



## Research Stimulus Fund

### Final Report

*Development of ante and post mortem meat inspection of pigs as a welfare diagnostic tool (PIGWELFIND)*

**DAFM Project Reference No:** 11/S/107

**Start date:** 01/03/2013

**End Date:** 30/06/2016

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#### **Collaborating Research Institutions and Researchers:**

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Dr. Niamh O' Connell - Queens University Belfast (QUB)

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- UCD School of Veterinary Medicine (replaced Dr. Paul Whyte, UCD)

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**Please place one "x" below in the appropriate area on the research continuum where you feel this project fits**

Basic/Fundamental ————— **Applied** ————— Pre Commercial

|   |   |   |   |     |   |   |
|---|---|---|---|-----|---|---|
| 1 | 2 | 3 | 4 | 5 x | 6 | 7 |
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**Please specify priority area(s) of research this project relates to from the National Prioritisation Research Exercise\* (NRPE) report:**

|                          |  |
|--------------------------|--|
| <b>Priority Area (s)</b> | Sustainable Food Production and Processing |
|--------------------------|--|

**Key words:** (max 4)

Welfare, carcass, slaughter, pig

## **1. Rationale for Undertaking the Research**

*This section should outline the rationale for carrying out the research and identify the need / problem to be addressed*

Pig production in Ireland is caught in a dilemma which is driven by narrow profit margins and the demand for cheap food on one side and regulatory requirements for food safety, animal welfare and environmental protection on the other. High feed prices combined with poor pig prices means that good herd management has never been more important to maximise efficiency and profitability of pig units. Suboptimal housing, management and stockmanship are associated with poor welfare in pigs and are reflected in disease, abnormal behaviour, injury, reduced longevity and productivity. More worryingly they result in an overuse of antibiotics and thereby contribute to the risk of antimicrobial resistance. Although maintaining high standards of animal welfare undoubtedly costs money, there are also financial costs associated with poor pig welfare. Carcass condemnation (CC) at Meat Inspection (MI) is a major source of financial loss in the pig industry and was one of the main problems which this research hoped to address. It was the finding from earlier related research that abscessation caused by tail biting (a major welfare problem for pigs) is one of the main reasons for CC which led to the strong focus on tail lesions arising from tail biting in the current project. In a broader context we were aware of the findings of the European Food Safety Authority (EFSA), that MI data are under-utilised in the EU, even as a means of informing herd health programmes. EFSA also advocated the inclusion of indicators specific to pig welfare in the MI process. Hence, it was clear that ante and post mortem MI could be developed as a welfare diagnostic tool and thereby act as an aid to improving pig welfare on farm, reducing carcass losses and ultimately improving profitability of the Irish pig industry. In order to broaden MI to incorporate lesions related to pig welfare it became clear that the association between carcass lesions (especially tail lesions) and pig welfare on farm had to be validated and that there was a need for a standardized computerized MI system in Irish slaughterhouses with which to record even routine MI findings. Ultimately though outside the remit of the current project the objective was for improved feedback of MI findings related to pig health and welfare to pig producers such that they could use such information to inform their herd management plans.

## **2. Research Approach**

*Specify the research methodologies employed, emphasising novel techniques and also outline any modifications from the original approved project proposal*

The research employed a combination of qualitative (social science) and quantitative (epidemiological and controlled) animal/veterinary science based studies. The qualitative work was conducted with stakeholders in the Irish and Northern Irish (NI) pig industry and the controlled animal/carcass based studies were conducted in the research farms at Moorepark (Teagasc) and Hillsborough (AFBI), NI, on commercial Irish pig farms and in slaughterhouses in ROI and NI.

Data on tail lesion scores, weights of condemned(trimmed carcass parts, reasons for viscera and carcass condemnation, bursitis and loin bruising collected on 3000 pig carcasses in one factory were compiled and analysed by the research officer hired for the PIGWELFIND project and yielded two papers (see Harley et al., 2014 and Teixeira et al., 2016). This work helped to refine the tail lesion scoring protocol which was to be used for most of the later work conducted by the PhD student based at Teagasc Moorepark. The first study involved a controlled comparison of the effects of mixing prior to slaughter on pig behaviour and carcass lesions. This study was conducted on a commercial farm and in the small, local abattoir they supplied. The following two trials were based in larger factories. The first recorded tail lesions in slaughter pigs in two factories and relationships with PigSys farm performance records were established. This work necessitated close collaboration with the Teagasc Pig Advisory service and utilised their eProfit Monitor. In the second, tail and lung pathologies were scored on the slaughterline in one slaughterplant. This work involved collaboration with pig pathologists in the Central Veterinary Research Laboratories in Backweston and UCD and a private veterinary practitioner with experience in scoring lung pathologies. The fourth study had two components. The first was a comprehensive health and welfare assessment of pigs on 30 commercial farms using a modified version of the Welfare Quality® protocol. This was combined with scoring of tail lesions of slaughter pigs from the same farms at the different slaughter plants they supplied around the country. Other epidemiological, factory based work conducted by the team at Moorepark involved recording of reasons for detention of pigs ante-mortem and establishing the link between these findings and the outcome of the post mortem meat inspection (on the basis of the acting veterinary inspectors decisions). Three years of data on ante mortem detentions from one Irish slaughterplant were also collected. In the original project plan we proposed to establish the prevalence of external abscesses etc. but it became clear that these occur at too low a prevalence to warrant further investigation.

