

Teagasc Pig Research Dissemination Day 2017

Teagasc Pig Development Department

Monday 29th May: Ballyhaise Agricultural College, Co. Cavan

Wednesday 31st May: Teagasc, Moorepark, Fermoy, Co. Cork



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AGRICULTURE AND FOOD DEVELOPMENT AUTHORITY

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Presentations

EU PIG: Europe-wide network to improve the pig industry

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EU PIG is a four-year €2m project funded by the European Commission's research and innovation programme, 'Horizon 2020'. It is a Europe-wide network developed to improve the pig industry and is made up of a consortium of 19 organisations from across 13 member states in Europe. It aims to improve the connection between pig producers and the latest science, husbandry techniques and technologies from within their industry via fellow producers, academics and advisors connected through thematic and regional platforms. The network will coordinate, collaborate and share findings from existing pre- farm gate research, share best practice on technical production and exchange approaches to knowledge transfer with pig producers and associated advisors.

The consortium represents 13 Member States that together account for 92% of the EU's pig meat production and 89% of the EU's pig herd in 2014. The EU PIG consortium consists of, or will have links to, national and regional pig producer groups, researchers, rural development boards and innovation practitioners, including a number of Small and Medium Sized Enterprises (SMEs). The project will look at four main areas, with two "challenges" per area to be addressed in the first year of the project:

- Health management: focus on Biosecurity and the Use of Antimicrobials
- Precision Production: focus on Feed Efficiency and Water Efficiency
- Animal Welfare: focus on Tail Docking and Castration
- Meat Quality: focus on Reduction of Boar Taint and Organisational Innovations in the Supply Chain

A key part of the project will be run as a competition with a "Grand Prix" designed to identify industry best practice for each area listed above. Eight winners ("Ambassadors") will be selected and their best practices shared via the project website in June 2017. Appropriate tools (*fact sheets, videos, etc.*) and practical guidance around innovative best practice, combined with scientific knowledge of the industry will also be made available with the results of the first 'Grand Prix' due to be published in November. Out of 247 entries, Ireland submitted 26 best practices; 4 Biosecurity, 5 Antimicrobials, 4 Supply Chain Innovation, 6 Tail Docking, 3 Feed Efficiency and 4 Water Efficiency. A website for the project has been launched www.eupig.eu and a Twitter account has been created at https://twitter.com/EU_PiG with the address of @EU_PiG.

Development of the Teagasc Pig Production Model – Progress to date

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The Teagasc Pig Production Model (TPPM) platform, which is currently under development, is a tool that can be used in all aspects of production. The model platform is Microsoft Excel using a stochastic budgetary (i.e. risk budgeting) simulation approach. Data from the Teagasc pig eProfit Monitor is being used for the assumptions (i.e. *production parameters, production costs, income*) around which the model is being built and it will also be used to validate the model once it is completed.

The model is based on the animal as a unit and it will be later scaled to simulate the herd and system as a whole. The core engine of the model is based on nutrition. Inputs to the system include those associated with improvements in pig performance, higher carcass grades, and lower penalties in the abattoir. The model is being developed with each of the subsystem components divided into sub-models: sows (*gestation, lactation, piglets*), weaners (*first and second stage*) and finishers. Each sub-model allow us to identify economic inefficiencies (*when/where/why cost are higher*) and to develop strategies to reduce cost and increase profitability.

The model will be flexible to allow for changes on farm (e.g. *new facilities, changing diet specifications, new genetics, management, etc.*) and to allow simulation of diseases, welfare problems and the economic impact of different strategies. The economic values (*cost, incomes and profit*) are calculated on a per pig produced basis and on a per unit pig meat (*kg. dead weight*) basis as certain practices may not alter production parameters but can have economic impacts (e.g. *energy system used to formulate diets*). Another reason is that fixed costs do not vary and they must be covered regardless of farm productivity.

To date, we collected the production parameters and economic values required for each of the sub-models as well as deriving them on a per pig basis. Also, we have the lay out for the TPPM Performance Monitor which is a decision tool to monitor farm performance that would be available to pig producers. Growth and intake curves are currently being developed and will be integrated into the model, then data from at least two farms will be used to validate it. Finally, risk simulation will take place allowing us to identify possible economic scenarios for the different strategies to be implemented on farm.

The development of digital & visual tools to improve efficiency & overcome barriers to knowledge transfer in the pig industry

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Live demonstrations, farms walks and open days are not a feasible method of knowledge transfer in the pig sector due to the threat to biosecurity. The use of digital and visual aids could improve knowledge transfer and teaching methods, improving farm efficiencies without compromising farm biosecurity. The objective of this study is to develop several digital and visual tools (e.g. video clips, factsheets, pictograms, webinars). Digital platforms provide the opportunity to have instant access to information on a continual basis, while visuals appeal to a broader audience and a wider range of learning styles.

It is expected that this project will:

- Improve knowledge transfer through increased availability of information available to clients in a user friendly, biosecure, non-location dependent method.
- Improve farm efficiency by providing visual and practical information for pig farmers to enhance their skills and knowledge at a time that is most suitable to their working routine.
- Enhance the education service through the improved delivery of workshops and Level 5 and 6 Pig Production courses.

Focus group meetings are being used to ascertain the thoughts and opinions of pig specialist advisors, farm managers/owners and farm staff relating to the three main research questions:

- What is required by advisors, farmers and farm staff?
- What tools content and delivery methods are appropriate?
- Have these requirement been fulfilled?

