Hemmerling *et al.*, 2013). This difference, as well as the low average age of our sample, might be inter alia explained by the fact that we generated our sample using an online survey. Online experiments have great advantages, since they are both low cost and able to reach many potential participants easily (Granello and Wheaton, 2004). However, access to the internet and willingness to participate in an online experiment is, to a great extent, education-dependent (Granello and Wheaton, 2004).

Over 70 % of the farms were located in Lower-Saxony or North-Rhine-Westphalia, which are the main hog production regions in Germany. The average pig producer cultivated 159 hectares of arable land, while sow keeping farms had 99 hectares on average. Therefore, both groups were above the German average of 65 hectares for pig and 37 hectares for sow keeping farms (BMEL, 2017). On average, there were 1,781 (Median = 1,450) pigs and 299 (Median = 240) sows kept on the sampled farms, which is more than the German average of 1,118 pigs and 199 sows (DBV, 2014) per farm.

**Table 3.** Demographics of analyzed pig (N=103) and sow producers (N=63) expressed by the mean and standard deviation (SD) or percentage of producers.

| Variable | Pig producer | Sow producer |
|---|---|---|
| | Mean (SD) or Percentage | |
| Average age in years | 30.65 (11. | 31.06 (12.65) |
| Female (%) | 7.77 | 3.18 |
| High school education (%) | 34.95 | 34.92 |
| Full-time farmer (%) | 92.23 | 95.24 |
| Farm manager (%) | 42.72 | 41.27 |
| Farm successor (%) | 49.51 | 52.38 |
| Farm located in Lower Saxony (%) | 41.75 | 58.73 |
| Farm located in North-Rhine-Westphalia (%) | 32.04 | 20.63 |
| Farm located in Hesse, Bavaria, Baden-Württemberg (%) | 14.56 | 14.29 |
| Arable land in hectare | 159.17 (255.7 | 98.6 (71.73) |
| Average number of pigs/sows | 1,781.83 (1516.69 | 299.04 (243.24) |
| Combined system of hogs and sows (%) | 7.77 | 33.33 |

*3.2 Status quo of implemented AWS*

Potential differences in the adoption of AWS were analyzed by considering the status quo of implemented AWS. Therefore, the Kruskal-Wallis-Test and the Mann-Whitney-U-Test were used to compare herd size differences between adopters and non-adopters of AWS. The results of the tests are shown in Table 4.

Both tests are non-parametric tests of the null hypothesis that a number of independent samples have the same distribution. We used these tests as our data failed to meet the assumption of normal distributions that is required for conducting t-tests.

For pig producers, we identified statistically significant differences in the status quo of AWS adoption for bedding material (P = 0.001) and outdoor yards (P = 0.028), with smaller farms more like to adopt these practices than larger farms. It should be noted, however, that only four pig producers in our sample implemented an outdoor yard. In addition, fully-slatted floors were adopted significantly more often on large farms (P = 0.005). No significant differences (P > 0.05) were detected for additional space, roughage, manipulatable material, partly-slatted floors and soft mats.

On sow keeping farms, significant differences in the status quo exist for the provision of roughage (P = 0.027) and the suckling period (P = 0.001). For the latter, larger farms tended to use shorter suckling periods. Roughage was more often provided on smaller farms. No significant differences (P > 0.05) were found for additional space per pig, manipulatable material, outdoor yard or farrowing space.