Similarly one of the studies proposed for the PhD student based at QUB could not proceed. The aim was to identify on-farm risk factors for behaviours linked to carcass condemnations and downgradings. However, following in-depth evaluation of the NI database of carcass condemnations (Carcass Information Analysis - CIA) we could not find enough farms with consistent condemnation problems for robust analysis. Instead we investigated the impact of carcass processing procedures on the visibility of carcass welfare lesions. The work was conducted in two abattoirs (Cookstown NI and Dawn ROI) in order to account for potential differences in processing between factories. The major part of the PhD research conducted by the NI team was carried out using the experimental pig herd at the Agri-Food and Biosciences Institute (AFBI) in Hillsborough. In a longitudinal study which followed pigs from birth through to slaughter the degree to which measures taken at slaughter reflect pig lifetime welfare was determined. Blood was also collected from these pigs at slaughter to enable physiological measurements (cortisol and acute phase proteins) to be related to indicators of pig lifetime welfare.

Semi-structured stakeholder (veterinary inspectors, private veterinary practitioners, meat inspectors [NI only] and meat plant managers) interviews were conducted to establish perspectives regarding the potential use of ante and post mortem MI as an

animal welfare (AW) diagnostic tool in pigs. Specifically a SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis was carried out to identify the existing strengths and weaknesses in the industry, opportunities and threats internally and externally. The stakeholder workshop conducted in November 2015 also employed a series of qualitative tools used in social science research.

### **3. Research Achievements/Results**

*Outline main results achieved*

- Carcass tail lesions (TL) are associated with a higher risk of carcass condemnation (CC) and of trimming. The primary reason for CC is abscessation (ABC) but we could not establish a link between carcass tail lesion scores and the risk of ABC. As the TL score increases the cold carcass weight decreases (significantly in the case of scores  $\geq 2$ ).
- There is a high prevalence of tail lesions and viscera condemnations in Irish pigs. Higher tail lesion scores are associated with a greater risk of lungs being condemned for pathologies. There is significant variation between veterinary inspections in the scoring of viscera pathologies at slaughter.
- Lameness, "downer" and stress were the most common reasons for detaining pigs ante-mortem (AM). Abscess(es) was the primary identified reason for post-mortem (PM) condemnation. There were significant relationships found between reasons for detaining pigs AM and the likelihood of full or partial condemnations.
- Mixing of entire male pigs before transport to slaughter increases the occurrence of aggressive and mounting behaviour. In spite of effects of mixing, transport, slaughter and carcass processing, carcass skin and tail lesions still reflect the presence of skin and tail lesions on-farm.
- Tail lesion prevalence at meat inspection is high but large variation was observed between farms, especially for moderate lesions. Such lesions are less common on farms which avail of record keeping through an advisory service. Prevalence of tail lesions at meat inspection is associated with farm productivity parameters.
- Indications of high prevalence of respiratory disease in Irish slaughter pigs is a cause for concern. Carcass tail lesions were associated with severe pleurisy, but not with enzootic pneumonia-like lesions.
- Health and welfare outcomes observed in the first weaner stage reflect conditions associated with post-weaning stress. In the second weaner and finisher stage conditions associated with higher body weights and growth rates were more common. Lesions caused by injurious behaviour (ear, tail and to lesser extent flank lesions) were highly prevalent. Carcass tail and skin lesions prevalence at MI accurately predicted farms with problems with poor body condition in the first weaner stage, bursitis in the second weaner stage and severe tail lesions in the finisher stage.
- Severe skin lesions, tail lesions and loin bruising are more visible on pig carcasses after they have been scalded and dehaired, and therefore this is when abattoir-based lesion scoring should take place. The high prevalence of all three lesion

types, and the links shown with economically important production parameters, suggests more research into identifying key risk factors is warranted.

- Tail lesions and skin lesions, acquired in both early and later life of the pig, remain visible on the carcass. Low carcass weight was associated with tail lesions, supporting previous research which suggests that tail lesions have a negative impact on growth performance in pigs.
- Pigs recorded as having tail lesions during their lifetime had significantly higher hair cortisol levels at slaughter than those with no tail lesions, and pigs recorded as having moderate or severe tail lesions had significantly higher Haptoglobin (Hp) levels than those with no or mild tail lesions. Pigs recorded as being lame during their lifetime also had significantly higher hair cortisol levels than non-lame pigs. As 'good welfare' quantitative behaviour analysis scores decreased, Haptoglobin levels tended to increase and C reactive protein (CRP) levels significantly increased. These findings suggest that Hp, CRP and hair cortisol measured at slaughter could provide insight into the welfare status of pigs during their lifetime.
- The relationship between aggression-related skin lesion scores and other parameters indicative of welfare is not straightforward. Larger pigs may be more inclined to engage in aggression and thus sustain higher levels of skin damage, while also being more susceptible to lameness. However, animals suffering from ill-health appear to avoid aggression and thus sustain fewer injuries. This would suggest that aggression-related skin lesions on the carcass are not a suitable iceberg indicator of welfare status in growing-finishing pigs.
- Producers recognised the benefit of using MI as a tool to improve pig health and welfare. However, some producers were dissatisfied with the current system of MI and were concerned over how MI data will be used if developed further.
- Producers reported positive relationships with their Private Veterinary Practitioner (PVP) but their tolerance of certain animal welfare issues may limit the usefulness of MI data feedback to inform planning for pig health and welfare.
- Communication and relationship difficulties are present within the pig industry
- Ante mortem data recording is achievable but post mortem data recording will be challenging.