The focus groups with farmers and farm staff are being formed using existing discussion groups and QQI level 5 participants, with a view to establishing further groups with a “less-engaging” audience later. Focus groups are an increasingly popular social research method where participants can discuss, probe and debate the rationale of each others ideas. Following analysis of the feedback from the focus groups, samples of each tool will be developed, creating templates and defined processes for future production. The focus groups will reconvene to assess the reaction to the tools developed, then a tool specific quantitative survey will be administered followed by a focus group discussion. This will quantify the reaction and obtain feedback to provide recommendations going forward.

Water foot-printing and water use reduction of Irish pig production

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Global water scarcity is set to rise in the next decade and consumption of animal source food is set to increase globally, thus water consumption is becoming a pertinent issue for the consumer base. Food producers and processors are coming under increasing pressure to implement sustainability programs for their customers to quantify and reduce the environmental burden associated with the production processes. Thus it is increasingly important that Irish pig producers satisfy global consumers of Irish pork by ensuring their production is carried out in a resource efficient and sustainable manner.

This project aims to development predictive models to quantify the direct and indirect water footprints and identify hot-spots of water consumption and water uage patterns of Irish pork production through intensive on-farm auditing and data collection. It will also examine the effect of group size and environmental enrichment provision on water use and pig performance. The effect of cleaning routine on water usage, environmental bacterial load of housing facilities and pig performance will also be examined. The outcomes of these studies will result in best practice recommendations for water consumption reduction at the farm and system levels.

This research will play a key role in assisting the pig sector taking a proactive approach in protection and optimisation of water as a resource. The results will help farmers adopt strategies to optimise water consumption, benefiting farm financial and productive performance, and increasing environmental efficiency of production systems. Moreover, high levels of water usage and wastage is costly as wastage increases manure volume produced, increasing the storage requirement, manure transport costs and reducing the fertilizer value/m³. Currently there is very little knowledge about the water footprint, water usage or water wastage of Irish pig farms. Quantifying the water footprint of pig production and identifying hot-spots of water consumption, will improve the sustainability of pig production by reducing consumption of resources and will increase market opportunities for Irish food products internationally. Additionally understanding the consumption patterns and identifying farm practices/equipment/methodologies that unnecessarily increase water usage or wastage is critical in reducing unnecessary water consumption and improving farm efficiencies while reducing costs. Furthermore, this project will close the gap between research and practice, by providing decision support tools and best practice guidelines for direct (*on-farm*) and indirect (*system level*) water consumption in pig production systems in Ireland.

Nutritional strategies for the gestating sow: Results so far from the OPTIPIG project

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Experiment 1: Effect of increasing feed allowance in late gestation

This study evaluated the effect of increasing the feed allowance of highly prolific multiparous sows during late gestation on sow and piglet performance. We hypothesised that piglets from sows with an increased plane of nutrition in late gestation would be heavier at birth, but there could be a risk of decreased sow feed intake in lactation if she became too fat during gestation. At service, 468 sows were allocated to one of two treatments. Up to d80 of gestation all sows were provided with 33MJ DE/day. From d80 to d112, half of the sows were fed 33MJ/day (FLAT), and the other half was fed 45MJ/day (INCREASE). We found no difference in the number born alive, piglet birth weight, average daily gain to weaning, or weaning weight. However INCREASE sows were heavier at d110 of gestation, and ate less during the 2nd week of lactation.

Experiment 2: Effects of increasing fibre level and/or supplementation with carnitine during gestation in gilt diets, on the performance of the piglets produced.

Previously, we found that sows supplemented with carnitine during gestation had heavier piglets (RDD, 2016). We further hypothesised that increasing the crude fibre level in the gestation diet may increase gut capacity, thereby facilitating increased feed intakes during lactation, and improving milk yield and piglet growth. At d38 of gestation, 84 gilts were assigned to one of four treatments; (1) Control (*crude fibre* (CF) = 4.5%), (2) High fibre (CF= 9.8%), (3) Control plus carnitine (0.125g/day) and (4) High Fibre plus carnitine (0.125g/day) until farrowing. There were limited effects of either carnitine or increased fibre level on pre-weaning piglet performance (See page 20). However, piglets from HF gilts had a greater ADG from weaning to slaughter, particularly during the finisher stage, and had a greater muscle % and cold weight at slaughter, than those on the control diet. Likewise, pigs from CAR gilts also had a greater muscle % and cold weight at slaughter.

Summary

Increasing the plane of nutrition in late gestation did not appear to improve either sow or piglet performance. However, a higher level of fibre, and supplementation with carnitine during gestation showed benefits for pig lifetime performance. Work is ongoing to further investigate the effects of carnitine supplementation.

Enrichment for pigs: Options for slatted systems (ENTAIL)

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Provision of effective enrichment material should help prevent harmful behaviours by giving the pigs something else to chew on rather than other pigs in the pen. The ENTAIL project has been running for just over two years now, and so far we have investigated the effectiveness of wood, compressed straw blocks (RDD 2016), and rubber devices, all materials which are suitable for use in slatted systems. An ideal environmental enrichment material should not only maintain or improve pig welfare, but should also improve the economics of the production system, and be practical to employ. Our initial work on the project identified that producers are willing to use wood, and there does not appear to be damage to the pigs' mouths and/or viscera when wood is used. Thus the next question is whether different species of wood are preferable than others. For the producer, wood should be long lasting to reduce costs, whereas for the pigs, the materials they are provided with work best to reduce biting behaviour if they readily wear away. We compared the rate of use of three species (*Beech*, *Larch* and *Spruce*). Beech is a hardwood, Spruce a softwood, and Larch is a softwood, but harder than Spruce. In two experiments with pigs which had their tails docked, we found that none of the types of wood were associated with outbreaks of tail biting, which shows promise as regards effectiveness. However, there were significant differences in the rate of wear, with spruce wearing away much more quickly in both studies. This meant that although the price of Spruce posts was only approximately half that of Larch or Beech, in fact it is less economical as the posts needed to be replaced more often, in some cases three or four times during the finishing stage. Larch appeared to be used more often than Beech, yet lasted almost as long, and thus could be a good compromise for pig and producer. In addition to our comparison of wood, we also investigated the rate of use of a commercially available floor toy for pigs. We found that this is most appropriate for pigs in weaner accommodation, as the wear is extremely fast in the finisher stage. Further work is ongoing to investigate how presentation of the enrichment affects its wear and effectiveness.

