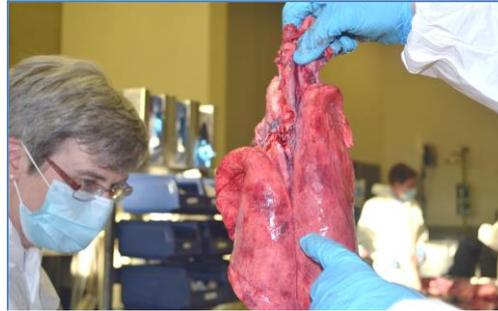**Project number:** 6747

Funding source: DAFM

Date: Nov- 2019

Project dates: Dec 2014 – May 2019

Investigation of respiratory disease in pigs, associated risk factors, and the relationship with performance, welfare and antimicrobial use

Key external stakeholders:

Pig producers, Teagasc pig advisors, private veterinary practitioners, agricultural consultants, pig breeding companies, feed industry personnel and associations, pharmaceutical companies and DAFM

Practical implications for stakeholders:

1. Respiratory disease is more important cause of disease and antibiotic use in Ireland than in other countries, perhaps related to our mild, damp weather
2. The amount of disease in lungs recorded at slaughter was lower than recorded in other countries but blood tests confirmed the widespread presence of the 4 major pathogens in most herds tested.
3. Biosecurity data from questionnaires showed that although external biosecurity is good on Irish farms, internal biosecurity is poor and means easy transmission of infection and disease within farms
4. There are substantial effects of respiratory disease on feed costs, average daily gain, time to slaughter and kilogrammes of meat produced.
5. Productive performance of pigs was more affected by respiratory disease than by the effects of biosecurity and feeding practices
6. Improvements to biosecurity and management offer more hope of reducing the economic and welfare burden of respiratory disease then the use of antimicrobials or vaccines

Main results:

- The overall internal biosecurity score for participating farms was 57/100. This score confirms that it is the internal biosecurity practices that are the main issues limiting Irish farm performance.
- Poor management practices play a significant and more important role than antimicrobials in the disease burden and associated poor performance of pigs on commercial farms
- Vaccination practices, serological prevalence of respiratory pathogens and lung lesions at slaughter explained 26% and 20% of the on-farm variability in weaner and finisher mortality respectively
- More than 30,000 lungs were examined at slaughter and over 15,000 laboratory diagnostic tests were completed. These data allowed a comprehensive assessment of the role of the 4 major pathogens in the porcine respiratory disease complex in Irish pig production.
- Disease in lungs recorded at slaughter was lower than recorded in other countries but blood tests confirmed the widespread presence of the 4 major pathogens in most herds tested.
- Intensive longitudinal studies provided comprehensive data on patterns of respiratory disease with information on the disease agents and on disease effects on production, health and welfare
- In addition to optimisation and application of a number of laboratory tests, a novel protocol was developed for testing oral fluids which enabled detection of both bacterial and viral pathogens.
- Data on hospitalised pigs collected from one intensively monitored herd has provided Irish information on welfare lesions and disease levels in these pigs for the first time.
- Results of an economic model showed the substantial effects of respiratory disease on feed costs, average daily gain, time to slaughter and kilogrammes of meat produced.

Opportunity / Benefit:

More than 30k lungs were examined at slaughter and over 15k laboratory diagnostic tests were completed. These data allowed a comprehensive assessment of the role of the 4 major pathogens in the porcine respiratory disease complex in Irish pig production. Intensive longitudinal studies undertaken on 9 farms provided comprehensive data on patterns of respiratory disease together with information on the disease agents and on disease effects on production, health and welfare. In addition to optimisation and application

1

| Contact | Dr. Laura Boyle | Email: laura.boyle@teagasc.ie |

of a number of laboratory tests, a novel protocol was developed for testing oral fluids which proved successful in enabling efficient detection of both bacterial and viral pathogens. An economic model for assessment of the effects of lung disease and exposure to respiratory pathogens was developed and validated during the project. The model can be used to estimate loss in profit associated with disease; for example, the presence of high levels of pleurisy at slaughter can reduce profit by €3.60 per pig.