The core finding of the stakeholder interviews was that any development and utilisation of MI data as a diagnostic tool for pig health and welfare must be supported by the implementation of a communication strategy that will help to build trust and positive relations between all stakeholders in the pig industry. Such a strategy will provide real-time data to support producers to improve pig health and welfare and thereby improve farm profitability.

- All stakeholders saw the benefit of meat inspection data collection and feedback, with certain conditions of high priority. They felt that a centralised system could also serve as national disease surveillance tool/early warning system. Ideally, all participants would like an all-island approach, achieving a "biosecure zone".

- Positive marketing potential if implemented, also saw potential for more targeted prophylaxis and possibly reduced antibiotic use leading to improved health and welfare of national herd.

According to participants, the main challenges facing the development of meat inspection (MI) as a diagnostic tool for pig health and welfare are:

- Time constraints on temporary veterinary inspectors (TVIs) to record additional meat inspection data and the initial investment in hardware/software.
- Batch 'vs' individual level recording
- Data protection issues
- Training for TVIs
- Uncertainty about visual only inspection

#### **Cost analysis of tail biting**

- Total carcass and production losses due to carcass condemnations and carcass downgradings = 1.7c per kg/deadweight or €1.37 per pig, on average=1.23% (1kg/81.1kg)
- Estimated annual carcass losses associated with tail lesions for 10,400 pigs (200 pigs sold p.w.) with tail lesion prevalence (mild to severe) of 72.5% = €14,248

Strategy to reduce tail biting = Provision of chopped straw

- A review of the literature showed that this strategy provides a 7 fold improvement in tail lesions.
- Cost of chopped straw per pig (12.5g/pig/day×90days) = €0.0675 per pig= €702 annually
- Cost of labour for straw provision per pig (x90 days) €0.25 per pig= €2,600 annually
- Total cost of light chopped straw €3,302 annually
- Prevalence of detectable tail lesions reduces from 72.5% to 10.4%
- Annual cost of tail biting is reduced from €14,248 to €2,044, giving a gross saving of €12,204 per year
- This strategy can result in an annual net saving of €8,902 for a production unit size of approx 10,000 pigs.

#### **4. Impact of the Research**

*A summary of the tangible impact of the research project should be provided under the outcomes' and 'outputs' heading below. In addition, please provide a short narrative synopsis of the benefits / improvements the research has made to the area under investigation particularly as regards end users, e.g. industry, consumers, regulatory authorities, policymakers, the scientific community, etc*

Based on the main findings of this project it can be concluded that carcass lesions such as skin and tail lesions observed at MI provide valuable information on pig performance, health and welfare on-farm. Indeed, the links discovered between tail lesion score and the lung diseases supports the relationship between poor health and poor welfare of pigs on

farms and reinforces the inclusion of tail lesion severity scores in the meat inspection process as a health and welfare diagnostic tool. However, to achieve this implementation of a standardized, computerized recording system at MI for the Irish pig industry is needed. Including carcass lesions and possibly other indicators of pig health and welfare at MI could provide a good monitoring tool allowing pig producers to evaluate their performance over time and against other producers for benchmarking purposes. This information can prove advantageous in developing pig health and welfare management plans and so contribute to the productivity and improved consumer image of the Irish pig industry. Future work should focus on implementation of such a recording system, evaluating the use of the generated data by producers, advisors and veterinarians and its effects on pig productivity, health and welfare, and include cost/benefit analyses of such a system.

#### **4(a) Summary of Research Outcomes**

##### **(i) *Collaborative links developed during this research***

The research helped the project team to solidify relationships with key local pigmeat processors which will help facilitate future research in this area. Links were also developed with pathologists at the Central Veterinary Research Laboratories in Backweston. These links were exploited in a follow on Stimulus funded research project (PathSurvPigs). The contract RO also worked with researchers in the Danish Meat Research Institute (DMRI) where skills associated with scoring welfare lesions and heart rate in pigs prior to slaughter were brought to the team. The links developed with DMRI personnel since proved useful such that, for example a DMRI researcher acted as the external examiner for one of the PIGWELFIND PhD theses in January 2017.

##### **(ii) *Outcomes where new products, technologies and processes were developed and/or adopted***

The project was instrumental in developing skills in conducting abattoir based welfare assessments in pigs, both among our project team and also in the wider scientific community through the publications generated by the project. This was also the first time that the team at Queen's University adopted a Qualitative Behavioural Assessment approach to their animal welfare research, and these skills are now embedded in the team. The final protocol developed by the project team will help to standardise the process of meat inspection and can be used in training of veterinary inspectors.

##### **(iii) *Outcomes with economic potential***

Links were found between several of the carcass lesions measured and indicators of economic performance such as carcass weight. By developing intervention protocols for the prevention of such welfare lesions pig producers can improve pig performance health and therefore profitability at farm level. Pigmeat processors will benefit economically from reduced costs of disposal of condemned carcasses and downgraded cuts of meats

because of bruising/lesions. Obviously this is on the basis that through a standardised system of meat inspection producers receive feedback on the status of such lesions from each batch of pigs they send to slaughter. In the absence of such information they cannot address the problems.