Relationships between ear lesions and ear biting behaviour

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A recent survey of pig welfare reported 100% prevalence of ear lesions (EL) on 31 Irish farms (PIGWELFIND). Little is known about this welfare problem except that ear biting (EB) is a risk factor. The lack of a negative impact of EL on performance is contributing to complacency about the problem. This is complicated by the multifactorial etiology of EB such that there is no single solution.

Several Teagasc projects yielded new information on EB and EL. The survey indicated that EL are most common in the 2nd weaner stage with 9.1% of pigs affected (*ranging from 2.64% to 26.4%*). This represents considerable variation between farms but it is worrying that over a ¼ of all 2nd stage pigs were affected on one farm. Lesion severity is also greater in the 2nd compared to the 1st weaner stage (0.77 ± 0.07 vs. 0.46 ± 0.07 severity score) (WELPIG). Conversely EB is performed more frequently in the 1st (c. 38 ear bites/hr) compared to the 2nd (c. 17 ear bites/hr) weaner stage. EB behaviour may initially be tolerated by 1st stage weaners or they may simply not be effective at defending their ears when young. However, as the lesions become more severe/painful pigs likely become less tolerant of the behaviour. Indeed, the head knocks and bites pigs perform to defend their ears in the 2nd weaner stage are more effective because of the pigs increased size and strength. This seems to cause a switch from ear to tail biting such that ear lesions heal and tail lesions become the most common injury seen in finisher pigs (10.5% (8.39-13.23] of pigs affected). Apart from age, EL severity and EB are also influenced by stocking density, room temperature, CO2 concentrations, relative humidity and in-feed medication (WELPIG).

Nevertheless, the primary key to solving the problem of EB, as with tail biting, probably lies in enriching the pigs' environment and from a much earlier age than we are currently doing. The support for this comes from behavioural observations of suckling piglets where biting of the ears and tails is seen in pigs as young as 7days (OPTIPIG). Piglets with enrichment perform less of this behaviour than piglets in barren farrowing crates (16.7 vs. 29.5 bites/hour). This finding supports the theory that the development of abnormal behaviours in pigs is largely associated with the redirection of their natural motivation to forage and explore towards their pen mates.

Effect of cereal fermentation and carbohydrase supplementation to liquid fed grow-finisher pigs

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Fermenting liquid feed prior to feeding can improve diet quality due to a reduced pH, proliferation of lactic acid bacteria and reduced enterobacteria counts. However, effects on growth performance are inconsistent. Fermenting only the cereal fraction of the diet has been suggested as a strategy to avoid degradation of free amino acids. Furthermore, carbohydrase supplementation to pig diets may improve feed efficiency in pigs by increasing the digestibility of non-starch polysaccharides and this effect could be increased where diets are liquid fed. The aim of this study was to assess the effect of fermenting the cereal fraction of the diet, with or without enzyme supplementation during fermentation, on growth and carcass quality of liquid-fed finisher pigs.

A total of 252 pigs (~31 kg) housed in same sex pens of seven pigs/pen ($n=9$ pens/treatment) were allocated to 1 of 4 dietary treatments: (1) Fresh liquid diet (Fresh) where the diet was mixed with water immediately prior to feeding; (2) Fresh+XB (2200 units xylanase/kg and 100 units β -glucanase/kg of feed; Rovabio Exel AP, Adisseo, France); (3) Fermented liquid diet (Ferm) where the cereal fraction (35% wheat, 38% barley and 11% pollard) of the diet was fermented prior to feeding the diet and (4) Ferm+XB. The fermented liquid cereal was prepared by an initial fermentation for 52 hours using a starter culture (Sweetsile, Agway, UK) in 2 tonne tanks which were replenished daily with a water:cereal ratio of 2.5:1. The experiment lasted 55 days.

Pigs fed the fermented cereal diets had increased average daily gain ($P<0.01$). At slaughter, pigs fed the fermented cereal diets had higher final live weight ($P<0.001$) and carcass weight ($P<0.01$) but a reduced lean meat percentage ($P<0.05$). Pigs fed the diets supplemented with XB had improved feed conversion ratio ($P<0.05$), while other growth and performance parameters remained unchanged ($P>0.05$).

In conclusion, fermenting the cereal fraction of the diet improved growth, final live weight and carcass weight but reduced lean meat percentage. Supplementing a carbohydrase enzyme (XB) to fresh or fermented diets improved the feed efficiency of pigs.

