



**An Roinn Talmhaíochta,
Bia agus Mara**
Department of Agriculture,
Food and the Marine

Research Stimulus Fund

Final Report

'Optimising annual output per sow by increasing the number of viable piglets born alive and minimising pre-weaning piglet mortality (OPTIPIG)'

DAFM Project Reference No: 13/S/428

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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	6 X	7

Please specify priority area(s) of research this project relates to from the National Prioritisation Research Exercise* (NRPE) report;

Priority Area (s)	Sustainable Food Production and Processing
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Key words: Sow nutrition, large litters, nurse sow, artificial rearing, energy supplement, piglet welfare

1. Rationale for Undertaking the Research

Sow output in Ireland is below that in more efficient pig producing countries. If an Irish 500 sow unit could increase output to that achieved in The Netherlands (26.5 pigs/sow/year), net profit p.a. would increase by €35,650. This would further stimulate growth of the national herd. Welfare and ethical concerns mean that genetic selection for hyper-prolificacy has received negative publicity in Denmark, where large litters of light, marginally viable pigs are associated with increased mortality. Hence, increases in sow output in Ireland should be achieved in a more sustainable manner. The objective of this project was to increase sow output by: 1. Improving sow nutrition (feed allowance, L-carnitine, L-arginine, fish oil, vitamin D supplementation, fermentable substrates) to maximise the sows' genetic potential for large litters, while also increasing the viability of the additional pigs born; 2. Improving colostrum quality to reduce piglet mortality; 3. Implementing pre-weaning interventions (nurse sows, rescue decks and energy supplementation) to keep weak piglets alive. Archived databases from sow nutrition studies were mined and animal experiments conducted. Best practice guidelines for optimisation of sow output were prepared and results disseminated effectively to enable prompt adoption by stakeholders with the aim of realising Harvest 2020 targets.

2. Research Approach

The overall objective of this project was to sustainably increase the number of pigs produced/sow/year to levels achieved in the most efficient pig producing countries, by using nutritional and management strategies.

Association analysis of sow parity, live-weight and back-fat depth as indicators of sow productivity: The objective of this study was to quantify the association between sow parity, live-weight and back-fat depth during gestation with subsequent sow reproductive performance. Records of 1058 sows and 13 827 piglets from 10 trials on two research farms between the years 2005 and 2015 were analysed. Variables that were analysed included total born (TB), born alive (BA), piglet birth weight (BtWT), pre-weaning mortality (PWM), piglet wean weight (WnWT), number of piglets weaned (Wn), wean to service interval (WSI), piglets born alive in subsequent farrowing, and sow lactation feed intake.

L-carnitine (CAR) and Sugar beet Pulp (SBP) supplementation of gilts: This study evaluated the effects of CAR and SBP inclusion in gilt gestation diets on gilt live-weight, cortisol concentration, lactation feed intake, and lifetime growth of progeny. Eighty-four pregnant gilts were randomly assigned to treatment at day 38 of gestation until parturition; Control (0% SBP, 0g CAR), CAR (0.125 g/d CAR), SBP (40% SBP), and SBP plus CAR (40% SBP, 0.125 g/d CAR).

CAR supplementation of multiparous sows: This study aimed to investigate the effect of L-carnitine (CAR) supplementation to sows during gestation and lactation on sow performance, semitendinosus muscle (STM) maturity, and lifetime growth in progeny. Sows (N = 64) were randomly assigned to treatment on d1 of gestation until weaning; CONTROL

(0mg CAR), GEST (125mg/d CAR during gestation), LACT (250mg/d CAR during lactation), and BOTH (125mg/d CAR during gestation & 250mg/d CAR during lactation).

Increasing dietary energy density for sows during lactation: The objective of this study was to investigate the effect of increasing dietary energy density for lactating sows on weight and back-fat changes in sows, milk composition, piglet vitality, and growth of progeny. Gestating sows (N = 100; Large White x Landrace) were randomly assigned to one of four energy dense diets at d108 of gestation until service; 13.8 (LL), 14.5 (L), 15.2 (H), and 15.9 MJ DE/kg (HH).