(iv) *Outcomes with national/policy/social/environmental potential*

The findings on the prevalence of tail and lung lesions in slaughter pigs matched with the prevalence of health and welfare problems detected on farms raises some concern for the health and welfare of the national pig herd. This finding is of social relevance given the growing concern amongst consumers about the welfare of food producing animals. It also raises concern at a wider level because of the threat of antimicrobial resistance. Given the value of the pig industry to the Irish economy (3<sup>rd</sup> in importance after dairy and beef) these findings also have national implications and implications for policy because of reputational risk. Nevertheless, the links between the investigated indicators (i.e. carcass lesions) which can be measured at meat inspection (MI) and indicators of relevance to pig performance and health on farm revealed by this project offers a promising way of addressing some of these welfare problems.

The work uncovered dissatisfaction amongst pig producers about current systems of MI and indeed inadequacies/inconsistencies in the way MI is performed (e.g. high variation between veterinary inspectors). Many of these issues have particular relevance to policy and could be overcome by the implementation of a standardised, computerised system for recording MI (and pig health and welfare measures) combined with some retraining of veterinary inspectors. This is in line with recent recommendations by other stakeholder groups charged with addressing profitability and sustainability issues in the Irish pig industry.

#### **4 (b) Summary of Research Outputs**

(i) *Peer-reviewed publications, International Journal/Book chapters.*

The project will ultimately lead to up to 15 peer reviewed publications with 12 papers already published or in the process of being published.

##### In preparation

- Carroll, G.A., Boyle, L.A., Hanlon, A., Griffin, K., Friel, M., Collins, L., O' Connell, N.E. What can carcass-based assessments tell us about the lifetime welfare of pigs? In preparation for submission to the Journal of Animal Science
- Carroll, G.A., Boyle, L.A., Hanlon, A., Collins, L., Griffin, K., Armstrong, D., O' Connell, N.E. Evaluating the use of skin lesion scores as a welfare assessment tool in growing-finishing pigs. In preparation for submission to Livestock Science

- Teixeira, D.L., Doyle, B., Hanlon, A., O'Connell, N., Boyle, L.A. Relationship between ante-mortem status and meat inspection outcome of slaughter pigs. In preparation for submission to *Preventative Veterinary Medicine*

## 2017

1. van Staaveren, N., Doyle, B., Manzanilla, E.G., Calderón Diaz, J.A., Hanlon, A. and Boyle, L.A. (2017). Prevalence of health and welfare outcomes in the weaner and finisher stages of the production cycle on 31 Irish pig farms. Submitted to *Journal of Porcine Health Management*
2. Carroll, G.A., Boyle, L.A., Hanlon, A., Palmer, M.A., Collins, L., Griffin, K., Armstrong, D., O' Connell, N.E. Identifying physiological measures of lifetime welfare status in pigs: Exploring the usefulness of Haptoglobin, C-Reactive Protein and hair cortisol sampled at the time of slaughter. Submitted to *Irish Veterinary Journal*
3. van Staaveren, N., Doyle, B., Manzanilla, E.G., Calderón Diaz, J.A., Hanlon, A. and Boyle, L.A. (2017). Validation of Carcass Lesions as Indicators for on-farm Health and Welfare of Pigs. Accepted for publication in *Journal of Animal Science* in January 2017
4. van Staaveren, N., Teixeira, D.L., Hanlon, A. and Boyle, L.A. (2017). Pig carcass tail lesions: the influence of record keeping through an advisory service and farm performance parameters. *Animal* 11, 140-146.

## 2016

5. Devitt, C., Boyle, L.A., Teixeira, D.L., O'Connell, N.E., Hawe, M., and Hanlon, A. (2016). Stakeholder perspectives on the use of pig meat inspection as a health and welfare diagnostic tool in the Republic of Ireland and Northern Ireland; a SWOT analysis. *Irish Veterinary Journal* 69, 17
6. Teixeira, D.L., Harley, S., Hanlon, A., O'Connell, N.E., More, S., Manzanilla, E.G., Boyle, L.A. (2016). Study on the association between tail lesion score, cold carcass weight and viscera condemnations in slaughter pigs. *Frontiers in Veterinary Scence*. doi: 10.3389/fvets.2016.00024
7. van Staaveren, N., Vale, A.P., Manzanilla, E.G., Teixeira, D.L., Leonard, F.C., Hanlon, A. and Boyle, L.A. (2016). Relationship between tail lesions and lung health in Irish slaughter pigs. *Preventative Veterinary Medicine* 127, 21-26
8. Devitt, C., Boyle, L.A., Teixeira, D.L., O'Connell, N.E., Hawe, M., and Hanlon, A. (2016). Pig producer perspectives on the use of meat inspection as an animal health and welfare diagnostic tool in the Republic of Ireland and Northern Ireland. *Irish Veterinary Journal* 69, 2. 9pgs. DOI 10.1186/s13620-015-0057-y

## 2015

9. Carroll, G.A., Boyle, L.A., Teixeira, D.L., van Staaveren, N., Hanlon, A. and O'Connell, N.E. (2015). Effects of scalding and dehairing of pig carcasses at abattoirs on the

visibility of welfare-related lesions. *Animal* 28, 1-8.  
doi:10.1017/S1751731115002037

10. van Staaveren, N., Teixeira, D.L., Hanlon, A. and Boyle, L.A. (2015). The effect of mixing entire male pigs prior to transport to slaughter on behaviour, welfare and carcass lesions. *PlosOne* 10(4), 1-15.

## **2014**

11. Teixeira, D.L. and Boyle, L.A. (2014). A comparison of the impact of behaviours performed by entire male and female pigs prior to slaughter on skin lesion scores of the carcass. *Livestock Production Science* 170, 142-149.
12. Harley, S., Boyle, L.A., O'Connell, N.E., More, S.J., Teixeira, D.L. and Hanlon, A. (2014). Docking the value of pigmeat? Prevalence and financial implications of welfare lesions in Irish slaughter pigs. *Animal Welfare* 23, 275-285.