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Bacteria in the gut are associated with feed efficiency and growth in pigs

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Study 1

Screening for feed efficient microbiota: Feed efficiency (FE) is critical in pig production, as feed accounts for ~70% of production costs. The gut microbiota may influence FE in pigs, considering its role in host metabolism and immunity. The aim here was to investigate the intestinal microbiota composition of 369 pigs ranked on residual feed intake (RFI; as a metric for FE) reared at three geographical locations (Republic of Ireland, Northern Ireland, Austria), using common genetics and management protocols. The rearing environment and intestinal site greatly impacted the pig gut microbiome, which in turn presents challenges when identifying consistent reliable microbial biomarkers for FE in pigs. However, some FE-associated bacteria (*Lentisphaerae*, *Mucispirillum*, *Methanobrevibacter*, *Ruminococcaceae*, and RF16) were common across rearing environments and related to a potentially 'healthier' and metabolically more capable microbiota. These taxa could therefore potentially be used as probiotics or targeted by dietary means as a strategy for improving FE in pigs in the future, but possibly on a site-specific basis.

Study 2

Faecal microbiota transplantation: Study 1 established a probable link between the intestinal microbiota and feed efficiency (FE) in pigs. Therefore, the aim of the present study was to determine if faecal microbiota transplantation (FMT), from highly feed efficient donor pigs to pregnant sows, could influence FE in offspring. This study investigated the use of FMT as a novel strategy to beneficially influence FE in pigs. Offspring intestinal microbial diversity and composition were impacted by FMT in sows. The latter was evidenced by the fact that offspring from FMT sows had a lower abundance of bacterial members known to play a role in metabolism and health (*Oribacterium*, *Butyricimonas*, *Sphaerochaeta*), and an increased abundance of potentially pathogenic bacteria (*Chlamydia*, *Campylobacter*). These findings may help to explain the depression in offspring body weight observed at slaughter, due to FMT in sows. Overall, although altering intestinal microbial composition through the use of maternal FMT proved unsuccessful in terms of improving FE, this study highlights the influence of the sow microbiota on offspring lifetime growth performance.

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Energy and protein levels in Irish pig diets – A discussion with farmers

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With the opening of the new Teagasc Pig Research Facility, many new trials are being carried out in different areas. In Irish pig farms, we often find inefficiencies in the utilization of protein/energy in diets which results in important economic losses. Thus, several of the trials being carried out are related to diet formulation (*energy and protein*) to improve feed efficiency. In particular these trials include the use of Net Energy systems, the use of alternative ingredients and changes in feeding practice.

The first trial compared the effects of using alternative protein sources (*field beans and rape seed*) included in diets with different levels of energy and protein. The results of this first trial are presented on page 21.

The next trials, already ongoing, will study the efficiency, growth curves and carcass traits of:

- Diets with high/high, high/low, low/high, low/low levels of energy and protein in pigs from 30 to 110 kg.
- Different transfer weights from weaning to finishing diets, from 25 to 65 kg.

More trials are being planned, and these will be discussed with farmers in the discussion groups to adapt future research to their interest. Please feel free to email us with any new idea you think is worth trying.

We are also comparing the performance of farms depending on the type of feeding practices they have. On page 22 of these proceedings you will find a comparison of productive performance for farms that are home milling vs. those purchasing diets, and a comparison of performance between farms depending on the way diet is provided to the animals (*meal/pellet, dry/wet*). Other comparisons are being done at the moment (*for example between genetics or use/not use of weaner diets*). Further calculations will be done in future to provide economic comparisons of the different practices.

Update on project PathSurvPigs: Longitudinal study of respiratory disease on Irish pig farms

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Pathsurvpigs is a collaborative project involving Teagasc, University College Dublin, Cork Institute of Technology and the Department of Agriculture, Food and the Marine. The main objectives of the project are to better understand respiratory disease in Irish pig farms and to develop diagnostic capacity in Ireland. Within the project there are two main sampling actions to characterize respiratory disease in Irish pig farms:

- A longitudinal study following a number of pigs from birth to slaughter in a number of selected farms.
- A cross-sectional study studying two batches of pigs at particular time points for a large number of farms.

Both actions are ongoing at the moment and the first results from the longitudinal study are available to be presented during the Pig Research Dissemination Day. The target is to include 14 farms in the longitudinal study. Due to the intensity of this work, it will be carried out during two consecutive years, 2016 and 2017, during the winter.

Seven pig farms were enrolled so far in the first phase of the project. For each one of the farms, 40 animals were tagged at birth and followed through the cycle up to the abattoir with samplings approximately every four weeks. The samples from the seven contributing farms for the study have been analysed for four selected respiratory pathogens: APP, MHyo, PRRSv and SIV.

To date, serology results indicate that there are notable differences in the development of immunity to different pathogens between the studied farms. The relationship of serology results with presence of the pathogens and clinical outbreaks will be further investigated. The observations on management of pigs in the different farms can explain some of the results observed and will be discussed with the farmers from the participant farms and in the Teagasc discussion groups in order to share the knowledge obtained.

Social factors associated with antimicrobial usage by Irish pig producers

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Antimicrobial (AM) use poses a threat to human and animal health due to the risk of antimicrobial resistance. This threat is driving research to consider the role social factors such as attitudes and culture have to play in AM use by pig producers.

We used a purposeful sampling technique to identify 30 producers providing data to PigSys and representing different geographical regions to target for inclusion in the study. One to eight open questions for each of five topics (1. *General information*, 2. *Health status*, 3. *Animal welfare*, 4. *AM usage*, 5. *Information network*) were used as guidelines in face to face semi-structured interviews. Interviews were audio recorded, coded to ensure anonymity, and transcribed by an external transcriber for thematic analyses.

