**The “Real Welfare” Scheme: benchmarking welfare outcomes for commercially farmed pigs**

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**Material S1** Sampling and data collection.

The number of assessments (2 to 4) depended on pig flow and they were carried out during quarterly visits from the farm veterinarian. All participating veterinarians were required to be members of the Pig Veterinary Society. All vets wishing to carry out these assessments were required to undergo online and practical training to ensure standardisation of recording [http://pork.ahdb.org.uk/health-welfare/welfare/real-welfare/real-welfare-vets/]. The assessment involved 5 main measures. Full details of the measurement protocol can be found at [http://pork.ahdb.org.uk/health-welfare/welfare/real-welfare/]. Tail lesions and body marks were assessed on a sample of pigs per pen but pigs requiring hospitalization, lame pigs and enrichment use were assessed for all pigs in the selected pens as this method improved the accuracy of the recording of these welfare outcomes which usually occur at low prevalence. The number of pens assessed at each visit was selected to be representative of the farm and to comply with the number of pigs required to be assessed each year for tail lesions and body marks. For units of 300 finisher places or less, a minimum of 300 pigs should be sampled each year, but for units of 900 finisher places or more, a total of 900 pigs should be sampled per year. For units of between 300 to 900 finisher places, an equivalent representative proportion should be sampled. The sampling of pigs within a pen was as follows: all pigs in the pen if there were fewer than 25 pigs, 25 pigs if there were up to 100 pigs in the pen, or 50 pigs if there were more than 100 pigs in the pen. Sampling more pigs than this per pen was allowed at the vets’ discretion and if the total number of pigs required to be sampled on farm could not be reached (for instance if a farm had only few pens, but with many pigs). In case the necessary number of pigs was not reached, therefore, the recommendation was to divide the number of pigs needed from a pen type by the number of pens available (eg if 150 pigs were needed from two pens of 100, sample 150/2 = 75 pigs per pen). Data were preferentially collected from pigs of ≥50kg liveweight, but if there were not enough pigs for the sample then pigs of ≥30kg liveweight were also included in the sample.

**Figure S1** *Means of welfare outcomes for the farms above the value of 90th percentile in 2013*

**Table S1***Measurements used in the assessment. Each pig in the sample selected was classified into one of the several levels for each measurement (the classification for Enrichment use only concerns the active pigs of the sample).*

|  |  |
| --- | --- |
| Measurements | Definitions |
| Pigs requiring hospitalizationYes No | Any pigs seen in the sampled pens that would benefit from being separated into a hospital pen. (The nature of the health condition and the pen environment will affect this measure). Some types of pigs which may benefit from being in a hospital pen include pigs which are sick, injured or lame and are unable to compete for resources, being bullied/ tail bitten or would benefit from access to bedding that is more comfortable than that available in the pen.Pigs that would not benefit from removal to a hospital pen. |
|  |
| Lame pigsLameNon lame | Pigs with signs of lameness. Include any pig that, when standing, will not bear full weight on the affected limb and/or appears to be standing on its toes. When moving there is a shortened stride with minimum or no weight-bearing on the affected limb and a swagger of the hind quarters. May still be able to trot and gallop. |
| Pigs without any sign of lameness |
| Pigs with tail lesionsSevereMildNo lesionsDirty | Pigs with severe tail lesions. Proportion of tail has been removed by biting, or tail is swollen or held oddly, or scab covering whole tip or fresh blood visible  |
| Pigs with mild tail lesions. Linear lesion extending 1cm or more, or scabs/lesions greater than 0.5cm diameter, or swelling visible  |
| Pigs without any of the above lesions  |
| Pigs dirty enough to obscure potential mild lesions but not the severe ones. Tail end or whole tail is soiled making assessment of mild lesions difficult. |
| Pigs with body marksSevereMildNo lesionsDirty | Pigs with severe body marks. Lesion is larger than 5x5cm diameter, or lesion extends into deeper layers of skin, or lesions cover a large percentage of skin (>25%) |
| Pigs with mild body marks. Linear lesion longer than 10cm or if there are 3 or more 3cm lesions or if there is a circular area larger than 1cm diameter |
| Pigs without any of the above body marks  |
| Pigs dirty enough to obscure potential mild body marks but not the severe ones. The pig is soiled with > a handsize (15cm x 10cm) of fresh/old slurry/urine/faeces, or mud which is dense enough to conceal mild lesions.  |
| Enrichment useEnrichmentOther | Pigs interacting with enrichment in the pen. Number of standing or sitting pigs investigating a manipulable material, i.e. substrate or toy provided as enrichment. |
| Pigs interacting with other pens features or pen mates. Number of standing or sitting pigs manipulating other pigs, pen fittings, pen floor or muck. |