(ii) *Popular non-scientific publications and abstracts including those presented at conferences*

### **Popular publications**

1. Doyle, B. and L. Boyle. 2016. Why are your pigs detained at lairage? *Teagasc Pig Newsletter*, April 2016
2. van Staaveren, N., B. Doyle and L. Boyle. Preliminary findings from pig health and welfare assessments on 31 farms. *Teagasc Pig Newsletter*, February 2016.
3. Doyle, B. Identifying Iceberg Welfare Indicators During Pig Meat Inspection. *Teagasc Pig Newsletter*, October 2015.
4. van Staaveren, N. Welfare Assessment during Meat Inspection. *Teagasc Pig Newsletter*, July 2015.
5. Boyle, L.A. and D.L. Teixeira. 2014. Caudofagia y bienestar en cerdos (Tail biting and welfare of pigs). *SUIS*. No. 113 December 2014. p. 14-18.
6. van Staaveren, N., and L. Boyle. Tail lesions on carcasses of Irish slaughter pigs. *Teagasc Pig Newsletter*, March 2015.

### **Conference presentations**

#### **2017**

1. van Staaveren, N., Doyle, B., Manzanilla, E.G., Calderón Díaz, J.A., Hanlon, A., Boyle, L.A. 2017. Validation of carcass lesions as indicators of pig welfare on farm. International Society for Animal Hygiene. Mazatlán, Sinaloa, Mexico, March 19<sup>th</sup>-24<sup>th</sup> 2017. [Oral presentation]
2. van Staaveren, N., Doyle, B., Manzanilla, E.G., Calderón Díaz, J.A., Hanlon, A., Boyle, L.A. 2017. Validation of carcass lesions as indicators of pig welfare on farm. In: Proceedings of the 7th International Conference on the Assessment of Animal Welfare at Farm and Group Level (WAFL). Wageningen, The Netherlands. 5<sup>th</sup>-8<sup>th</sup> September 2017.

## 2016

3. van Staaveren, N., A. Hanlon, and L. Boyle. 2016. Pig carcass tail lesions: associations with record keeping and farm performance parameters. In: Book of Abstracts of the 67th Annual Meeting of the European Federation of Animal Science (EAAP), Belfast, United Kingdom, 29 August - 02 September 2016. Wageningen, The Netherlands: Wageningen Academic Publishers, 2016, p. 221. [Oral presentation]
4. van Staaveren, N., B. Doyle, A. Hanlon, and L. Boyle. 2016. Carcass lesions as indicators of injurious behaviour and welfare lesions in pigs. In: Proceedings of the 48th Congress of the International Society for Applied Ethology (ISAE), Edinburgh, United Kingdom, 12 - 16 July 2016. Wageningen, The Netherlands: Wageningen Academic Publishers, 2016, p. 296. [Poster presentation]
5. van Staaveren, N., A. Vale, E.G. Manzanilla, B. Doyle, A. Hanlon and L. Boyle. 2016. Associations between tail lesions and lung health in slaughter pigs. In: The 16th International Conference on Production Diseases in Farm Animals (ICPD) - Book of abstracts, Wageningen, The Netherlands, 20 - 23 June 2016. Wageningen, The Netherlands: Wageningen Academic Publishers, 2016, p. 130. [Oral presentation]
6. van Staaveren, N., B. Doyle, A. Hanlon and L. Boyle. 2016. Occurrences of production diseases in grower pigs on Irish pig farms. In: The 16th International Conference on Production Diseases in Farm Animals (ICPD) - Book of abstracts, Wageningen, The Netherlands, 20 - 23 June 2016. Wageningen, The Netherlands: Wageningen Academic Publishers, 2016, p. 129. [Oral presentation]
7. Doyle, B., D.L. Teixeira, J. Calderon Diaz, N. O'Connell, A. Hanlon and L. Boyle. 2016. The relationship between the status of Irish slaughter pigs detained ante mortem and their meat inspection outcome. The 24th International Pig Veterinary Society Congress and 8th European Symposium of Porcine Health Management, 7 - 10 June 2016, Dublin, Ireland, p. 436 [Poster presentation]
8. van Staaveren, N., B. Doyle, A. Hanlon and L. Boyle. 2016. Associations between carcass tail lesions and other welfare conditions and the performance of negative behaviours in pigs. In: The 24th International Pig Veterinary Society Congress and 8th European Symposium of Porcine Health Management Abstracts Book, Dublin, Ireland, 7 - 10 June 2016, p. 631. [Poster presentation]
9. van Staaveren, N., B. Doyle, A. Hanlon and L. Boyle. 2016. Prevalence of health conditions in grower pigs on Irish pig farms. In: The 24th International Pig Veterinary Society Congress and 8th European Symposium of Porcine Health Management Abstracts Book, Dublin, Ireland, 7 - 10 June 2016, p. 306. [Poster presentation]
10. Carroll, G., L. Boyle, A. Hanlon, M. Palmer, L. Collins, K. Griffin, and N. E. O'Connell. 2016. Investigating physiological measures of lifetime welfare in slaughter pigs. Annual BSAS Conference 2016 - Animal Science for a Sustainable Future, 6 - 7 April 2016 [Oral presentation]