Dietary oil type and energy intake in lactating sows: This study investigated the effect of salmon oil in lactating sow diets and offering lactation diets in a phased dietary regimen to increase the energy density of the diet in late lactation. Sow and piglet productivity to weaning, were the main parameters measured. Multiparous sows (n = 100) (LR x LW) were offered dietary treatments from day 105 of gestation until weaning. Dietary treatments (2 x 2 factorial) included oil type (soya or salmon oil) and dietary regimen (Flat 14.5 MJ DE/kg diet offered until weaning or Phased 14.5 MJ DE/kg diet offered to day 14 of lactation then a second diet containing 15.5 MJ DE/kg offered from day 15 until weaning).

The effect of nurse sow strategies on sow and piglet performance and welfare: Two different nurse sow strategies were compared: sows which were either 7 or 21 days into lactation had their own piglets removed, and were assigned day old piglets. Piglets from sows 7 days into lactation were moved onto another sow 21 days into lactation. We also compared the effects of leaving litters intact on their mothers, or cross fostering other piglets into the group. The behaviour and weights of sows and piglets were monitored throughout lactation, as well as stress hormone levels in sows.

The effect of artificial rearing in the milk feeding period on piglet performance and welfare: Seven day old piglets were removed from their mother, and placed in an artificial rearing area (Rescue Deck®). The growth and behaviour of these piglets was monitored until slaughter, and compared to similar aged piglets which remained with their mother.

Use of energy supplementation to improve piglet vitality and survival: At 3 hours post-partum, piglets weighing less than 1.1kg were either 1: dosed with 2ml of coconut oil, 2: 2ml of a commercial energy supplement, 3: 2 ml of water, or 4: sham dosed. Their survival, growth, temperature, and glucose levels were monitored in detail over the first 24h of life, as well as weight and survival to weaning.

3. Research Achievements/Results

Association analysis of sow parity, live-weight and back-fat depth as indicators of sow productivity: Heavier sow live-weight throughout gestation was associated with an increase in PWM and reduced Wn and lactation feed intake. Deeper back-fat depth in late gestation was associated with fewer BA but heavier BtWT, whereas deeper back-fat depth throughout gestation was associated with reduced lactation feed intake. This study

showed that sow parity, live-weight and back-fat depth can be used as indicators of reproductive performance.

CAR and SBP supplementation of gilts: Fed separately to gilts, CAR increased the live weight, carcass weight, and muscle depth of progeny at slaughter. Feeding a SBP diet increased faecal consistency in gilts pre-farrowing and increased live weight and carcass muscle depth of progeny.

CAR supplementation of multiparous sows: CAR supplementation during gestation increased litter size at birth without compromising piglet birth-weight. Results also showed that the muscle of piglets born to sows supplemented with CAR during gestation was more mature at birth. However, carcass weight at slaughter was reduced in progeny of sows fed CAR.

Increasing dietary energy density for sows during lactation: Increasing the energy density of lactation diets increased energy intake in sows, without depressing appetite and prevented the excessive mobilisation of maternal body reserves. Feeding a 15.9 MJ DE/kg diet improved piglet muscle tone at birth, whereas feeding a 15.2 MJ DE/kg diet increased litter size at weaning. Inconsistent results were observed for other traits of piglet vitality and for pre-weaning litter growth.

Dietary oil type and energy intake in lactating sows: Substituting soya oil with salmon oil in lactation diets improved sow milk yield and litter gain during the suckling period. Additionally, salmon oil tended to reduce pre-weaning mortality, and therefore its use in lactation diets should be further investigated. A phased dietary energy regimen increased sow lactation energy intake, but sow body condition and piglet growth performance to weaning were not improved.

The effect of nurse sow strategies on sow and piglet performance and welfare: No difference was detected between nurse sows and non-nurse sows in body condition or severity of lesions. Although some nurse sows experienced stress at fostering, no long-term effect of the nurse sow strategies was detected on stress levels compared with sows that raised their own litter. The strategies did not appear to compromise piglet growth. However, new-born piglets transferred onto 21 days lactation sows experienced more competition at the udder. Thus, transferring piglets onto a sow 7 days into lactation is likely the best option as it minimises the difference between piglet age and sow stage of lactation. Cross fostering had a significant negative impact on piglet growth, especially when heavier pigs were fostered.