The majority of producers (80.6%) used in-feed AM even though only 13.3% reported having a high level of disease. Simultaneously the majority ($n=25$) perceived that they use very little AM and less or at least the same amount as used in other countries. There was an association between the type of medication used and the information network used by producers for advice on pig health issues ($P=0.05$). Those who consulted other producers were more likely to use in-feed AM (as well as vaccinations and AM injections) while those who consulted either vets or other professional advisors were more likely to use AM injections and vaccinations only. Producers with a lower level of education tended to use more in-feed AM ($P=0.09$). Higher levels of education were associated with a preference for vet consultation while a low level of education was associated with a greater likelihood to consult other advisors or other farmers ($P=0.09$). Producers who reported having a high level of disease were more likely to consult foreign pig vets ($P=0.05$). Older producers having more years of experience in pigs were more likely to use in-feed AM. More than half of the producers interviewed expressed a positive disposition towards a possible ban of in-feed AM. A minority ($n=6$) mentioned that they would need financial assistance to improve their farm in order to deal with such legislation.

These findings will help in developing appropriate strategies to encourage prudent use of AM by pig producers in the Irish pig industry.

Project AMURAP: Data collection on antibiotic use in pigs farms

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AMURAP is a collaborative project involving Teagasc, University College Dublin and the Department of Agriculture, Food and the Marine. The project includes pigs and broiler chickens as main users of antibiotics. Teagasc coordinates the pig part of the project.

The main objectives of the project are:

- To better understand the current use of antibiotics in Irish pig farms, and factors involved, to help farmers reduce their use with no economic loss.
- To determine the actual effect of specific antimicrobial use practices on the occurrence of resistance in zoonotic and commensal bacteria.

Data collection will be done on a voluntary bases using the antimicrobial use calculator adapted by Ger McCutcheon from the one used in the UK. Lorcan O'Neill (*Teagasc, PhD student*) will be collecting the data on the farms and PVPs will be also involved in the process to obtain the best final result for the Irish pig industry.

Once the first data are available, farms with high use of antibiotics will be compared to those with low levels of antibiotics in order to discuss with farmers and PVPs what are the main factors involved in antibiotics usage (*case – control study*). Recommendations for future actions will be agreed and delivered to the DAFM.

This project is expected to result in an improved performance at a country level and a more sustainable Irish pig industry. In a preliminary study that can be found on page 22, Maria Costa showed that those farms using antibiotics in several production stages have lower productive performance than those using antibiotics for a limited time or not using them at all. The same results have been shown in other countries and refocusing on improving biosecurity and management on those farms has resulted in an increase in performance and less reliance on antibiotics.

Posters

In-vitro evaluation of feed enzymes for use in pig diets

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Feed represents ~72% of pig production costs. Therefore, nutritional strategies to increase feed efficiency are especially relevant for the pig industry. Enzyme supplementation has been suggested as a means of increasing feed efficiency in pigs by increasing nutrient digestibility. Phytase, carbohydrases and protease may increase phosphorous, non-starch polysaccharide and protein digestibility, respectively. Laboratory based (i.e. in-vitro) digestion techniques are a cheap and fast way to screen enzymes or enzyme combinations for their ability to increase digestibility of particular ingredients or diets when fed to pigs. This study aimed to determine the in-vitro digestibility of dry matter (DM), organic matter (OM) and crude protein (CP) of pig diets supplemented with different enzymes and enzyme combinations. In-vitro digestibility was determined following a two-step in-vitro incubation technique, during which diets were incubated at 39°C in nylon bags, first for 5h with a pepsin solution, followed by 17h incubation with a pancreatin solution. Two experiments were conducted. In experiment 1, the effect of supplementing phytase, carbohydrase and protease, alone or in combination, to wheat DDGS- and rapeseed meal-based diets on in-vitro digestibility was studied. Eight diets were formulated and in-vitro digestibility determined: (1) Control diet (C); (2) C+phytase (Phyzyme 5000 XP TPT, Danisco Animal Nutrition); (3) C+xylanase+ β -glucanase (Rovabio Spiky, Adisseo); (4) C+protease (Ronozyne ProAct, DSM); (5) NC+phytase+protease; (6) NC+phytase+XB; (7) NC+XB+protease; (8) NC+phytase+XB+protease. Diets including phytase (4, 7 and 8) were formulated to allow a P and Ca sparing effect from phytase for of 0.15 and 0.10 g/kg, respectively. The results showed that in-vitro digestibility of DM, OM and CP was higher when diets were supplemented with xylanase alone (diet 3) or when a combination of enzymes (diets 5, 6, 7, 8) were used. In experiment 2, the effect of supplementing protease and α -galactosidase to field bean-based diets on in-vitro digestibility was determined. Four diets were formulated; (1) Soybean-based diet (SB); (2) Field bean-based diet (FB); (3) FB+Protease; (4) FB+ α -galactosidase. Soybean meal and FB diets had similar in-vitro DM, OM and CP digestibility. Enzyme supplementation with protease or α -galactosidase did not affect in-vitro digestibility.

In conclusion, supplementation of enzyme complexes has potential to increase nutrient digestibility in pigs but live animal trials are required to prove their efficacy.

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Comparing the effects of four liquid feeding practices on finisher pig growth

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Up to 70% of Irish pigs are liquid-fed. This study aims to examine the effects of four liquid feeding practices on pig growth, feed efficiency and nutrient digestibility under the same environmental conditions. The results will help to inform future investment decisions for Irish farmers.