## 2015

11. Carroll, G. A., L. A. Boyle, A. Hanlon, L. Collins, K. Griffin, D. Armstrong and N. E. O'Connell. 2015. Evaluating the use of aggression-related skin lesion scores as a welfare assessment tool in growing-finishing pigs. In: ISAE UK & Ireland regional meeting, Teagasc Moorepark, Fermoy, Co. Cork, Ireland, 10 November 2015, p. 23. [Oral presentation]
12. van Staaveren, N., E. Moussard, A. Hanlon and L. Boyle. 2015. Relationship between tail lesions and other welfare conditions and behaviours in pigs. In: ISAE UK & Ireland regional meeting, Teagasc Moorepark, Fermoy, Co. Cork, Ireland, 10 November, p. 22. [Oral presentation]
13. Carroll, G., L. Boyle, A. Hanlon, K. Griffin, L. Collins and N. O'Connell. 2015. What can carcass-based assessments tell us about the lifetime welfare of pigs? In: Proceedings of the 49th Congress of the International Society for Applied Ethology (ISAE), Sapporo, Japan, 14 - 17 September 2015. Wageningen, The Netherlands: Wageningen Academic Publishers, 2015, p. 49. [Oral presentation]
14. van Staaveren, N., A. Vale, E.G. Manzanilla, F. Leonard, A. Hanlon and L. Boyle. 2015. Relationship between tail lesions and lung health in Irish slaughter pigs. In: Proceedings Book Epidemiology and control of hazards in pork production chain - SafePork Conference, Porto, Portugal, 7 -10 September 2015, p. 267 - 271. [Poster presentation]
15. Carroll, G. A., L. A. Boyle, A. Hanlon, K. Griffin, L. Collins and N. E. O'Connell. 2015. Validation of on-line slaughter checks as a pig welfare diagnostic tool. International Pig Welfare Conference (IPWC), Copenhagen, Denmark, 29 -30 April 2015, p. 119. [Poster presentation]
16. van Staaveren, N., D. Teixeira, A. Hanlon, and L. Boyle. 2015. Tail lesions on carcasses of Irish slaughter pigs in relation to producer association with advisory services. International Pig Welfare Conference (IPWC), Copenhagen, Denmark, 29 - 30 April 2015, p. 104. [Poster presentation]
17. Carroll, G., L.A. Boyle, D. Teixeira, N. van Staaveren, A. Hanlon, and N.E. O'Connell. 2015. The effect of routine abattoir processes on the visibility of welfare-related lesions in pigs. In: BSAS Proceedings, Chester, United Kingdom, 14 - 15 April 2015, p. 152. [Oral presentation].
18. van Staaveren, N., D. Teixeira, A. Hanlon, and L. Boyle. 2015. Relationship between Lesions Observed on Farm and on the Carcass and the Influence of Mixing Pigs before Slaughter. In: Book of Abstracts of the Midwest Meeting of the American Society of Animal Science (ASAS) and American Dairy Science Association (ADSA), Des Moines, Iowa, US, March 15-18 2015, p. 101. [Poster presentation]
19. van Staaveren, N., D. Teixeira, A. Hanlon, and L. Boyle. 2015. Prevalence of Loin Bruising and Tail Lesions in Irish Slaughter Pigs. In: Book of Abstracts of the Midwest Meeting of the American Society of Animal Science (ASAS) and American Diary Science Association (ADSA), Des Moines, Iowa, US, March 15-18 2015, p. 185. [Poster presentation]
20. Teixeira, D., S. Harley, A. Hanlon, N. O'Connell, E. Manzanilla, and L. Boyle. 2015. The relationship between tail lesion scores and viscera condemnations in slaughter pigs. In: Agricultural Research Forum, Tullamore Court Hotel, Ireland, 9 - 10 March 2015, p. 127. [Oral presentation]

21. van Staaveren, N., D. Teixeira, A. Hanlon, and L. Boyle. 2015. Variation between farms in tail lesion scores of slaughter pigs. In: Agricultural Research Forum, Tullamore Court Hotel, Ireland, 9 - 10 March 2015, p. 27. [Oral presentation]

**2014**

22. Teixeira, D., N. van Staaveren, and L. Boyle. 2014. Carcass skin lesions in boars reflect their aggressiveness on farm. In: Proceedings of the 6th International Conference on the Assessment of Animal Welfare at Farm and Group Level (WAFL), Clermont-Ferrand, France, 3 - 5 September 2014. Wageningen, The Netherlands: Wageningen Academic Publishers, 2014, p. 133. [Poster presentation].
23. Boyle, L. A., C. Devitt, A. Hanlon and N. E. O'Connell. 2014. Pig producer perspectives on the potential of meat inspection as an animal welfare diagnostic tool. In: Proceedings of the 6th International Conference on the Assessment of Animal Welfare at Farm and Group Level (WAFL), Clermont-Ferrand, France, 3 - 5 September 2014. Wageningen, The Netherlands: Wageningen Academic Publishers, 2014, p. 213. [Poster presentation]
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25. Teixeira, D. L., A. Hanlon, N. O'Connell and L. Boyle. 2014. Carcass skin lesions in boars reflect their behaviour on farm. In: Book of Abstracts of the 65th Annual Meeting of the European Federation of Animal Science (EAAP), Copenhagen, Denmark, 25 - 29 August 2014. Wageningen, The Netherlands: Wageningen Academic Publishers, 2014, p. 220. [Oral presentation]
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27. van Staaveren, N., D. Teixeira, A. Hanlon, and L. Boyle. 2014. Skin lesions in entire male pigs in relation to aggressive and mounting behaviour in response to mixing prior to slaughter. In: Proceedings of the 48th Congress of the International Society for Applied Ethology (ISAE), Vitoria-Gasteiz, Spain, 29 July - 02 August 2014. Wageningen, The Netherlands: Wageningen Academic Publishers, 2014, p. 285. [Poster presentation]
28. Teixeira, D. L., N. van Staaveren, A. Hanlon, N. O'Connell and L. Boyle. 2014. Carcass skin lesions in boars reflect their aggressiveness on farm. In: Proceedings of the 48th Congress of the International Society for Applied Ethology (ISAE), Vitoria-Gasteiz, Spain, 29 July - 02 August 2014. Wageningen, The Netherlands: Wageningen Academic Publishers, 2014, p. 277. [Poster presentation]
29. Teixeira, D. S. Harley, A. Hanlon, N. O'Connell, S. More and L. Boyle 2014. Severity, prevalence, risk factors and economic implications of tail lesions in slaughter pigs.