The effect of artificial rearing in the milk feeding period on piglet performance and welfare: Artificial rearing (AR) had a negative effect on growth to weaning compared to sow reared piglets, and they also performed more harmful behaviours and were dirtier. Qualitative behaviour assessment also showed a more negative emotional state in AR piglets. Thus AR from 7 days of age should not be recommended as routine practice.

Use of energy supplementation to improve piglet vitality and survival: There was no overall effect of treatment on any of the parameters measured; a single oral dose of fat-based energy supplement at birth did not improve growth, survival, rectal temperature or vitality of low birth weight piglets.

In line with project objectives the two main goals of OPTIPIG were to:

- 1. To increase the number of pigs born alive per litter by 1.3 to increase and to increase the average Irish litter size to 13.6.*
- 2. To improve the survival of live-born piglets, thereby maintaining mortality close to the current Irish industry average of 15.9 per cent.*

During the lifetime of OPTIPIG it is evident that adoption of the results from the project helped Irish pig producers to achieve these goals. From e-Profit Monitor results, it can be seen that average born alive was 13.7 piglets while total mortality was 16.4% on Irish pig farms in 2018 (Teagasc, 2018). The top 25% of herds achieved an average born alive of 14.2 piglets while total mortality was 13.6% in the same year on these farms.

4. Impact of the Research

This project was extremely timely and of great importance to the industry, from both a pig growth and animal welfare perspective, due to the ongoing and significant increases in litter size across the industry. Effective nutritional and management practices to increase sow productivity and piglet growth have been identified and when implemented at farm level will increase profitability. Additionally, established piglet management practices were identified which reduce piglet performance, and should be avoided.

4(a) Summary of Research Outcomes

- (i) Collaborative links developed during this research
Collaborative links were developed with three universities during the project, through supervision of the students:
 - a. Kathryn Reid and Hazel Rooney were supervised by Prof. John O'Doherty, UCD. Prof. O'Doherty is a world expert in pig nutrition and added value to the project through his advice re- experimental design and data analysis. Dr. Lawlor has subsequently developed the collaboration, and has successfully sourced further funding with him for future work.
 - b. Anna Lavery was supervised by Prof. Helen Miller from Leeds University. Prof Miller's research focuses on developing feeding systems which enhance animal health, performance, meat and egg quality of pigs and poultry in a sustainable manner. She provided valuable advice regarding the underlying physiology of pigs and expertise in selection of appropriate measurements.
 - c. Oceane Schmitt was supervised by Dr. Emma Baxter, of the Scottish Rural College, and Prof. Eddie Clutton of the University of Edinburgh. Dr. Baxter is a leading expert on piglet management. The collaboration has

led to the development of a link with Teagasc whereby we host visiting MSc students from University of Edinburgh for their research projects.

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

To date, carnitine has not been extensively researched in an applied pig production setting. Throughout the project we liaised with Lonza, a company which produces and markets a product called 'Carniking' for use in pet food. This was the source of carnitine for our experimental work.

(iii) Outcomes with economic potential

The most significant economic potential which could be realised from the project is the use of carnitine as a supplement for gestating sows and gilts, as it was demonstrated to increase piglet birthweight, and key indicators of performance in the carcass. We carried out a cost-benefit analysis of CAR supplementation to sows and gilts during gestation using the calculator from the Teagasc Pig Production Model. At the CAR inclusion rates used during gestation in our studies (125mg/d) and using the current cost of CAR (€15,000/tonne), the financial benefit at farm level from the additional carcass weight of pigs sold at slaughter is €0.59/pig, where gilts only in the herd are supplemented with CAR during gestation. The financial benefit of the increase in sow litter size at birth due to supplementing multiparous sows with CAR during gestation is €1.85/pig. Thus, supplementation of CAR to gestating gilts and sows will provide a financial benefit to the industry.