Project team:	Dr. Laura Boyle
	Dr. Edgar Garcia Manzanilla
	Dr. Julia Calderon Diaz
	Dr. Maria Rodrigues da Costa
Collaborators:	Dr. Nola Leonard, UCD (PI)
	Dr. Lorna O'Brien, UCD
	Dr. Helen O'Shea, CIT
	Ms. Rose Fitzgerald, CIT
	Dr. Maire McElroy, CVRL
	Dr. John Moriarty, CVRL

1. Project background:

Respiratory disease is among the most significant infectious conditions contributing to production losses in the pig industry. There is little published on disease types, morbidity, mortality and their significance for commercial pig units in Ireland despite high levels of antimicrobial drug usage (Gibbons, 2011; Healy, 2013), the need to improve productive efficiency (SSAPRI report), and for livestock producers to operate at the highest standards of animal health and welfare (Food Harvest 2020). In addition, improving animal health surveillance and the identification of simple and reliable indicators of animal health are priorities in the current EU agenda on animal health (Sanchez-Vazquez et al., 2011). The main objective of this project was to investigate respiratory disease in Irish pig herds, including identification of risk factors, new diagnostic requirements, relationships with other health and welfare issues and assessment of the cost-benefit of control measures.

2. Questions addressed by the project:

- What are the infectious diseases of primary importance to the Irish pig industry, their effects on growing-finishing efficiency and assessment of associated risk factors?
- What is the prevalence and aetiology of pleurisy and bronchopneumonia in Irish slaughter pigs and effects on carcass quality and farm profitability?
- What are the pathology and pathogens associated with respiratory disease in commercial pig herds (prospective longitudinal study)?
- Can we develop cost efficient diagnostic tools for the management of respiratory disease in Irish pigs and identify novel pathogens or strains that may be present?
- What tail-lesion and other external welfare-related lesions are pigs that die affected by?
- What is the financial cost of disease and welfare problems on Irish pig farms and what are the current treatment and preventive measures?

3.   The experimental studies:

- **Identification of infectious diseases of primary importance to the Irish pig industry, effects on grow-finish efficiency and assessment of associated risk factors:** The biosecurity questionnaire based on the BIOCHECK.UGENT® protocol was completed for 72 farms. While completing this additional data were collected (feeding/vaccination, antibiotic usage and genetics).
- **Causes and prevalence of pleurisy and pneumonia in Irish slaughter pigs, associated risk factors and effect on carcass quality:** A multiplex RT-PCR assay for the detection of four respiratory pathogens, Actinobacillus pleuropneumoniae (APP), Mycoplasma hyopneumoniae (MHyo) and Haemophilus parasuis from tissue was developed and optimized at DAFM laboratories using field isolates collected during this project. The method was validated by testing 968 tissue samples which were collected at the abattoir during previous tasks. Examination was completed of 30,808 lungs in 199 batches from 69 farrow-to-finish farms in 9 slaughterhouses (2 in NI); 24,358 of these lungs were examined during reporting period 4. A total of 465 lung samples were collected from 48 farms. These tissue samples were processed for bacterial culture, molecular analysis and histology. Additionally, eleven tissue samples were collected from hearts where pericarditis was observed. These tissue samples were also processed for bacterial culture, molecular analysis and histology.
- **Prospective longitudinal study to investigate pathology and pathogens associated with respiratory disease in commercial Irish pig herds:** On 9 farms 40 pigs were selected at birth and followed through the production stages until slaughter. Information on sow parity, gender and weaning age was recorded for each pig. Starting 1wk after weaning, blood, saliva and faecal samples were

collected every 4wks. Blood samples were tested for APP, Mhyo, porcine reproductive and respiratory syndrome virus (PRRSv) and swine influenza virus (SIV) using ELISA kits. Lungs were scored for lesions and sampled in the abattoir. Farm management practices were recorded using a standardized questionnaire. Measures on environmental control, coughing and sneezing were taken for each farm.

- **To develop cost efficient diagnostic tools for the management of respiratory disease in Irish pigs in Ireland and to identify novel pathogens or strains that may be present:** The same farms as in previous tasks were used. 10,698 serum aliquots, from 2,451 unique pigs, originating from 68 individual farm/slap nos. were anonymously recorded. Serological analysis of both blood and oral fluids, PCR techniques were utilised to validate the presence of the pathogens, and to facilitate sequence analysis and phylogenetic studies, with the ELISA results being used as a comparison/confirmatory tool. The serological analysis was used to identify herds with the pathogens of interest. The relationship between serological results and pathogen detection using molecular techniques was investigated to assist with the development of cost efficient diagnostic tools.