**Table 4.** Results of the Kruskal-Wallis-Test[a)] and Mann-Whitney-U-Test[b)] for determining herd size effects on the status quo of implemented animal welfare standards of analyzed hog (n=103) and sow keeping farmers (N=63). Complied data is from 2014.

| Variable | Number of pigs | | | | Number of sows | | | |
|---|---|---|---|---|---|---|---|---|
| | N | Mean rank | Median | p-value | N | Mean rank | Median | p-value |
| Additional space [a)] | | | | | | | | |
| +0% | 66 | 52.48 | 1,425 | 0.546 | 40 | 35.48 | 250 | 0.095 |
| +10% | 27 | 54.37 | 1,600 | | 17 | 27.94 | 200 | |
| +20% | 10 | 42.45 | 1,152 | | 6 | 20.33 | 158 | |
| Manipulatable material [b)] | | | | | | | | |
| non-adopters | 61 | 50.89 | 1,000 | 0.648 | 36 | 34.49 | 260 | 0.213 |
| adopters | 42 | 53.62 | 1,495 | | 27 | 28.69 | 200 | |
| Roughage [b)] | | | | | | | | |
| non-adopters | 81 | 54.92 | 1,500 | 0.057 | 42 | 35.60 | 250 | 0.027 |
| adopters | 22 | 41.25 | 1,250 | | 21 | 24.81 | 200 | |
| Fully-slatted floor [b)] | | | | | | | | |
| non-adopters | 17 | 33.56 | 500 | 0.005 | | | | |
| adopters | 56 | 55.65 | 1,500 | | | | | |
| Partly-slatted floor [b)] | | | | | | | | |
| non-adopters | 54 | 51.46 | 1,445 | 0.848 | | | | |
| adopters | 49 | 52.59 | 1,450 | | | | | |
| Bedding material [b)] | | | | | | | | |
| non-adopters | 93 | 55.13 | 1,500 | 0.001 | | | | |
| adopters | 10 | 22.85 | 230 | | | | | |
| Soft mat [b)] | | | | | | | | |
| non-adopters | 99 | 51.63 | 1,450 | 0.533 | | | | |
| adopters | 4 | 61.13 | 1,600 | | | | | |
| Outdoor Yard [b)] | | | | | | | | |
| non-adopters | 99 | 53.30 | 1,500 | 0.028 | 54 | 32.71 | 350 | 0.449 |
| adopters | 4 | 19.75 | 780 | | 9 | 27.72 | 250 | |
| Suckling period [a)] | | | | | | | | |
| 3 weeks | | | | | 23 | 42.72 | 300 | 0.001 |
| 4 weeks | | | | | 36 | 26.99 | 200 | |
| 5 weeks | | | | | 4 | 15.5 | 150 | |
| Farrowing [b)] | | | | | | | | |
| 5.0m², permanent fixation | | | | | 54 | 32.32 | 235 | 0.731 |
| 7.5m², no permanent fixation | | | | | 9 | 30.06 | 250 | |

### *3.3 Producers' attitudes and herd size*

For further characterization of our sample, we analyzed correlations between the producers' views on whether a specific AWS increases the welfare of animals and the herd size. In addition, we present means and correlations of the investment confidence and attitude towards bonus payments with herd size. Producers attitudes were measured on a five-point Likert scale from 1 = “I completely disagree” to 5 = “I completely agree”. Results are presented in Table 5.

**Table 5.** Correlations of the herd size with the producers’ animal welfare assessment of specific AWS, their investment confidences and their attitudes towards bonus payments. Analysis was carried out for pig (N=103) and sow producers (N=63). Statements were measured on a five-point Likert scale from 1 = “I completely disagree” to 5 = “I completely agree”.