Another outcome with economic potential is our finding that cross-fostering of piglets, an activity which is widespread in pig production, has significant negative effects on piglet growth and weaning weight, and that this is worst for piglets which are born heavy. If producers can reduce this practice they are likely to have increased weaning weights, leading to increased subsequent animal performance.

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

The image of the Irish pig industry was enhanced as the project had a major focus on increasing sow output sustainably, such that piglet mortality was minimised and piglet health and welfare were maximised. The increase in employment, exports and profitability in the sector as a result of adopting the successful strategies identified in this project to increase sow output will be of benefit to the economy, particularly in rural areas. Likewise, the results have great potential to inform EU legislation in this area.

Cross-border collaboration between Teagasc and AFBI in OPTIPIG assimilated critical mass to tackle a major issue for the pig sector. Project findings not only add to the pool of scientific knowledge on sow output, but

also created recognised expertise which will assist in leveraging future EU funding.

The project had strong input from stakeholders through the Teagasc/IFA joint programme (0.75 of a RO's time was committed to the project by the joint programme) and proven dissemination routes were employed. Hence, we are confident that benefits from the project are being realised by the pig industry.

4 (b) Summary of Research Outputs

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

1. Rooney, H.B., O'Driscoll, K., O'Doherty, J.V. and Lawlor, P.G. 2019. Effect of incremental sow dietary energy density during late gestation and lactation on sow lactation performance, piglet vitality and lifetime growth of offspring. *Journal of Animal Science*. Accepted December 2019. <https://doi.org/10.1093/jas/skz379>
2. Lavery, A. Lawlor, P.G., Magowan, E., Miller, H.M. 2019. The effect of dietary oil type and energy intake in lactating sows on the fatty acid profile of colostrum and milk, and piglet growth to weaning. *Animals* 9(11) 1092; <https://doi.org/10.3390/ani9121092>
3. Schmitt, O., O'Driscoll, K., Baxter, E. and Boyle, L. 2019. Artificial rearing affects the emotional state and reactivity of pigs post-weaning. *Animal Welfare* 28(4):433-442. <https://doi.org/10.7120/09627286.28.4.433>
4. Rooney, H.B., O'Driscoll, K., O'Doherty, J.V. and Lawlor, P.G. 2019. Effects of L-carnitine supplementation and sugar beet pulp inclusion in gilt gestation diets on gilt live-weight, lactation feed intake and offspring growth from birth to slaughter. *Journal of Animal Science* 97(10):4208-4218 <https://doi.org/10.1093/jas/skz268>
5. Schmitt, O., Baxter, E., Lawlor, P., Boyle, L. and O'Driscoll, K. 2019. A single dose of energy supplement to light birth-weight pigs shortly after birth does not increase their survival and growth. *Animals*. 9:227 <https://doi.org/10.3390/ani9050227>
6. Schmitt, O., O'Driscoll, K., and Baxter, E. 2019. Exploratory study of the effects of Intra-Uterine-Growth-Retardation and neonatal energy supplementation of low birth-weight piglets on their post-weaning cognitive abilities. *Animal Cognition* 22:373-385 <https://doi.org/10.1007/s10071-019-01251-8>
7. Schmitt, O., Baxter, E., Boyle, L. and O'Driscoll, K. 2019. Nurse sow strategies in the domestic pig (*Sus Scrofa*): II. Consequences piglet growth, suckling behaviour, and sow nursing behaviour. *Animal*. 13:590-599 <https://doi.org/10.1017/S1751731118001702>
8. Schmitt, O., Baxter, E., Boyle, L. and O'Driscoll, K. 2019. Nurse sow strategies in the domestic pig (*Sus Scrofa*): I. Consequences for the selected measures of sow welfare. *Animal*. 13:580-589 <https://doi.org/10.1017/S175173111800160X>
9. Lavery, A. Lawlor, P.G., Magowan, E., Miller, H.M., O'Driscoll, K. and Berry, D.P. 2019. An association analysis of sow parity, live-weight and back-fat depth as indicators of sow productivity. *Animal*. 13:622-630 <https://doi.org/10.1017/S1751731118001799>
10. Schmitt, O., O'Driscoll, K., Boyle, L. and Baxter, E. 2019. Artificial rearing affects piglets pre-weaning behaviour, welfare and growth performance. *Applied Animal Behaviour Science*. 210:16-25.