Table S2 *Number of pens and pigs in the study population with objects and/or substrates for enrichment.*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|   | Farms | Percentage | Pens | Percentage | Pigs | Percentage |
| Substrates and Objects | 279 | 14.5 | 3 111 | 2.8 | 204 580 | 3.7 |
| Substrates1 | 1 330 | 69.0 | 51 234 | 45.6 | 3 386 964 | 62.0 |
|  *Including* Straw | 1 310 | 67.9 | 50 136 | 44.7 | 3 320 398 | 60.8 |
| Objects2 | 1 012 | 52.5 | 51 826 | 46.2 | 1 740 123 | 31.9 |
| Total | 1 928 | 100 | 112 240 | 100 | 5 463 348 | 100 |

1Pens with substrates (with or without objects)

2Pens with objects (with or without substrates)

Table S3 *Qualification of quantity provided for the substrates present in the pens.*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Enrichment |  | Number of Pens | Percentage of all pens with straw | Number of pigs | Percentage of all pigs with straw |
| Straw |  |  |  |  |  |
|  | Restricted | 439 | 1.18 | 12 466 | 0.53 |
| Low | 4 617 | 12.38 | 148 853 | 6.27 |
| Medium | 17 055 | 45.75 | 872 111 | 36.76 |
| Deep | 6 306 | 19.91 | 659 317 | 27.79 |
| Deep and medium2 | 21 | 0.06 | 1 184 | 0.05 |
| Low and deep or restricted or medium2 | 73 | 0.20 | 2 583 | 0.11 |
| Not qualified | 8 771 | 23.53 | 676 158 | 28.50 |
| Total straw1 | 37 282 | 100 | 2 372 672 | 100 |  |
| Total without straw1 | 37 314 | - | 1 310 650 | - |

1Based on a subset of assessments of 74 596 pens reporting qualification of amount

2Two qualifications were recorded for the straw (the straw bedding was not uniform)

Table S4 *Proportion of pens and pigs in the study population with undocked tails.*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Tails | Number of pens | % | Number of pigs | % |
| Docked | 96 009 | 85.54 | 3 847 672 | 70.43 |
| Mixed | 3 628 | 3.23 | 290 433 | 5.31 |
| Undocked | 12 584 | 11.21 | 1 324 936 | 24.25 |
| Not recorded | 19 | 0.02 | 307 | 0.01 |
| Total | 112 240 | 100.00 | 5 463 348 | 100.00 |

Table S5 *Tail lengths (proportion of tail remaining) for the pens and pigs in the study population.*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Length | Number of pens | % | Number of pigs | % |
| <0.33 | 38 934 | 34.69 | 1 539 023 | 28.17 |
| ~0.5 | 30 379 | 27.07 | 1 259 775 | 23.05 |
| >0.5 | 24 040 | 21.41 | 962 980 | 17.63 |
| Mix of lengths | 5 272 | 4.70 | 263 595 | 4.83 |
| Undocked | 12 584 | 11.21 | 1 324 936 | 24.25 |
| Not recorded | 1 031 | 0.92 | 113 039 | 2.07 |
| Total | 112 240 | 100 | 5 463 348 | 100 |