| | Hog farmers | | Sow farmers | |
|---|---|---|---|---|
| Statement | Number of hogs | Mean (SD) | Number of sows | Mean (SD) |
| +10% more space increases animal welfare | -0.16 | 3.66 (0.96) | -0.17 | 3.37 (1.10) |
| +20% more space increases animal welfare | -0.17 | 3.41 (1.08) | -0.04 | 3.21 (1.10) |
| +40% more space increases animal welfare | -0.17 | 2.99 (1.32) | 0.03 | 2.68 (1.33) |
| Manipulatable material increases animal welfare | -0.02 | 3.64 (1.07) | 0.05 | 3.35 (1.10) |
| Roughage increases animal welfare | -0.15 | 3.40 (1.20) | 0.05 | 3.38 (0.99) |
| Outdoor yard increases animal welfare | -0.13 | 2.86 (1.31) | | |
| Comfortable lying area increases animal welfare | -0.12 | 3.04 (1.28) | | |
| 4-week suckling period increases animal welfare | | | -0.18 | 3.29 (1.20) |
| 5-week suckling period increases animal welfare | | | -0.16 | 2.06 (1.15) |
| Free farrowing increases animal welfare | | | 0.04 | 2.00 (1.15) |
| I`m not willing to reconstruct my stable to increase the welfare of animals. | -0.30** | 3.31 (1.01) | -0.25* | 3.19 (1.03) |
| Investments in animal welfare will amortize over time. | -0.24* | 2.89 (1.02) | -0.01 | 2.92 (0.94) |
| I will not recoup my investment expenses in additional welfare | 0.22* | 3.44 (1.00) | -0.09 | 3.73 (0.97) |
| Investing in animal welfare is only profitable with long-term guaranteed bonus payments. | 0.11 | 3.77 (0.96) | -0.16 | 3.84 (0.88) |
| In the long-term, higher costs for animal welfare will be covered by the willingness to pay of consumers. | -0.21* | 2.27 (1.07) | 0.01 | 2.16 (0.94) |
| The costs of animal welfare should be covered by governmental payments. | -0.01 | 2.60 (1.28) | 0.05 | 2.63 (1.29) |
| Producers should pay the costs for animal welfare by themselves. | 0.05 | 1.85 (1.02) | 0.15 | 1.90 (1.07) |

a) **p < 0.01; *p < 0.05.

Considering the means, pig and sow producers agreed that additional space of 10% and 20% improves the welfare of animals, while there was a neutral reaction (2.99) and slight disagreement (2.68) by pig and sow producers, respectively, with the statement that 40% more space further increases welfare. Furthermore, manipulatable material and roughage were evaluated as improving the welfare of animals. While outdoor yards were evaluated as providing no animal welfare improvement, pig producers were indifferent in their assessment of comfortable lying areas. In addition, sow producers evaluated a suckling period of 4 weeks as positive and 5 weeks and free farrowing as negative.

Although the relationship between positive animal welfare valuation of additional space and the herd size was negative, the correlation was not significant (P > 0.05). This holds also for the remaining AWS. Our results confirm the findings by Vanhonacker *et al.* (2008) that producers assess the relation between the farm size and animal welfare as weak.

Analysis of producers' investment confidences and attitudes towards bonus payments show that hog and sow producers believed that they would not recoup their expanses for animal welfare investments. Furthermore, they rejected the statement that expenses for animal welfare should be paid by the government or by themselves. However, they strongly agreed with the statement that investing in animal welfare is only profitable with long-term guaranteed bonus payments. Thus, bonus payments were, in general, evaluated as a suitable tool to cover the costs for implementing higher AWS; however, bonus payments may currently be either insufficient or not guaranteed over a long enough period to warrant AWS adoption.

The significant correlation between the statement "I`m not willing to reconstruct my stable to increase the welfare of animals" and the herd size for pig and sow producers implies that larger farms will not make structural changes in their production systems. In addition, pig producers with large herd sizes were in less agreement with the statement that investments in animal welfare will amortize over time. Moreover, pig producers with large production units did not believe that the willingness to pay of consumers will cover the costs for additional AWS. However, it should be noted that the aforementioned correlations were indeed significant, but only modest in their strength (Manion *et al.*, 2011).

### *3.4 Preferences for animal welfare implementation*

Initially, potential differences in the producers' evaluation of AWS had to be detected. To achieve this, a mixed logit model was used to identify heterogeneity in the producers` preferences for implementing AWS (Model 1 and Model 2). Preference heterogeneity is indicated by significant standard deviations of the attributes. In contrast, insignificant standard deviations show homogeneity of preference for the attribute. Table 6 displays the mixed logit models with detected preference heterogeneity. The resulting coefficients for each attribute are the mean parameter estimate across all producers.