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

1. O'Driscoll, K. and Schmitt, O. 2019. Use of infra-red thermography to non-invasively assess neonatal piglet temperature. Proceedings of the 9th European Conference on Precision Livestock Farming, 26-29 August, Cork, Ireland.
2. Rooney, H. B., O'Driscoll, K., O'Doherty, J.V. and Lawlor, P.G. 2019. The effect of incremental dietary energy density from 13.8 to 15.9 MJ DE/kg on piglet vitality and growth to weaning. Proceedings of the 2019 ASAS Midwest Section /ADSA Midwest Branch Joint meeting, 11-13 March 2019.
3. O'Driscoll, K., Reid, K. and Lawlor, L. 2018. Successful supplementation. TResearch, Vol. 13 no. 3, Autumn 2018
4. Rooney, H. B., O'Driscoll, K., O'Doherty, J.V. and Lawlor, P.G. 2018. Exploring the effect of dietary L-carnitine inclusion on the performance of hyper prolific sows. Proceedings of the 69th Annual Meeting of the European Federation of Animal Science, 2018.
5. Schmitt, O., O'Driscoll, K., Boyle, L. and Baxter, E. 2018. Intra-uterine growth retardation may influence spatial cognition of weaned pigs. Proceedings of the 50th meeting of the French Society for Study of the Behaviour of Animals, 19-21 June, 2018.
6. Schmitt, O., Boyle, L., Baxter, E., and O'Driscoll, K. Neonatal energy supplementation of low birth weight piglets does not enhance their health and survival. Proceedings of the BSAS Conference, 9-11 April, 2018
7. Rooney, H., O'Driscoll, K., O'Doherty, J. and Lawlor, P. Effect of sugar beet pulp and L-carnitine supplementation in gilt gestation diets on gilt weight and lactation feed intake and progeny growth. Proceedings of the BSAS Conference, 9-11 April, 2018
8. O'Driscoll, K., Boyle, L. and Schmitt, O. 2018. Piggy in the Middle. TResearch, Vol. 12 no.4, Winter 2017
9. Schmitt, O., O'Driscoll, K., Boyle, L.A., and Baxter, E.M. Pre-weaning environment affects pigs' emotional state. In: De Jong IC, Koene P, editors. Proceedings of the 7th International Conference on the Assessment of Animal Welfare at Farm and Group Level. Ede, The Netherlands: Wageningen Academic Publishers; 2017. p. 143.
10. Schmitt, O., Boyle, L., Baxter, E.M., and O'Driscoll, K. Pre-weaning environment affects pigs' emotional reactivity. In: Jensen MB, Herskin MS, Malmvist J, editors. Proceedings of the 51st Congress of the International Society for Applied Ethology. Aarhus, Denmark: Wageningen Academic Publishers; 2017. p. 196.
11. Schmitt, O. and O'Driscoll, K. 2017. Taking the milky way: the benefits of supplementary milk for piglets. Teagasc pig newsletter October 2017.
12. Schmitt, O. and O'Driscoll, K. 2017. Small and imperfectly formed - what is the outcome for very small piglets. Teagasc pig newsletter October 2017.
13. Schmitt, O., Boyle, L., O'Driscoll, K. and Baxter, E. 2017. Assessment of the emotional state of pigs reared artificially or by a sow. UFAW international Animal Welfare Science Symposium, Royal Holloway, University of London, Surrey, UK. 27 - 29 Jun, 2017
14. O'Driscoll, K. and Schmitt, O. 2016. Giving piglets the best start in life. Teagasc Pig Newsletter October 2016.
15. Schmitt, O., Baxter, E., Boyle, L and O'Driscoll, K. 2016. Nurse sow strategies: an effective way to rear super-numerous piglets. Proceedings of the 67th Annual Meeting of the European Federation of Animal Science, Belfast, NI, 29 August - 2 September 2016
16. Reid, K., O'Driscoll, K., Magowan, E., O'Doherty, J. and Lawlor, P. 2016. L-arginine and L-carnitine in gestating sow diets to optimise output and piglet growth. Proceedings of the 67th Annual Meeting of the European Federation of Animal Science, Belfast, NI, 29 August - 2 September 2016
17. Lavery, A., Lawlor, P., Miller, H.M.M., O'Driscoll, K., Berry, D.P. and Magowan, E. 2016. Digestible energy intake during gestation and associated sow reproductive performance