Table S6 *Proportion of pens with undocked pigs according to the environment. Data collected at pen level from April 2013 to May 2016.*

|  |  |
| --- | --- |
| Categories Number of Pens |  Number of pigs |
|   | Docked | Mixed | Undocked |  Undocked | % undocked in the sub-category |
| Pen type  |
| Indoor | 89 868 | 3 436 | 10 289 | 1 118 087 | 22.0 |
| In&outdoor | 5 350 | 129 | 610 | 21 146 | 14.0 |
| Other type | 478 | 39 | 68 | 7 515 | 28.6 |
| Outdoor | 301 | 24 | 1617 | 178 265 | 89.6 |
| Pen size  |
| Large | 3 205 | 466 | 2 509 | 787 034  | 42.2 |
| Medium | 33 213 | 1 682 | 5 573 | 76 413 | 6.4 |
| Small | 59 591 | 1 480 | 4 502 | 461 489 | 19.2 |
| Ventilation  |
| Natural | 68 554 | 3 420 | 11 585 | 1 267 719 | 23.20 |
| Powered | 26 332 | 182 | 885 | 41 201 | 0.75 |

Table S7 *Proportion of pens with undocked tail pigs according to the enrichment. Data collected at pen level from April 2013 to May 2016.*

|  |  |
| --- | --- |
| Categories Number of Pens | Number of pigs |
|   | Docked | Mixed | Undocked | Undocked | % |
| Substrate | 39 123 | 2 638 | 9 462 | 1 063 415 | 31.2 |
| No Substrate | 56 886 | 990 | 3 122 | 261 521 | 12.6 |

Table S8 *Description of welfare outcomes at farm level (% of pigs or ratio).*

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Welfare outcomes  | Mean | SD | 1st Quartile | Median | 3rd Quartile | Min | Max |
| Pigs requiring hospitalization1 | 0.001 | 0.002 | 0 | 0 | 0 | 0 | 0.05 |
| Lame pigs1 | 0.002 | 0.005 | 0 | 0 | 0.002 | 0 | 0.19 |
| Severe tail lesions1 | 0.001 | 0.006 | 0 | 0 | 0 | 0 | 0.15 |
| Severe body marks1 | 0.002 | 0.009 | 0 | 0 | 0 | 0 | 0.15 |
| Enrichment ratio1 | 0.505 | 0.261 | 0.318 | 0.512 | 0.680 | 0 | 1.00 |

1: Values based on annual rolling averages

Table S9 *Description of the Welfare outcomes at pen level (% of pigs or ratio) (April2013-May2016).*

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Average percentage | Mean | SD | 1st Quartile | Median | 3rd Quartile | Min | Max |
| Pigs requiring hospitalization | 0.09 | 0.79 | 0 | 0 | 0 | 0 | 50 |
| Lame pigs | 0.21 | 1.30 | 0 | 0 | 0 | 0 | 100 |
| Enrichment use ratio | 0.47 | 0.36 | 0.11 | 0.47 | 0.75 | 0 | 1 |
| Severe tail lesions | 0.17 | 1.61 | 0 | 0 | 0 | 0 | 100 |
| Mild tail lesions1 | 1.45 | 4.79 | 0 | 0 | 0 | 0 | 100 |
| Dirty tail1 | 5.70 | 15.87 | 0 | 0 | 0 | 0 | 100 |
| Severe body marks | 0.28 | 1.94 | 0 | 0 | 0 | 0 | 100 |
| Mild body marks1 | 11.00 | 15.22 | 0 | 5.55 | 16 | 0 | 100 |
| Dirty body1 | 3.33 | 12.96 | 0 | 0 | 0 | 0 | 100 |

1Includes only the pens where mild lesions were assessed

Table S10 *Description of the Welfare outcomes at pen level (% of pigs or ratio) (April2013-November2013).*