The alternative specific constant (ASC) in Model 1, which represents the producers' general preference to choose program A or B instead of the opt-out, was not significant, meaning that the pig farmers' choices were not dependent on their general preference for choosing an animal welfare program. A significant negative influence on producers' choices was estimated for additional space, outdoor yard, partly-slatted floor, soft mat and bedding.

**Table 6.** Results of the mixed logit model[1)] with detected preference heterogeneity of analyzed pig (N = 103; number of observations = 3,708) and sow producers (N = 63, number of observations = 2,268).

| Variables | Model 1 | | Model 2 | |
|---|---|---|---|---|
| | Pig producers | | Sow producers | |
| | Mean | SD | Mean | SD |
| ASC[2)] | -0.177 | 2.393*** | 2.827*** | 3.587*** |
| Additional space[3)] | -0.076*** | 0.051*** | -0.072*** | 0.099*** |
| Manipulatable material[4)] | 0.427* | – | -0.656** | – |
| Roughage[4)] | 0.659** | – | -0.287 | – |
| Both materials[4)] | 0.211 | – | -1.681*** | – |
| Outdoor yard[5)] | -3.457*** | 2.340*** | – | – |
| Partially-slatted floor[6)] | -0.688** | 0.883** | – | – |
| Soft mat[6)] | -1.196*** | 0.676** | – | – |
| Bedding[6)] | -2.607*** | 1.832*** | – | – |
| Bonus payment per pig[3)] | 0.174*** | 0.065*** | – | – |
| Bonus payment per piglet[3)] | | | | |
| €8 | – | | 0.779** | – |
| €12 | – | | 2.181*** | – |
| €16 | – | | 1.774*** | – |
| Suckling period 5 weeks[7)] | – | | -2.274*** | – |
| $7.5m^2$, permanent fixation[8)] | – | | -0.638** | – |
| $7.5m^2$, no permanent fixation[8)] | – | | -2.493*** | 3.201*** |
| Group farrowing[8)] | – | | -4.809*** | 2.247*** |
| Goodness of fit measures | | | | |
| LL | -780.938 | | -439.596 | |
| AIC | 1595.875 | | 911.192 | |
| $R^2$ | 0.24 | | 0.31 | |

a) ***p < 0.01; **p < 0.05.; *p < 0.10. The model was estimated with Stata 15, using Halton draws with 1,000 replications.
b) ASC= alternative specific constant; binary coded variable with 1 if an alternative is chosen and 0 for the no choice option.
c) A Wald test of linear restrictions confirms the linearity of the attributes bonus payment per pig (P = 0.224), additional space per pig (P = 0.813), and additional space per sow (P = 0.526). Non-linearity was detected for bonus payment per piglet (P < 0.05). Therefore, price levels were estimated as dummy-coded variables with reference = €4.
d) Reference is no manipulatable material or roughage.
e) Reference is no outdoor yard.
f) Reference is fully-slatted floors.
g) Reference is suckling period of 4 weeks
h) Reference is $5m^2$ permanent fixation.

Conversely, implementing manipulatable material and roughage as well as receiving bonus payments had a positive impact on pig producers' decision. Sow producers in general favored program participation instead of remaining at the status quo with no bonus payments (ASC in Model 2 is significantly positive). Offering additional space, manipulatable material solely or in combination with roughage, and an extension of the suckling period were evaluated negatively by sow producers. In addition, relative to a farrowing system with 5m² and fixation of sows, producers show negative preferences for 7.5m² with permanent fixation, 7.5m² with no permanent fixation, and group farrowing.