Proceedings of the 67th Annual Meeting of the European Federation of Animal Science, Belfast, NI, 29 August - 2 September 2016 p 446.

18. Schmitt, O., Baxter, E., Boyle, L and O'Driscoll, K. 2016. Nursing behaviour and teat order in pigs reared by their dam or nurse sow. Proceedings of the 50th International Congress of the International Society of Applied Ethology, Edinburgh, UK, 12 - 16 July 2016.
19. O'Driscoll, K. 2016. How to manage piglets from large litters: Should I stay or should I go now? Teagasc Pig Newsletter July 2016.
20. Schmitt, O., Baxter, E., Boyle, L. and O'Driscoll, K. 2015. A comparison of the evolution of teat fights during lactation in litters reared by biological or nurse sows. Proceedings of the UK/Ireland Regional meeting of the International Society for Applied Ethology, Moorepark, Fermoy, Ireland, 11 November 2015. p 28.
21. Lavery, A., Lawlor, P.G., Magowan, E., Miller, H.M, O'Driscoll, K and Berry, D.P. 2016. An association analysis of sow live-weight and back-fat depth as indicators of reproductive performance. In: *Advances in Animal Bioscience, Proceedings of the British Society of Animal Sciences*; 2016: 7(1) page 109.
22. Lavery, A., Magowan, E., Miller, H.M., Berry, D.P and Lawlor, P.G. 2017. Reproductive benefits and trade-offs with increasing sow live-weight and back-fat depth in late gestation. In: *Advances in Animal Bioscience, Proceedings of the British Society of Animal Sciences*; 2017: 8 (1) page 49
23. Lavery, A., Lawlor, P.G., Miller, H.M and Magowan, E. 2018. The effect of litter birth order on piglet birth weight and vitality measures. In: *Advances in Animal Bioscience, Proceedings of the British Society of Animal Sciences*; 2018: 9 (1) page 214
24. Lavery A., Miller, H.M., Lawlor. P.G and Magowan, E. 2018. Effect of dietary oil type and vitamin D3 level during gestation on sow and litter performance. In: *Advances in Animal Bioscience, Proceedings of the British Society of Animal Sciences*; 2018: 9 (1) page 191

(iii) National Report

1. Lawlor, P., O'Driscoll, K. and Boyle, L. 2019 Optimising annual output per sow by increasing the number of viable piglets. Teagasc Technology Update.
https://www.teagasc.ie/media/website/publications/2020/6595_OPTIPIG_AGRIP_Peadar_Lawlor.pdf

(iv) Workshops/seminars at which results were presented

1. Rooney, H.B., O'Driscoll, K., O'Doherty, J.V. and Lawlor, P. 2019. Optipig: Optimising annual sow output by increasing the number of viable piglets born alive and reducing pre-weaning mortality through nutritional management of the sow. Proceedings of the Teagasc Pig Development Department Research Dissemination Day 30 April - 1 May.
2. Rooney, H.B., O'Driscoll, K., O'Doherty, J.V. and Lawlor, P. 2018. Effect of sugar beet pulp and L-carnitine in gilt gestation diets on gilt weight, lactation feed intake and growth of progeny. Proceedings of the Teagasc Pig Development Department Research Dissemination Day 24-25 April.
3. Schmitt, O., Boyle, L., Lawlor, P.G. and O'Driscoll, K. 2018. Management strategies to optimise piglet survival. Proceedings of the Teagasc Pig Development Department Research Dissemination Day 24-25 April.
4. Schmitt, O., Boyle, L., O'Driscoll, K. and Baxter, E., 2017. Effects of artificial rearing on piglets' growth and emotional state. Proceedings of the Teagasc Pig Development Department Research Dissemination Day 29-31 May.