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Percentage | Mean | SD | 1st Quartile | Median | 3rd Quartile | Min | Max |
| Pigs requiring hospitalization | 0.15 | 1.06 |  0 | 0 |  0 | 0 | 33.3 |
| Lame pigs | 0.36 | 1.88 |  0 | 0 |  0 | 0 | 100 |
| Enrichment use ratio | 0.47 | 0.36 |  0 | 0.50 |  0.75 | 0 | 1 |
| Severe tail lesions | 0.16 | 1.51 |  0 | 0 |  0 | 0 | 52.9 |
| Mild tail lesions | 1.72 | 5.23 |  0 | 0 |  0 | 0 | 100 |
| Dirty tail  | 5.63 | 14.96 |  0 | 0 |  0 | 0 | 100 |
| Severe body marks | 0.27 | 2.05 |  0 | 0 |  0 | 0 | 100 |
| Mild body marks | 13.00 | 16.36 |  0 | 8 |  20 | 0 | 100 |
| Dirty body  | 3.03 | 11.95 |  0 | 0 |  0 | 0 | 100 |

Table S11 *Variance inter-pen in the same farm (intra farm): Mean value, minimum and maximum in the pig population of farms studied.*

|  |  |  |  |
| --- | --- | --- | --- |
|   | mean values of the intra-farm variances | Min | Max |
| Pigs requiring hospitalization % | 0.46 | 0 | 35.3 |
| Lame pigs % | 1.22 | 0 | 206.9 |
| Severe tail lesions % | 2.20 | 0 | 581.3 |
| Severe body marks % | 2.89 | 0 | 338.4 |
| Enrichment use ratio | 0.025 | 0 | 0.094 |

Table S12 *Four groups of farms (one for each welfare outcome) were selected with a prevalence above the 90th percentile in 2013. The mean and the standard deviation (SD) of each welfare outcome for these groups of selected farms were calculated for each year from 2013 to 2016. The result of the Friedman test is reported for each group of farms.*

|  |  |  |  |
| --- | --- | --- | --- |
|   | 90thPercentiles | Mean values of the welfare outcomes for the selected farms | P valueFriedman test |
| Mean 2013 | SD2013 | Mean 2014 | SD2014 | Mean 2015 | SD2015 | Mean 2016 | SD2016 |
| Lame pigs | 0.954 | 1.944 | 1.326 | 0.700 | 0.763 | 0.340 | 0.410 | 0.291 | 0.523 | <0.001 |
| Pigs requiring hospitalization | 0.382 | 0.759 | 0.456 | 0.119 | 0.215 | 0.062 | 0.126 | 0.065 | 0.167 | <0.001 |
| Pigs with severe tail lesions | 0.333 | 1.083 | 1.196 | 0.426 | 0.711 | 0.298 | 0.801 | 0.354 | 1.650 | <0.001 |
| Pigs with severe body marks | 0.605 | 2.157 | 1.904 | 0.807 | 1.645 | 0.714 | 2.091 | 0.293 | 0.821 | <0.001 |

Table S13 *Kendall’s tau-b correlation coefficient between the average percentages of lame pigs for individual farms in each year.*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|   | 2013 | 2014 | 2015 | 2016 |
| 2013 | 1.000 |   |   |   |
| 2014 | 0.3601 | 1.000 |   |   |
| 2015 | 0.299 | 0.4441 | 1.000 |   |
| 2016 | 0.239 | 0.316 | 0.3711 | 1.000 |

1Considered significant *P*<0.05 tau>0.3

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|   | 2013 | 2014 | 2015 | 2016 |
| 2013 | 1.000 |   |   |   |
| 2014 | 0.108 | 1.000 |   |   |
| 2015 | 0.103 | 0.3021 | 1.000 |   |
| 2016 | 0.125 | 0.133 | 0.190 | 1.000 |

Table S14 *Kendall’s tau-b correlation coefficient between the average percentages of pigs requiring hospitalization for individual farms in each year.*