In the case of pig producers, preferences varied for the ASC, additional space, outdoor yard, partly-slatted floor, soft mat, bedding and bonus payments. Heterogeneity in the preferences of sow producers were found for the ASC, additional space, farrowing in a 7.5m² area with no permanent fixation, and group farrowing. To detect potential sources of preference, heterogeneity interaction terms of these coefficients and farm individual characteristics can be implemented in the model estimation. As we were especially interested in the effect of the herd size on the producers' adoption of AWS, we built interactions between the attributes with identified preference heterogeneity and the herd size as well as the ratio of herd size per hectare (Model 3 to Model 6). Significant interactions reveal an impact of the herd size and herd size per hectare on the willingness of producers to adopt an AWS. Results of this estimation are presented in Table 7.

An increasing number of hogs had a negative influence on the pig producers' willingness to adopt an outdoor yard and bedding material (Model 3). Conversely, the preferences for the remaining AWS were unaffected by the number of pigs. An outdoor yard had the highest negative coefficient and was therefore the most important attribute for the hog producers' decision to participate in an animal welfare program (Model 1). This result is underlined by a study by Gocsik *et al.* (2016), who also found a low preference of pig producers for adopting free-range access. Following Vanhonacker *et al.* (2008), producers evaluated an outdoor yard as less important for the welfare of animals, although research has shown that outdoor yards extend the space allowance, reduce health problems, allow more time to be spent in motion, and reduce behavioral disorders (Guy *et al.*, 2002). Even though the health of pigs in an outdoor yard may be compromised by atmospheric conditions and parasite infections, Bornett *et al.* (2003) drew the conclusion that outdoor yards improve the welfare of animals. This raises the question of why large pig farms, in particular, reject outdoor yards. According to Hess *et al.* (2014), larger farms tend to save costs, reduce the working time per animal, and give lower weight to the importance of non-use values regarding the welfare of animals. Bock and van Huik (2007) state that investments in cost-intensive AWS are often associated with producers' concerns about the economic feasibility. More specifically, such investments potentially result in sunk costs and are associated with an unclear income effect, resulting in rejection by producers (Hubbard *et al.*, 2007). Our finding that increasing herd size reduced the producers' willingness to adopt an outdoor yard could therefore stem from the increasing investment and labor costs for realizing an outdoor yard with increasing herd size (Bornett *et al.*, 2003) and the fact that producers do not believe their expenses will amortize over time.

**Table 7.** Results of the mixed logit model[1)] with interactions between pig (N = 103; number of observations = 3,708) and sow producers' (N = 63, number of observations = 2,268) attribute preferences and the herd size as well as the number of pigs/sows per hectare. For clarity, coefficients are only presented for interaction variables. Remaining variables are presented in Appendix A2.

| Variables | Model 3 | Model 4 | Model 5 | Model 6 |
|---|---|---|---|---|
| | Number of pigs (per 100) | Pigs per hectare | Number of sows (per 100) | Sows per hectare |
| | Mean | Mean | Mean | Mean |
| ASC[2)] | -0.003 | -0.015 | 0.345* | 0.256** |
| Additional space (per 10%) | -0.002 | 0.001 | -0.035 | -0.044 |
| Outdoor yard | -0.070** | -0.085** | | |
| Partially-slatted floor | -0.003 | -0.042** | | |
| Soft mat | -0.021 | -0.089*** | | |
| Bedding | -0.111** | -0.184*** | | |
| Bonus payment per pig | 0.002 | 0.003* | | |
| 7.5m², no permanent fixation | | | 0.118 | -0.013 |
| Group farrowing | | | 0.209 | 0.068 |
| Goodness of fit measures | | | | |
| LL | -768.697 | -760.327 | -437.236 | -436.862 |
| AIC | 1585.394 | 971.648 | 914.472 | 913.723 |
| $R^2$ | 0.24 | 0.24 | 0.31 | 0.31 |

a) ***p < 0.01; **p < 0.05.; *p < 0.10. The model was estimated with Stata 15, using Halton draws with 1,000 replications.
b) ASC= alternative specific constant; binary-coded variable with 1 if an alternative is chosen and 0 for the no choice option.