5. Rooney, H.B., O'Driscoll, K., O'Doherty, J.V. and Lawlor, P. 2017. Effect of fibre level and L-carnitine inclusion in the gestation diet on gilt and piglet performance. Proceedings of the Teagasc Pig Development Department Research Dissemination Day 29-31 May.
6. O'Driscoll, K., Reid, K., Rooney, H., Magowan, E., O'Doherty, J.V. and Lawlor, P.G. 2017. Nutritional strategies for the gestating sow: Results so far from the Optipig project. Proceedings of the Teagasc Pig Development Department Research Dissemination Day 29-31 May.
7. O'Driscoll, K., Reid, K., Magowan, E., O'Doherty, J.V. and Lawlor, P.G. 2017. Effect of K-arginine and L-carnitine in gestating sow diets on sow output and piglet growth. Workshop proceedings: Importance of nutrition and environment on birth weight, muscle growth, health and survival of the neonate. 4 - 5 May.
8. Rooney, H.B., O'Driscoll, K., O'Doherty, J.V. and Lawlor, P. 2017. Effect of dietary crude fibre level and L-carnitine inclusion during gestation on gilt and piglet performance. Workshop proceedings: Importance of nutrition and environment on birth weight, muscle growth, health and survival of the neonate. 4 - 5 May.
9. O. Schmitt, O'Driscoll, K., Baxter, E.M. and Boyle, L. 2017. Effect of management strategies for rearing supernumerary piglets on piglet survival and growth rates. Workshop proceedings: Importance of nutrition and environment on birth weight, muscle growth, health and survival of the neonate. 4 - 5 May.
10. O. Schmitt, O'Driscoll, K., Boyle, L., Baxter, E.M. and Lawlor, P. 2017. Effects of energy supplementation to low-birth weight neonatal piglets on their survival, growth and blood glucose level. Workshop proceedings: Importance of nutrition and environment on birth weight, muscle growth, health and survival of the neonate. 4 - 5 May.
11. O'Driscoll, K., Reid, K., Schmitt, O., Magowan, E., Berry, D., Boyle, L. and Lawlor, P. 2016. Home or away: The effect of cross-fostering on piglet growth (OPTIPIG). Proceedings of the Teagasc Pig Development Department Research Dissemination Day 27-28 April.
12. Schmitt, O., Baxter, E., Boyle, L., and O'Driscoll, K. 2016. Nurse sow strategies: an effective way to rear super-numerous piglets? Proceedings of the Teagasc Pig Development Department Research Dissemination Day 27-28 April.
13. Reid, K., O'Driscoll, K., Magowan, E., O'Doherty, J. and Lawlor P.G. 2016 Supplementing gestating sows with L-Arginine and L-Carnitine to optimise sow output and piglet growth. Proceedings of the Teagasc Pig Development Department Research Dissemination Day 27-28 April.
14. Lavery, A., Lawlor, P.G., Miller, H.M., O'Driscoll, K., Magowan, E. and Berry D.P. 2016. Digestible energy intake during gestation and associated sow reproductive performance. Proceedings of the Teagasc Pig Development Department Research Dissemination Day 27-28 April.
15. Reid, K., O'Driscoll, K., Magowan, E., O'Doherty, J. And Lawlor, P. 2015. Nutritional strategies to increase piglets born alive and minimise piglet mortality (OPTIPIG). Proceedings of the 2015 Pig Research Dissemination Day p.29.
16. Schmitt, O., Boyle, L. And O'Driscoll, K. 2015. The use of nurse sows to keep weak piglets alive (OPTIPIG). Proceedings of the 2015 Pig Research Dissemination Day p.31.
17. Reid, K., Boyle, L., Lefebvre, R., Lawlor, P.G., Stickland, N.C. and O'Driscoll, K. 2015. Effect of gestation feed intake on survival traits of piglets. Proceedings of the Agricultural Research Forum, Tullamore, Ireland, 10-11 March 2015.
18. O'Driscoll, K. and Lawlor, P. 2014. Benchmarking Irish sow performance based on average farm output. Proceedings of the 2014 Teagasc Pig Farmers Conference p.30-36.
19. O'Driscoll, K. and Lawlor, P. 2013. Optimising output per sow. Proceedings of the 2013 Teagasc Pig farmers conferences p.15-18.