The four treatments being investigated are; (1) single spaced wet/dry feeders, (2) fermented cereal diet, (3) fermented whole diet and (4) fresh liquid feeding. All pigs will be fed the same meal diet, which is formulated to 9.8 MJ NE/kg (13.8 MJ DE/kg) and 1% SID (*standardised ileal digestible*) lysine (1.1% total lysine). The fermented cereal diet involves fermenting the cereal (*wheat and barley*) component of the diet only. A balancer containing soybean meal, soya oil, lysine, synthetic amino acids, phytase, minerals and vitamins is mixed with the fermented cereal just prior to feeding. The fermented cereal diet, the fermented whole diet and the fresh liquid diet are provided at a water:meal ratio of 2.5:1 on a dry matter basis. An inoculant or starter culture (*Sweetsile, Agway, UK*) was used to start the fermentation of these two diets, and this was monitored over a 48 hour start-up period, by measuring bacterial counts, pH and temperature. It is expected that fermenting the whole diet will reduce the availability of free amino acids, particularly lysine, compared with the other three treatments. Fermenting the cereal fraction of the diet only, is expected to increase nutrient digestibility and thereby improve growth and feed efficiency.

The experiment has just commenced, with a total of 216 pigs (*average starting weight of 29.4 kg*) housed in same sex pens of 6 pigs/pen (9 pens/treatment) allocated to one of the four dietary treatments. The environmental temperature is being maintained at 20-22°C. Feed and faecal samples are being collected throughout the trial for microbiological and digestibility analyses. Individual and group weights are being monitored throughout the trial and feed intakes are recorded daily. Pigs will be slaughtered at ~110 kg and data for cold carcass weight, kill out yield, fat and muscle depth and lean meat yield will be recorded. Ileal and caecal digesta will also be sampled for microbiological and digestibility analysis and blood samples will be taken to assess pig health.

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Effect of fibre level and L-carnitine inclusion in the gestation diet on gilt and piglet performance

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Selection for increased sow prolificacy has resulted in lower piglet birth-weight and increased piglet mortality. Previous research found that supplementing gestating sows with L-carnitine increased piglet birth-weight; however, information is limited regarding L-carnitine supplementation to gilts. Piglets from gilts are lighter at birth and have lower growth rates than the progeny of sows. High lactation feed intake is important to maximise milk production and piglet growth. In general, gilts have lower lactation feed intakes than sows, partly due to lower gut capacity. Increasing the crude fibre level in the gestation diet may help increase gut capacity, thereby facilitating increased feed intakes during lactation. The aim of this experiment was to determine the effect of increasing fibre level and L-carnitine inclusion in gilt gestation diets on gilt and piglet performance. We hypothesised that L-carnitine would increase mean piglet birth-weight, and that increased fibre, from sugar-beet pulp, in the gestation diet would increase gilt lactation feed intakes, thereby increasing piglet survival and growth.

84 pregnant gilts were used in the study. At d38 of gestation, gilts were assigned to one of four treatments; (1) Control fibre [crude fibre (CF) = 4.5%], (2) High fibre (CF= 9.8%; HF), (3) Control plus L-carnitine (0.125g/day; CAR) and (4) HF plus L-carnitine (0.125g/day; HFCAR), until farrowing. Gilts were weighed and back-fat depth was recorded at d38, d90, d108 and at weaning (~d26 of lactation). Saliva samples were collected every three weeks between d90 and d108 of gestation. Numbers born alive and numbers born dead were recorded. Piglet weights were recorded at birth, 24hr after birth, d6, d13 and weaning. A blood sample was taken from the ear vein of piglets at 24hr old and glucose concentration was determined. Birth-weight of piglets was not affected by treatment. However, sex did have an effect ($P<0.05$), with males (1.22kg) being born heavier than females (1.18kg). Total number born and the number born alive were similar for all treatments ($P>0.05$). Cortisol levels were numerically higher for High Fibre (0.53 u/DI) when compared with Control (0.46 u/DI), however, the difference was non-significant ($P>0.05$). Glucose levels were not significantly affected by treatment ($P>0.05$), although sex did have an effect ($P<0.01$), with males (5.03 mg/dL) having higher glucose levels than females (4.80 mg/dL). Glucose level was affected by birth-weight ($P<0.001$). Results do not support our original hypothesis.

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The effects of dietary inclusion of rapeseed meal and faba beans combined, formulated with different nutrient densities as a replacement for soyabean meal on finisher pig performance

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Currently feed costs account for approximately 70% of overall costs of pig meat production, with energy representing the greatest proportion. As the main barrier to growth in the Irish pig industry is low profitability, any change in feed costs and diet formulation will have a big impact on farm profitability. In order for the pig sector to remain competitive in the global market, more viable and sustainable ingredients need to be used to replace the importation of soyabean meal (SBM). Therefore, the aim of this experiment is to investigate the use of rapeseed meal (RSM) and beans as an alternative to SBM in pig diets, when formulated using two different nutrient densities.

108 terminal and maternal line males and females were used in this study. Animals were housed in pairs by weight, genetic line and gender following a 2x3 factorial arrangement, with two levels of energy (9.5 MJ NE/kg & 8.9 MJ NE/kg), and three levels of by-product inclusion (*no by-products*, *low*: 10% rapeseed meal and 15% beans, and *high*: 10% rapeseed and 30% beans) The resulting six treatments, were as follows; (1) Control high energy, (2) Control low energy, (3) Low beans & RSM high energy (4) Low beans & RSM low energy (5) High beans & RSM high energy (6) High beans & RSM low energy. Pigs were weighed every two weeks and weekly feed intakes were recorded also.