Gourmelen *et al.* (2000) found out that high welfare systems with bedding material have lower housing costs than conventional systems. However, they state that these benefits are outweighed by higher labor and straw costs, resulting in higher production costs. In this context, the availability of labor and straw as bedding material may become critical, especially on large farms, which explains the negative interaction between herd size and the attribute bedding material. In geographic areas with less arable crops, the provision of straw in substantial quantities may be cost intensive due to purchase prices and transport costs. This also applies to the availability of straw on the farm level for farms with less arable crops. Even if farms have enough arable land to provide bedding material, they are confronted with opportunity costs resulting from the loss of positive effects gained by leaving straw on the arable land. Additionally, the need for storage capacities for bedding material is higher on large farms.

Qualitative analyses indicate that higher costs are critical for farmers, as they worry about the lack of knowledge of consumers regarding animal welfare issues (Nocella *et al.*, 2010) and doubt the WTP of consumers for more animal welfare practices. According to these studies, producers are not convinced that the higher costs of providing animal welfare result in higher product prices and, thus, fear an increase in their economic risk (Bock and van Huik, 2007; Hubbard *et al.*, 2007; Kauppinen *et al.*, 2010), which may explain the aversion to adopt cost-intensive AWS.

The interaction term herd size per hectare is a variable that may approximate the importance of pig production relative to arable farming for individual farms and, therefore, the intensity of pig production per farm. Model 4 shows that an increasing number of hogs per hectare has not only a negative effect on the adoption of an outdoor yard and bedding, but also on the producers' preferences for a partly-slatted floor and soft mats. The higher the income reliance on pig production, the higher the economic risk of implementing AWS. This is underpinned by the significant positive interaction between the herd size per hectare and the required bonus payments, which indicates a higher demand for bonus payments by farms with a higher ratio of pigs per hectare. The economic importance of the pig operation compared to the total farm activities measured in monetary indicators or the working time requirements for each operation of the farm would give additional information about this issue. Analyses of these variables related to the adoption of AWS are highly recommended for future research.

The results observed for the influence of the number of sows and the ratio of sows per hectare show a significant positive effect on the ASC. Thus, participation in an animal welfare program was generally more likely for larger sow farmers. However, no influence was present for the remaining AWS. Therefore, the standard criticism that larger farms are less willing to adopt AWS was proven incorrect by the DCE with sow farmers. However, pig farmers with larger herd sizes seemed to be less willing to implement AWS that result in higher labor and investment costs. Nevertheless, it should be noted that the standard criticism was not appropriate for all AWS.

Our results underline that animal welfare strategies have to consider differences in the farm structure in order to increase animal welfare as effectively as possible without endangering farm profitability. In this regard, policy should support effective animal welfare strategies suited to farms of all sizes instead of attempting to decrease farm size or raising questions about the appropriate farm size.

## 4. Conclusion

The data obtained in this study show that specific animal welfare standards are more implemented on small farms. While the future willingness of sow farmers to implement higher animal welfare standards is not affected by the herd size, pig farmers with large herd sizes are less willing to implement outdoor yards and bedding material. Moreover, producers with large herd sizes reject to reconstruct their buildings and are less convinced about the economic feasibility of implementing additional animal welfare standards. However, the standard criticism regarding the lack of animal welfare adoption on large farms was not supported by this study. Finally, the findings of this study indicate that the heterogeneity in the farm structure has to be regarded in future animal welfare strategies.

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## Appendix A

### A1 Cheap talk script

"The experience from previous similar surveys is that people often respond in one way but act differently. It is particularly common that one states a higher compensatory payment than what one actually needs in practice for covering the costs for the implementation of an animal welfare practices So please make your choice as if you really have to implement the suggested animal welfare packages."

Adapted from Carlsson *et al*. (2005).