1Considered significant *P*<0.05 tau>0.3

Table S15 *Kendall’s tau-b correlation coefficient between the average percentages of severe tail lesions for individual farms in each year.*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|   | 2013 | 2014 | 2015 | 2016 |
| 2013 | 1.000 |   |   |   |
| 2014 | 0.199 | 1.000 |   |   |
| 2015 | 0.180 | 0.260 | 1.000 |   |
| 2016 | 0.134 | 0.125 | 0.242 | 1.000 |

1Considered significant *P*<0.05 tau>0.3

Table S16 *Kendall’s tau-b correlation coefficient between the average percentages of severe body marks for individual farms in each year.*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|   | 2013 | 2014 | 2015 | 2016 |
| 2013 | 1.000 |   |   |   |
| 2014 | 0.3231 | 1.000 |   |   |
| 2015 | 0.217 | 0.3941 | 1.000 |   |
| 2016 | 0.146 | 0.213 | 0.3281 | 1.000 |

1Considered significant *P*<0.05 tau>0.3

Table S17 *Odds ratio, confidence intervals and p-value. The proportion of lame pigs and pigs requiring hospitalization were the dependent variables and the season was the independent variable in a model that considered the farm as a random effect.*

|  |  |  |
| --- | --- | --- |
|   | Lame pigs | Pigs requiring hospitalization |
|   | Odd ratios | CI95% | P values | Odd ratios | CI95% | P values |
| Spring | *Intercept* |   |   | Intercept |   |   |
| Summer | 0.775 | 0.718 | 0.837 | <0.001 | 0.866 | 0.767 | 0.978 | 0.021 |
| Autumn | 0.825 | 0.766 | 0.889 | <0.001 | 0.842 | 0.749 | 0.948 | 0.004 |
| Winter | 0.847 | 0.789 | 0.910 | <0.001 | 0.831 | 0.741 | 0.931 | 0.001 |

Table S18 *Odds ratio, confidence intervals and p-value. The proportion of pig with severe tail lesions, the proportion of pigs with severe body marks and the proportion of pigs that interacted with the enrichment were the dependent variables and the season was the independent variable in a model that considered the farm as a random effect.*

|  |  |  |  |
| --- | --- | --- | --- |
|   | Severe tail lesions | Severe body marks | Enrichment use ratio |
|   | Odd ratios | CI95% | P values | Odd ratios | CI95% | P values | Odd ratios | CI95% | P values |
| Spring | Intercept |   |   | Intercept |   |   | Intercept |   |   |
| Summer | 0.915 | 0.826 | 1.015 | 0.093 | 0.956 | 0.882 | 1.036 | 0.276 | 0.925 | 0.842 | 1.016 | 0.105 |
| Autumn | 1.019 | 0.926 | 1.121 | 0.705 | 0.822 | 0.759 | 0.891 | <0.001 | 1.313 | 1.194 | 1.443 | <0.001 |
| Winter | 1.018 | 0.923 | 1.123 | 0.714 | 0.911 | 0.844 | 0.984 | 0.018 | 1.373 | 1.240 | 1.521 | <0.001 |

# Table S19 *Correlations between percentage of the different measures of pig welfare for all pens.*

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|   | Hospital | Lame | Severe tail lesions | Severe body marks | Ratio | Absence of tail lesions | Absence of body marks |
| Pigs requiring hospitalization | 1.00 |  |  |  |  |  |  |
| Lame pigs | 0.331 | 1.00 |  |  |  |  |  |
| Severe tail lesions | 0.19 | 0.05 | 1.00 |  |  |  |  |
| Severe body marks | 0.04 | 0.01 | 0.05 | 1.00 |  |  |  |
| Enrichment use ratio | 0.01 | 0.02 | -0.02 | 0.00 | 1.00 |  |  |
| Absence of tail lesions | -0.11 | -0.04 | -0.21 | -0.04 | 0.01 | 1.00 |  |
| Absence of body marks | -0.09 | -0.06 | -0.02 | -0.15 | 0.03 | 0.351 | 1.00 |