- **Tail lesions and other external welfare-related lesions in pigs that die on Irish farms:** Detailed welfare inspection (59 scores), was performed by a single observer at the time of euthanasia. Necropsies were carried out by a pathologist within 24h and major gross pathologies were classified.

- **Cost-benefit analysis:** Date from the previous tasks were used to quantify the effects of positive (+) status for PRRSv, SIV and Mycoplasma hyopneumoniae (MHYO) on the profitability of farrow-to-finish pig farms and to examine the financial impact of vaccination status in SIV positive farms. In the analysis, farms (-) for either PRRSv, SIV or MHYO were assumed as baseline farms when presenting results for farms (+) for each pathogen. While all PRRSv and MHYO(+) farms used vaccination; not all SIV(+) farms vaccinated against the disease. Thus, to simulate the effect of vaccination for SIV on farm profitability, vaccinated [vacSIV(+)] and unvaccinated [unvacSIV(+)] farms were compared to SIV(-) farms. For all scenarios, a 775 sow farrow-to-finish pig farm was simulated. Risk analysis was conducted by Monte Carlo simulation using the Microsoft Excel add-on @Risk. Mortality rates, feed ingredients costs and price per kg of meat produced were included as stochastic variables.

4. Main results:

- **Identification of infectious diseases of primary importance to the Irish pig industry, their effects on growing-finishing efficiency and assessment of associated risk factors:** External biosecurity was good on farms but internal biosecurity practices could be greatly improved. A large number of different risk factors were identified. Better biosecurity practices were associated with better production outcomes including increased average daily gain and reduced mortality in some production stages.

- **Causes and prevalence of pleurisy and pneumonia in Irish slaughter pigs, their associated risk factors and effect on carcass quality:** Data regarding vaccination, serology and slaughter checks are able to explain large proportions of the variability of ADFI, ADG and age at slaughter. Serology and lesion scores at slaughter are useful tools to understand the impact of the farm health status on production performance. Av. figures for pleurisy and pneumonia scores of lungs are among the lowest published in the literature but prevalence of milk spots in the liver was much higher.

- **Prospective longitudinal study to investigate pathology and pathogens associated with respiratory disease in commercial Irish pig herds:** Serological results for the 4 major pig respiratory pathogens across all 9 farms were assimilated indicating notable differences between farms and between the occurrence and prevalence of bacterial and viral pathogens investigated. In general, the serological prevalence of APP was high at all time points whereas the prevalence of PRRSv was low initially on the 6 positive farms with prevalence increasing at time points 3 and 4. A consistent pattern across farms was not observed for the other pathogens.

- **To develop cost efficient diagnostic tools for the management of respiratory disease in Irish pigs in Ireland and to identify novel pathogens or strains that may be present:** A novel protocol was developed for nucleic acid extraction from oral fluids which proved successful in enabling efficient detection of bacterial and viral pathogens. The results were comparable or better than those obtained using individual nasal swabs. Thus, this method of sample collection and analysis offers a fast, welfare-friendly and cost-effective method for detection of pathogens at pen level. Lab. diagnostic techniques for molecular detection of respiratory pathogens in nasal swabs, oral fluids and serum were optimized. Phylogenetic analysis of PRRSv circulating in Ireland confirmed that only subtype 1 is prevalent although there is genetic variability in other strains. This has implications for vaccination policies.

- **Tail lesions and other external welfare-related lesions in pigs that die on Irish farms:** Using data from euthanized pigs, ear, body and tail lesions were present in 54.8%, 53.2% and 50% of pigs, respectively while poor body condition was recorded in 35.5% of pigs. Ear necrosis, umbilical hernias, navel infections and scouring, were observed in 11.3%, 9.7%, 4.8% and 4.8% of pigs, respectively. Respiratory (58.1%), dermal (37.1%), gastrointestinal (30.6%) and cardiac (19.4%) were the most common lesions. Hospitalised pigs were lighter than those retained in the home pen but there was no

difference between the two groups in the prevalence of disease lesions. This suggests that all sick pigs may not have been removed from their own pen on this farm, which is a welfare concern.