## A2 Attribute coefficients related to Table 7 for the model with interactions.

| Variables | Model 3 | | Model 5 | |
|---|---|---|---|---|
| | Hog farmers | | Sow farmers | |
| | Mean | SD | Mean | SD |
| ASC[2)] | | 2.393*** | 1.873** | 3.391*** |
| Additional space[3)] 100) | -0.076*** | 0.051*** | -0.065*** | 0.102*** |
| Manipulatable material[4)] | 0.427* | | -0.677** | |
| Roughage[4)] | 0.659** | | -0.371 | |
| Both materials[4)] | 0.211 | | -1.713** | |
| Outdoor yard[5)] | -3.457*** | 2.340*** | | |
| Partially slatted floor[6)] | -0.688** | 0.883** | | |
| Soft mat[6)] | -1.196*** | 0.676** | | |
| Bedding[6)] | -2.607*** | 1.832*** | | |
| Bonus payment per pig[3)] | 0.174*** | 0.065*** | | |
| Bonus payment per piglet[3)] | | | | |
| €8 | | | 0.802** | |
| €12 | | | 2.218*** | |
| €16 | | | 1.803*** | |
| Suckling period of 5 weeks[7)] | | | -2.279*** | |
| 7.5m², permanent fixation[8)] | | | -0.645** | |
| 7.5m² no permanent fixation[8)] | | | -2.863*** | 3.099*** |
| Group farrowing[8)] | | | -5.553*** | 2.237*** |
| Goodness of fit measures | | | | |
| LL | -780.938 | | -439.596 | |
| AIC | 1595.875 | | 911.192 | |
| R² | 0.24 | | 0.31 | |

a) ***p < 0.01; **p < 0.05.; *p < 0.10. The model was estimated with Stata 15, using Halton draws with 1,000 replications.
b) ASC= alternative specific constant; binary coded variable with 1 if an alternative is chosen and 0 for the no choice option.
c) A Wald test of linear restrictions confirms the linearity of the attributes bonus payment per pig (P = 0.224), additional space per pig (P = 0.813), and additional space per sow (P = 0.526). Non-linearity was detected for bonus payment per piglet (P < 0.05). Therefore, price levels were estimated as dummy-coded variables with reference = €4.
d) Reference is no manipulatable material or roughage.
e) Reference is no outdoor yard.
f) Reference is fully-slatted floors.
g) Reference is suckling period of 4 weeks
h) Reference is 5m² permanent fixation.

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1969/70 wurde durch Zusammenschluss mehrerer bis dahin selbständiger Institute das **Institut für Agrarökonomie** gegründet. Im Jahr 2006 wurden das Institut für Agrarökonomie und das Institut für Rurale Entwicklung zum heutigen **Department für Agrarökonomie und Rurale Entwicklung** zusammengeführt.

Das Department für Agrarökonomie und Rurale Entwicklung besteht aus insgesamt neun Lehrstühlen zu den folgenden Themenschwerpunkten:

- Agrarpolitik
- Betriebswirtschaftslehre des Agribusiness
- Internationale Agrarökonomie
- Landwirtschaftliche Betriebslehre
- Landwirtschaftliche Marktlehre
- Marketing für Lebensmittel und Agrarprodukte
- Soziologie Ländlicher Räume
- Umwelt- und Ressourcenökonomik
- Welternährung und rurale Entwicklung

In der Lehre ist das Department für Agrarökonomie und Rurale Entwicklung führend für die Studienrichtung Wirtschafts- und Sozialwissenschaften des Landbaus sowie maßgeblich eingebunden in die Studienrichtungen Agribusiness und Ressourcenmanagement. Das Forschungsspektrum des Departments ist breit gefächert. Schwerpunkte liegen sowohl in der Grundlagenforschung als auch in angewandten Forschungsbereichen. Das Department bildet heute eine schlagkräftige Einheit mit international beachteten Forschungsleistungen.

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