(v) Intellectual Property applications/licences/patents
NA

(vi) Other
NA

5. Scientists trained by Project

Total Number of PhD theses: 3

- Hazel Rooney, University College Dublin. PhD Thesis title: Maternal feeding strategies during gestation and lactation to optimize annual sow output and to promote the growth and development of progeny from large litters. Submitted October 2019
- Anna Lavery, The University of Leeds. PhD Thesis title: Identifying and investigating factors which affect sow productivity in UK and Irish pig herds. Submitted October 2018
- Oceane Schmitt, The University of Edinburgh. Thesis title: Increasing sow output through implementation of pre-weaning interventions to keep weak piglets alive. Submitted August 2018

Total Number of Masters theses: 1

1. Kathryn Reid, University College Dublin. Thesis title: Optimising annual sow output through nutritional strategies. Submitted October 2016.

6. Permanent Researchers

Institution Name	Number of Permanent staff contributing to project	Total Time contribution (person years)
Teagasc	8	4.62
AFBI	12	1.94
Total	20	6.56

*Dr. Keelin O'Driscoll also worked on the project for 2.93 years and was paid from the Teagasc/IFA Joint Levy.

7. Researchers Funded by DAFM

Type of Researcher	Number	Total Time contribution (person years)
Post Doctorates/Contract Researchers	-	-
PhD students	4	8.08
Masters students	1	2.06
Temporary researchers	-	-
Other - Technician	2	2.97
Total	7	13.11

8. Involvement in Agri Food Graduate Development Programme

Name of Postgraduate / contract researcher	Names and Dates of modules attended
Hazel Rooney	Analysis and interpretation of experimental data for agri-food researchers (FDSC40170). 12-14 th December 2016.
Hazel Rooney	PhD skills master class for the agri-food researcher (FDSC40670). January 25-27 th 2017.
Hazel Rooney	AFGDP scientific writing and presenting skills for the agri-food researcher (FDSC40470). May 31 st - June 2 nd 2017.

9. Project Expenditure

Total expenditure of the project:	€511,650.33
Total Award by DAFM:	€510,956.78
Other sources of funding including benefit in kind and/or cash contribution(specify):	N/A

Breakdown of Total Expenditure

Category	Teagasc Institution 1	AFBI Institution 2	Total
Contract staff	72,055.00	37,086.55	109,141.55
Temporary staff			-
Post doctorates			-
Post graduates	153,999.96		153,999.96
Consumables	50,972.29	40,963.50	91,935.79
Travel and subsistence	22,938.96	201.43	23,140.39
Sub total	299,966.21	78,251.48	378,217.69
Durable equipment	14,395.54		14,395.54
Other	5,571.79		5,571.79
Overheads	89,989.86	23,475.44	113,465.31
Total	409,923.40	101,726.92	511,650.33

10. Leveraging

Dr Keelin O'Driscoll's contribution to the project (2.93 person years) was funded by the Teagasc/IFA pig levy

One year of Anna/Lavery's PhD was funded by The University of Leeds

One and a half years of Hazel Rooney's PhD was funded by Teagasc

11. Future Strategies

The Teagasc and AFBI teams will continue to disseminate results from the OPTIPIG project for the betterment of the pig industry. It is planned that results from the OPTIPIG project will be comprehensively covered in the 2020 Teagasc Pig Development Department, Research Open-day in April 2020. Furthermore, it is expected that 2 additional peer review publications will arise from this project.