The diet, sex and genetics of the animal all had a significant effect on the growth performance ($P<0.05$), with ADG being higher for low energy diets $1100\text{g/day} \pm 0.04\text{g}$ and $1002\text{g/day} \pm 0.04\text{g}$ ADG for high energy diets. The energy level of the diet had a significant effect on the kill out % of animals ($P<0.05$) with high energy on average $74.3 \pm 0.28\%$ and low energy diets $75.1 \pm 0.28\%$. Energy and inclusion level had a significant effect on intakes with diets 2 and 4 having highest intakes 2.61kg/day , 2.65kg/day respectively and diet 1 having the lowest, 2.43kg/day .

Main management practices in Irish pig farms and their effect on performance

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Farmers monitor production according to key performance indicators. The Teagasc e-profit Monitor (€PM) ensures farms in Ireland use the same criteria, thus allowing benchmarking. We aimed to describe the main management practices regarding feed, vaccination, and use of antibiotics in Irish pig farms and to assess their impact in performance.

From February to November 2016, 65 Irish pig farmers (70 *farrow-to-finish* farms) were interviewed to assess biosecurity and collect information on the feeding strategies, genetics, use of antibiotics and vaccination. Fifty-six farms were analysed with their 2015 performance data extracted from the €PM.

Around 70% of farms feed pigs with four (41%) or five (29%) diets from weaning to slaughter. These diets are commonly Creep, Link, Weaner (1st and 2nd stage for five diets) and Finisher diet. Farms with four diets had an Average Daily Gain (ADG) of 700±37.7g, Average Daily Feed Intake (ADFI) of 1700±83g, Feed Conversion Ratio (FCR) of 2.43±0.09 and a Kill Out of 76.4±0.68%. Farms with more than five diets had better ADG of 724±46.6g and ADFI of 1753.8±86.2g, but similar FCR and Kill Out (2.44±0.11 and 76.5±0.42%, respectively). Over 63% of farms vaccinate against all of the following etiologic agents: Parvovirus, Erysipelas, Circovirus, Mycoplasma and E. coli. Farms with antibiotics in water (44%) had ADG of 696±50g, ADFI of 1670±124g, FCR of 2.41±0.13 and a Kill Out of 76.4±0.51%. Farms without antibiotics in water had better ADG of 716±48.7g and ADFI of 1731±108g but similar FCR of 2.41±0.07 and Kill Out of 76.3±0.89%. On all farms the Creep, Link and/or weaners' diet had ZnO added to meet nutritional requirements in. Also, 83% of farms have antibiotics in feed. In these, FCR was improved (2.41±0.1 against 2.44±0.1 in farms with no in-feed antibiotics), but finisher mortality was higher (2.20±0.87% vs 1.79±0.68%).

Feeding practices are diverse but it is possible to characterize them and compare their results. Conversely, vaccination practices are quite uniform throughout Ireland. Finally, the data shows that usage of antibiotics is not always associated with better performance and in some cases improvement in biosecurity and management should be introduced as an alternative.

Strategies to optimize gilt lifetime performance (GiltLife)

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The two most common reasons for involuntary culling of sows on Irish farms are infertility and lameness. Thus to optimise output, rearing strategies that promote long term good health and reproductive performance of sows must be identified. Gilts destined as replacements are commonly reared with finishing pigs, and thus provided with an ad libitum, energy rich diet. The high growth rate and good body condition associated with this type of diet during development is associated with large litters, reduced age at puberty and age at first estrus, as well as high milk production. However, high developmental growth rates also cause limb weakness that predisposes the sow to lameness and culling, and can cause pain and stress. Moreover, management of developing gilts with male finisher pigs exposes these animals to higher levels of aggression and mounting behaviour, which could also cause injuries and elevated stress levels. This experiment investigated two different strategies which may improve the health and longevity of replacement gilts; 1) rearing gilts in all-female groups from weaning onwards, and 2) supplementation of a finisher type diet with a mineral supplement rich in manganese, zinc and copper (Avalia Sow™), minerals which are involved in improving foot and limb health.

Sows from the Moorepark herd were bred with maternal line semen to produce 288 replacement gilts, born from November 2016 to January 2017. These were assigned to four treatments: 1) Rearing with males on a standard finisher diet, 2) rearing in female groups, with a standard finisher diet 3) rearing with males and provision of supplementary minerals (*from approx. 70 kg*), and 4) rearing in female groups and provision of supplementary minerals (*from approx. 70 kg*). The following tasks are being carried out every second week from transfer to the finisher stage onwards: locomotion scoring, animal behaviour recording (*to assess levels of aggression and mounting*) and collection of saliva (*to assess hormonal stress levels*). Additionally, hoof examinations are being carried out at approx. 70 kg, at finisher age (*approx. 106 kg*), and at breeding. Bones will be removed from a sub sample of gilts at breeding age, and examined for development of osteochondrosis. The remainder of the gilts will be served, and effects of rearing strategy on their offspring also investigated.

Effects of artificial rearing on piglets' growth and emotional state

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When the number of piglets exceeds the sow's rearing capacity (*number of teats, colostrum, milk yield*) management strategies are needed to optimise survival and growth of super-numerous piglets. Artificial rearing (AR) involves transferring 2-7 day-old healthy piglets from their mother to a separate enclosure (e.g. Rescue Deck) and feeding them milk replacer until weaning. This allows their dam to act as a foster mother for super-numerous piglets from newly farrowed large litters. However, AR piglets' growth and welfare might be compromised by early separation from their mother and the low space allowance in Rescue Decks. This experiment assessed the consequences of artificial rearing on piglet growth and emotional state. AR ($n=10$ litters) piglets were transferred to a Rescue Deck at seven days old and fed milk replacer until weaning. Sow reared (SR, $n=10$ litters) piglets remained with their dam until weaning. Piglets were weighed on the day of transfer (D0), 24 h after (D1), every week (D8, D15, D22) until weaning (approx. 26 days-old), and at slaughter (approx. 160 days-old). Emotional state of pigs was evaluated using the Qualitative Behavioural Assessment (QBA) method from the Welfare Quality® protocol. Pigs were observed and scored pre-weaning (approx. 21 days-old), post-weaning (approx. 69 days-old) and during finishing (approx. 100 days-old).