- **Cost-benefit analysis:** High levels of pleurisy and lung scarring increased feed costs and time to slaughter. Profits per pig were reduced by €3.60 and €3.10 respectively on affected farms when compared to farms with low levels of pleurisy and scarring. Farms with pigs which were exposed to respiratory pathogens had reduced profits as average daily gain, no. finishers sold and kg of meat produced were less than farms which were negative for pathogens:
  - Farms + for M. hyo lost €5 per pig compared to MHyo (-) farms
  - Farms + for PRRSv lost €3.65 per pig
  - Farms + for SIV but vaccinating for it lost €4.60 per pig
  - Farms + for SIV but not vaccinating lost €1.40 per pig

Smaller losses on the SIV(+) farms which were not vaccinating shows they had higher biosecurity scores, reflecting better overall disease status. Similarly, unvacSIV(+) were stochastically dominant over vacSIV(+) suggesting that they mitigate adverse effects by other means.

5. Opportunity/Benefit:

The success of the Biocheck.UGentTM employed in this project led to AHI offering completion of the questionnaire to all pig farmers through their PVPs under a TASAH scheme. The scheme piloted in this project and to be rolled out under AHI, whereby farmers will receive comprehensive benchmarking for their farms, will be of great benefit to the industry. A multiplex RT-PCR assay for the detection of APP, MHyo and Haemophilus parasuis from tissue was developed and optimized at DAFM laboratories using field isolates collected during this project. This test is now available to DAFM veterinarians.

6. Dissemination:

- International Conference on Production Diseases in Farm Animals (2016, 2019)
- European Symposium of Porcine Health Management, Utrecht (2016, 2017, 2018, 2019)
- European Federation of Animal Science (2016, 2018)
- British Society of Animal Science Annual Conference (2017)
- 51st Annual meeting of the Association of Veterinary Teaching and Research Work (2017)
- International Pig Veterinary Society (IPVS) (2016, 2019)
- 18th International Congress on Animal Hygiene (ISAH) (2017
- Teagasc Pig Farmers' Research Dissemination Days (2015, 2016, 2017, 2018, 2019)
- Teagasc Pig Farmers' Conferences (2013, 2014)
- Teagasc Farmer Discussion Groups (2016, 2017, 2018)
- End of Project Dissemination Day (June 2019)

Main publications here

1. Diana, A., Boyle, L.A., Manzanilla, E.G., Leonard, F.C., Calderón Díaz, J. A. 2019. When 'All-In/All-Out' is not 'All-In/All-Out': implications for pig welfare and performance. Porcine Health Management 5, 19. https://doi.org/10.1186/s40813-019-0126-9
2. Rodrigues da Costa, M., Gasa Gasó, J., Calderón Díaz, J.A., Postma, M., Dewulf, J., McCutcheon, G., Garcia Manzanilla, E. 2019. Using the Biocheck.UGentTM scoring tool in Irish farrow-to-finish pig farms: assessing biosecurity and its relation to productive performance. Porcine Health Management. 5, 4. DOI 10.1186/s40813-018-0113-6
3. Calderón Díaz, J. A., Manzanilla, E.G., Diana, A., Boyle, L. 2018. Cross-fostering implication for pig mortality, welfare and performance. Frontiers in Veterinary Science – Animal Behaviour and Welfare section. 5:123. doi: 10.3389/fvets.2018.00123.

Popular publications:

1. Rodrigues da Costa, M., Manzanilla, E. G., Leonard, F. 2019. Respiratory disease monitoring to improve pig efficiency. TResearch Volume 14: Number 1. Spring 2019. p 18-19.
2. Manzanilla, E.G. 2016. Utilización de crotales para comprobar la bioseguridad interna [in Spanish]. Available online at https://www.3tres3.com/trucos/utilizacion-de-crotales-para-comprobar-la-bioseguridad-interna_36907/
3. Calderón Díaz, J.A., Boyle, L., Manzanilla, E.G. 2016. Effects of birth weight, parity and litter size on pig performance, health and welfare. https://www.pig333.com/what_the_experts_say/effects-of-birth-weight-parity-and-litter-size-on-pig-performance-he_11619/

7. Compiled by: **Dr. Laura Boyle,**