In: Agricultural Research Forum, Tullamore Court Hotel, Ireland, 10 March 2014, p. 23. [Oral presentation]

## 2013

30. Harley, S., L. Boyle, N. O'Connell, S. More, T.A., Clegg, D. Teixeira, P. Whyte and A. Hanlon. 2013. Evaluating the potential of abattoir meat inspection as an animal welfare surveillance tool. In: Universities Federation for Animal Welfare (UFAW) International Animal Welfare Science Symposium, Barcelona, Spain, 4 - 5 July 2013, p. 56. [Poster presentation]
31. Boyle, L., S. Harley, N. O'Connell, S. More, T.A., Clegg, P. Whyte, D. Teixeira and A. Hanlon. 2013. Incorporation of welfare lesions in slaughter pigs to the meat inspection process. The 15th International Conference on Production Diseases in Farm Animals (ICPD), Uppsala, Sweden, 24 - 28 June 2013, p. 134. [Poster presentation]

### (iii) *National Report*

Doyle, B., Gibbons, J., Hanlon, A., O'Connell, N. and Boyle, L.A. 2016. The development of ante mortem and post mortem meat inspection as a diagnostic tool for pig health and welfare. End of Project Report launched to industry on 28 April 2016 at Horse and Jockey, Co. Tipperary. Teagasc Pig Development Department. 26p.

### (iv) *Workshops/seminars at which results were presented*

1. Boyle, L., E. Garcia Manzanilla, A. Diana, J. Calderón Díaz, N. van Staaveren, D. Lemos Teixeira, B. Doyle, G. Carroll, N. O'Connell, N. Leonard and A. Hanlon. 2016. New insights into the complex relationship between pig behaviour and welfare and pig health. Pig Research Dissemination Day, 27 April 2016 Cavan Crystal Hotel, Cavan and 28 April 2016 Horse & Jockey Hotel, Ireland. [Oral presentation]
2. Doyle, B., J. Gibbons, N. van Staaveren, G. Carroll, N.E. O Connell, A. Hanlon, and L. Boyle. 2016. PIGWELFIND in Practice: Recording and reporting meat inspection outcomes to improve pig welfare, health and performance. Pig Research Dissemination Day, 27 April 2016 Cavan Crystal Hotel, Cavan and 28 April 2016 Horse & Jockey Hotel, Ireland. [Oral presentation]
3. van Staaveren, N., B. Doyle, A. Hanlon and L. Boyle. 2016. Environmental enrichment, abnormal behaviour and welfare lesions on Irish pig farms. Pig Research Dissemination Day, 27 April 2016 Cavan Crystal Hotel, Cavan and 28 April 2016 Horse & Jockey Hotel, Ireland. [Poster presentation]
4. Boyle, L.A. 2015. Pigwelfind Stakeholder Workshop. Nova Centre, UCD, Belfield, Dublin 4. 26<sup>th</sup> November 2015.
5. Boyle, L. 2015. Development of ante and post mortem meat inspection of pigs as a welfare diagnostic tool (PIGWELFIND). Research Update. Teagasc Pig Research Dissemination Day, 12 May 2015 Teagasc, Moorepark, Fermoy and 15 May 2015 Cavan Crystal Hotel, Cavan, Ireland, p. 11. [Oral presentation]

6. Boyle, L.A. 2014. Improving welfare to reduce behavioural vices in finishers and sows. VI FeetFirst® Spain Swine Seminar. Barcelona, Spain 27th and 28th March 2014.
7. Boyle, L., D. Teixeira, C. Devitt, A. Hanlon, N. O'Connell and M. Hawe. 2014. Perspectives of stakeholders in the pig industry on the potential use of ante and post mortem meat inspection as a pig welfare diagnostic tool. Annual Pig Farmers Conference, 21 October 2014 Horse & Jockey Hotel and 22 October 2014 Cavan Crystal Hotel, Ireland, p. 37. [Oral presentation]
8. Teixeira, D., N. van Staaveren, and L. Boyle. 2014. Carcass skin lesions in boars reflect their aggressiveness on farm. In: Agricultural Research Forum, Tullamore Court Hotel, Ireland, 10 March 2014, p. 19. [Oral presentation]
9. Teixeira, D. and L. Boyle. 2013. Development of ante and post mortem meat inspection of pigs as a welfare diagnostic tool (PIGWELFIND). Research Update. Annual Pig Farmers Conference, 22 October 2013 Cavan Crystal Hotel and 23 October 2013 Horse & Jockey Hotel, Ireland, p. 10. [Oral presentation]
10. Hanlon, A. and Boyle, L. 2013. Training session for DAFM veterinary inspectors at CVRL Backweston. Presentation: Good animal welfare makes economic sense: potential of pig abattoir meat inspection as a welfare diagnostic tool 27-May-13.
11. Boyle, L., Hanlon, A. and Teixeira, D. 2013. Training session for DAFM veterinary inspectors at CVRL Backweston. Presentation: Good animal welfare makes economic sense: potential of pig abattoir meat inspection as a welfare diagnostic tool 28-May-13.