Although AR and SR piglets had similar weights on D0 (2.77 ± 0.07 vs. 2.80 ± 0.07 kg), by D1 (3.13 ± 0.07 vs. 3.32 ± 0.07 kg) and until weaning (6.53 ± 0.07 vs. 7.97 ± 0.07 kg) AR piglets were lighter than SR. The growth rate of AR piglets was lower than SR piglets pre-weaning (0.24 ± 0.01 vs. 0.26 ± 0.01 kg/d), but it was similar between weaning and slaughter (0.75 ± 0.03 vs. 0.75 ± 0.02 kg/d) and between D0 and slaughter (0.68 ± 0.01 vs. 0.69 ± 0.02 kg). Thus, SR and AR pigs had similar slaughter weights (109.17 ± 1.13 vs. 109.14 ± 1.22 kg). AR pigs had the lowest QBA score ("poorest" emotional state) pre-weaning and the highest QBA score ("best" emotional state) post-weaning and during finishing, compared to SR pigs.

These results suggest that while AR initially had a negative effect on pigs' growth and emotional state, they rebounded after weaning to achieve the same slaughter weight as SR piglets and had higher QBA scores. This could suggest they were less emotionally affected by weaning compared to SR piglets.

Developing a Precision Livestock Farming (PLF) tool to monitor ear biting behaviour in pigs

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Precision Livestock Farming (PLF) tools are technologies that allow farmers to better monitor and thereby better manage their herds. There is growing interest in the development of PLF tools to monitor animal behaviour such that real-time updates on behavioural changes can be provided to farmers. The ability to predict the onset of damaging behaviours (*e.g. tail or ear biting (EB)*) is also important because it facilitates early intervention which could help to prevent such behaviours from escalating. This could be achieved by directly observing pigs and looking for changes in their behavioural patterns. However, this is time-consuming, potentially inaccurate and requires specialist training.

We are collaborating with researchers in KU Leuven (Belgium) and UML (Italy) on the development of a PLF tool to monitor/detect EB behaviour. To achieve this, algorithms are required. These represent a process to be followed in detecting the behavioural problem. Step one: Data are collected using conventional monitoring tools such as video or audio recording devices. We set up cameras on a commercial farm with a history of EB and recorded 13.2h (2.2h/pen x 6pens). Step two: One or more 'feature variables' (FV) are defined. These are easily measured indicators which contain relevant information related to the target behaviour (*i.e. EB behaviour*). Potential FV could be a specific sound or behaviour. In order to identify FV associated with EB, an ethogram was developed by observing the video data collected in step 1. The ethogram is a catalogue of all the different kinds of behaviours associated with an EB event and includes the behavioural patterns performed by biter (*quick biting, shaking head, pulling the ear and chewing*) and bitten (*head knocking, moving head away, moving away and vocal response*) pigs. Step three: This is a manual audio-visual analysis of the data collected based on the ethogram called 'labelling'. This analysis allows us to identify the most reliable FV to use in the algorithm. Step four: The algorithm will be 'built' based on the results obtained with the labelling process and the final product validated 'in the field'.

Clearly, understanding EB behaviour is a fundamental step in the development of this PLF tool. However, this knowledge will also be put to good use in devising practical solutions to EB, which appears to be a growing welfare problem for weaner pigs.

Entail: Control strategies for tail-biting outbreaks among undocked pigs

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According to the EU Council Directive (2008/120/EC), tail docking should not be used as a routine practice but only a last resort when all other options to control tail biting are exhausted. Following increasing public demand to enforce a no-dock policy, farmers should be better equipped with knowledge of how to manage undocked pigs. One crucial issue will be how to intervene when a tail biting outbreak occurs, as this could be common in the transition period.

During an experiment testing the effectiveness of using wood as enrichment and a high fibre diet to control tail biting in undocked pigs on fully slatted floors, three different intervention methods to stop tail biting outbreaks were tested: 1) remove the biters, 2) remove the victims, and 3) provide more enrichment. 672 undocked pigs were used, housed in pens of 14 pigs across two replicates. A tail biting outbreak was defined when three or more pigs in a pen (over 20%) had fresh and easily detectable blood on their tails. When an outbreak was declared, one intervention method was randomly assigned. Biters were identified by continuous observation of the outbreak pen and by the pig's history. The additional enrichment used was three hemp ropes tied at three locations on the pen walls. Appropriate treatment was also applied to victims if removed, or to all pigs if victims remained in the pen, in order to reduce attention to treated bitten tails. If multiple instances of fresh blood recurred, the method was considered unsuccessful and a second randomly assigned intervention was used and so forth. An intervention was considered successful when no fresh blood was observed after 72 hour of deployment. In total, there were 26 tail biting outbreaks. The earliest outbreak occurred 13 days after weaning, and culminated at week 4 post-weaning. Closer to moving into the finisher house, tail biting showed a trend of gradual decline, but later increased again at week 10 post-weaning before completely ceasing two weeks before slaughter. As a first intervention method, removing the victims had the highest success rate. Removing the biters was always a successful second intervention if the first method failed. Similarly, when an outbreak progressed to the 3rd stage, the only effective method to control persistent biting was by removing the biters. Further analysis is required to determine the optimal intervention strategy.

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