# 1*P*<0.05 and R>0.3 or <-0.3

# Table S20 *Correlation of the different measures of welfare (%) for the pens which received an assessment for both severe and minor lesions and body marks over the whole 3-year assessment period.*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|   | Mild marks | Mild tail lesions | Dirty tail | Dirty body | Hospital | Lame | Severe tail lesions | Severe body marks | Ratio | No tail lesions | No body marks  |
| Mild marks | 1.00 |  |  |  |  |  |  |  |  |  |  |
| Mild tail lesions | 0.20 | 1.00 |  |  |  |  |  |  |  |  |  |
| Dirty tail | 0.11 | 0.19 | 1.00 |  |  |  |  |  |  |  |  |
| Dirty body | -0.01 | 0.12 | 0.491 | 1.00 |  |  |  |  |  |  |  |
| Pigs requiring hospitalization | 0.08 | 0.09 | 0.08 | 0.05 | 1.00 |  |  |  |  |  |  |
| Lame pigs | 0.05 | 0.05 | 0.02 | 0.04 | 0.341 | 1.00 |  |  |  |  |  |
| Severe tail lesions | 0.03 | 0.21 | 0.03 | 0.00 | 0.20 | 0.06 | 1.00 |  |  |  |  |
| Severe body marks | 0.09 | 0.04 | 0.02 | -0.02 | 0.04 | 0.01 | 0.03 | 1.00 |  |  |  |
| Enrichment use ratio | -0.03 | -0.01 | 0.02 | 0.04 | 0.01 | 0.02 | -0.02 | -0.01 | 1.00 |  |  |
| No Lesions | -0.17 | -0.641 | -0.811 | -0.421 | -0.11 | -0.03 | -0.21 | -0.04 | 0.00 | 1.00 |  |
| No body marks | -0.871 | -0.20 | -0.29 | -0.381 | -0.08 | -0.05 | -0.02 | -0.15 | 0.03 | 0.321 | 1.00 |

1 *P*<0.05 R>0.3 or <-0.3

Table S21 *Correlation of the different measures of welfare (%) for the pens which received an assessment for both severe and minor lesions and body marks during the start-up assessment period (April 2013-Nov2013).*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|   | Mild body marks | Mild tail lesions | Dirty tail | Dirty body | Hospital | Lame | Severe tail lesions | Severe body marks | Ratio | No tail lesions | No body marks  |
| Mild body marks | 1.00 |  |  |  |  |  |  |  |  |  |  |
| Mild tail lesions | 0.19 | 1.00 |  |  |  |  |  |  |  |  |  |
| Dirty tail | 0.12 | 0.21 | 1.00 |  |  |  |  |  |  |  |  |
| Dirty body | -0.01 | 0.12 | 0.511 | 1.00 |  |  |  |  |  |  |  |
| Pigs requiring hospitalization | 0.07 | 0.09 | 0.07 | 0.05 | 1.00 |  |  |  |  |  |  |
| Lame pigs | 0.04 | 0.04 | 0.02 | 0.05 | 0.341 | 1.00 |  |  |  |  |  |
| Severe tail lesions | 0.04 | 0.21 | 0.04 | 0.00 | 0.21 | 0.06 | 1.00 |  |  |  |  |
| Severe body marks | 0.09 | 0.05 | 0.03 | 0.00 | 0.05 | 0.03 | 0.04 | 1.00 |  |  |  |
| Enrichment use ratio | -0.03 | -0.01 | 0.03 | 0.04 | 0.02 | 0.02 | -0.02 | -0.01 | 1.00 |  |  |
| No tail lesions | -0.18 | -0.651 | -0.811 | -0.431 | -0.11 | -0.03 | -0.21 | -0.05 | 0.00 | 1.00 |  |
| No body marks | -0.871 | -0.19 | -0.311 | -0.381 | -0.09 | -0.05 | -0.03 | -0.14 | 0.03 | 0.331 | 1.00 |

1 P<0.05 R>0.3 or <-0.3