- (v) *Intellectual Property applications/licences/patents*  
N/A  
(vi) *Other* N/A

## 5. Scientists trained by Project

Total Number of PhD theses: 2

Nienke van Staaveren, University College Dublin  
Title: 'Validation of Tail Lesions on the Carcass as Indicators of Pig Welfare on Farm'; November 2016

Grace Carroll, Queens University Belfast  
Title: "Exploring the potential of pre- and post-mortem assessments for use as welfare diagnostic tools in pigs" Due to be submitted May 1<sup>st</sup> 2017

Total Number of Masters theses: 0\*

\*The first PhD above was originally supposed to be conducting a Masters thesis. However additional funding was secured from the Teagasc Walsh Fellowship fund for an additional two years of funding to extend the research to a PhD.

## 6. Permanent Researchers

| Institution Name | Number of Permanent staff contributing to project | Total Time contribution (person years) |
|------------------|---|--|
| Teagasc          | 2   | 1.06                                   |
| UCD              | 2   | 0.55                                   |
| QUB              | 1   | 0.30                                   |
| CAFRE            | 1   | 0.05                                   |
| <b>Total</b>     | <b>6</b>  | <b>1.96</b>                            |

## 7. Researchers Funded by DAFM

| Type of Researcher              | Number   | Total Time contribution (person years) |
|---------------------------------|----------|--|
| <i>Post Doctorates/Contract</i> |          |  |
| Researchers                     | 2        | 3.10                                   |
| PhD students                    | 1        | 3.00                                   |
| Masters students                | 1        | 2.01*                                  |
| Temporary researchers           | 0        |  |
| Other                           | 0        |  |
| <b>Total</b>                    | <b>4</b> | <b>8.11</b>                            |

\*Funding for a 2 year Masters came from PIGWELFIND but this funding was 'topped up' by a Teagasc Walsh Fellowship to fund a PhD for a total of 3.5yrs

## 8. Involvement in Agri Food Graduate Development Programme

| Name of Postgraduate / contract researcher | Names and Dates of modules attended |
|--|-------------------------------------|
|--|-------------------------------------|

N.A

## 9. Project Expenditure

|   |           |
|---|-----------|
| Total expenditure of the project:   | € 360,938 |
| Total Award by DAFM:  | € 376,658 |
| Other sources of funding including benefit in kind and/or cash contribution(specify): | € 0       |

### Breakdown of Total Expenditure

| Category               | Teagasc           | UCD              | QUB              | CAFRE    | Total             |
|------------------------|-------------------|------------------|------------------|----------|-------------------|
| Contract staff         | 131,502.92        | 0                | 0                | 0        | 131,502.92        |
| Temporary staff        |                   |                  |                  |          |                   |
| Post doctorates        |                   |                  |                  |          |                   |
| Post graduates         | 0                 | 44,287.10        | 66,000           | 0        | 110,287.10        |
| Consumables            | 327.73            | 0                | 1,009.53         | 0        | 1,337.26          |
| Travel and subsistence | 14,976.55         | 415.16           | 4,476.55         | 0        | 19,868.26         |
| Sub total              | 146,807.2         | 44,702           | 71,486           | 0        | 262,995           |
| Durable equipment      | 1,069.16          | 0                | 654.64           | 0        | 1,723.80          |
| Other                  | 3,719.53          | 13,600.50        | 0                | 0        | 17,320.03         |
| Overheads              | 44,042.16         | 13,410.68        | 21,445.82        | 0        | 78,898.66         |
| <b>Total</b>           | <b>195,638.05</b> | <b>71,713.44</b> | <b>93,586.54</b> | <b>0</b> | <b>360,938.03</b> |

## 10. Leveraging

*Summarise any additional resources'/funding leveraged by this award from other sources e.g. Additional Staff, National/EU funding secured, EI Commercialisation Fund, etc.*

An additional 18 months of funding was leveraged from the Teagasc Walsh Fellowship fund to convert the DAFM funded Masters to a PhD.

The project resulted in an award of c. €100k from Teagasc (internal grant in aid funding) to conduct follow on research in this area (January 2017).

## 11. Future Strategies

*Outline development plans for the results of the research.*

As outlined above the PIGWELFIND project provided the platform for the development of the meat inspection process in Irish pig slaughterhouses to be standardised and computerised under a new Teagasc project:

Precision Livestock Farming strategies to improve pig health, welfare and carcass quality (PLFpigCarc)

The potential benefits of this are enormous both to the producer in terms of improved pig health and reduced cost of sub clinical diseases and carcass condemnation but also to the processor in terms of higher pork value and reduced disposal costs. This project commenced in January 2017 and will run for 4 years during which time considerable focus will be placed on providing feedback to the pig producers, developing intervention plans based on the information they are receiving and conducting a comprehensive cost benefit analysis of the new system for the pig industry.