Animal & Grassland Research and Innovation Centre

Pig Development Department

Teagasc Pig Research Dissemination Day 2016

Teagasc Pig Development Department

Wednesday 27th April: Cavan Crystal Hotel, Cavan
Thursday 28th April: Horse & Jockey Hotel, Tipperary

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Agriculture and Food Development Authority

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Presentations

Posters

Presentations

The effect of feed enzymes on growth and feed efficiency in finisher pigs

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Feed represents 72% of the cost of producing a kg of pigmeat and volatility in the ingredients market means that this cost has fluctuated hugely in recent years. To reduce feed costs the pig industry must avail of alternative ingredients and by-products as well as making greater use of conventional ingredients. Dietary supplementation with non-starch polysaccharide degrading enzymes (*e.g. ß-glucanase and xylanase*) could potentially improve nutrient availability from fibrous ingredients. Furthermore, supplementing diets with proteases could increase protein digestion as well as inactivating anti-nutritional factors. Our objective here was to evaluate the use of feed enzymes in cereal and by-product based diets and to determine if using feed enzymes can allow the formulation of nutritionally optimum diets but at a lower cost.

Experiment 1

A total of 162 pigs (*~38Kg*) housed in same sex pairs were allocated to 1 of 9 dietary treatments: (1) Positive control (*PC*) diet formulated to exceed nutritional requirements (*9.9 NE MJ/kg, 8.3 g/kg of available Lys*), (2) Negative control (*NC*) diet formulated to 95% of the NE and amino acid content of PC, (3) NC+phytase, (4) NC+xylanse+β-glucanase (*XB*), (5) NC+protease, (6) NC+phytase+protease, (7) NC+phytase+XB, (8) NC+XB+protease, (9) NC+phytase+XB+protease. Diets with phytase allowed a sparing effect from phytase of 0.15 for digestible P and 0.10 g/kg for Ca. The experiment lasted 63 days. ADG on all treatments was similar (*~1051g/day*) and final live weight was ~106.8kg. Pigs fed the NC diet had higher ADFI and poorer FCR than pigs fed the PC diet. The sparing effect of phytase was effective, as ADG, ADFI and FCR were similar to that of diets formulated with adequate Ca and P ($P>0.05$). XB or protease supplementation did not improve FCR ($P>0.05$). Supplementation of phytase, XB and protease did not improve FCR when used alone or in combination.

Experiment 2

Mixing the cereal fraction of pig diets with water prior to feeding (*soaking*) may improve the efficacy of feed enzymes. Pigs (*252; ~31.0 kg*) housed in pens of 7 pigs were allocated to 1 of 4 dietary treatments: (1) Fresh liquid diet (*FLD*) where the diet was mixed with water immediately prior to feeding, (2) FLD + xylanase and β-glucanase, (3) Soaked liquid diet (*SLD*) where the cereal fraction (*35% wheat, 38% barley and 11% pollard*) of the diet was soaked for 3h before feeding the diet and (4) SLD + xylanase and β-glucanase. The experiment lasted 71 days when pigs were ~98kg. Pigs fed

the soaked cereal diets had higher ADG than pigs fed the fresh liquid diets (*731 vs. 669g/day P<0.10*) and a 4% improvement in FCR during the first week of the experiment. For the entire experiment, ADG, ADFI and FCR were not affected by enzyme supplementation. Lean meat yield was reduced by enzyme supplementation (*57.3 vs. 56.6%*). In conclusion, carbohydrase supplementation reduced lean meat yield in finisher pigs and tendencies indicate that soaking cereals before feeding may increase ADG.

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Biosecurity in farrow-to-finish Irish pig herds

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Teagasc and the Central Veterinary Research Laboratory have put into practice a plan to assess biosecurity in Irish pig farms to reduce disease, especially respiratory disease, and the use of antibiotics. The method used is Biocheck.UGent, a biosecurity benchmarking system developed by Ghent University, Belgium, currently used in different EU countries. The initial target is to assess biosecurity in a total of 70-80 farms by the September 2016 but it has been suggested by the stakeholders that the assessment should be extended to all the Irish herds as it is being done in other countries.

So far, 30 Irish farrow-to-finish pig farms have completed the questionnaire. The average size of the sampled farms was 626 sows (*range 180 to 2300*). Concerning external biosecurity, Irish farms scored higher than the EU average (*Belgium, France, Germany and Sweden*) in all parameters, achieving a mark of 77% compared to the 65% average for the rest of EU countries. Internal biosecurity scores are overtly lower than the external biosecurity ones. Compared to the rest of EU countries, Ireland's results showed that farms presented deficiencies in most of the studied aspects except for "Disease Management" (*79% in Ireland and 61% for the EU*) and for "Farrowing and suckling period" (*58% in Ireland and 53% for the EU average*). To picture some of the main deficiencies, farmers admitted that they rarely:

- Change clothes between compartments (*96.7%*);
- Check the efficacy of cleaning and disinfection (*100%*);
- Wash their hands between compartments (*70%*).

In spite of this reality, the low Irish internal biosecurity scores are consistent with those reported by other countries such as Sweden and Belgium.

Much needs to be improved in terms of biosecurity to prevent the impact of major diseases on Irish farms. This improvements could be simple and zero cost things such as designing a plan for the work flow at the farm (*e.g., from the youngest to the oldest and from the healthy to the diseased*). Little changes may be the key to solve big problems such as the excessive use of antibiotics or to control particular diseases.

Home or away: The effect of cross-fostering on piglet growth (OPTIPIG)

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The Optipig project aims to identify strategies to improve sow output per year in Ireland to levels achieved in the most efficient pig producing countries. There are two main streams to the work: optimising nutritional management of the sow, and improving methods of managing piglets, particularly small and weak ones. To date two large experiments have been completed, one on sow supplementation, and the other investigating use of nurse sows. Although these experiments had separate aims, they were both carried out on commercial farms, so additional data was collected on the usual management of piglets. In both studies we recorded whether or not piglets were cross fostered, as well as their weights to weaning, and this has allowed us to investigate the effect that cross fostering has on pre-weaning growth.

Experiment 1

Effect of widespread cross fostering on piglet weaning weight. As part of the study investigating the effects of carnitine and/or arginine supplementation on sow output, we recorded the birth and weaning weights of 1836 piglets. Out of these, 801 piglets (*43.6%*) were cross fostered during lactation. We found that for the piglets that were very light at birth, there was no difference in weaning weight whether or not they were cross fostered. However, for piglets that were of average weight or heavy at birth, the ones that were cross fostered were lighter at weaning than piglets that were left with their own mother. The difference was greatest for the heavier piglets.

Experiment 2

Effects of cross fostering on vulnerable piglets. This work was carried out using 482 piglets from the nurse sow study. In this experiment only 63 piglets (*13.1%*) were fostered after initial creation of the nurse sow litters. Piglets that were fostered were on average 97g lighter at birth than non-fostered piglets. Over half of the piglets that were cross fostered were in the lightest 20% of piglets born, and they were about 160g lighter than the ones in this group that were not fostered. These also tended to be more likely to die than piglets that were born heavy and subsequently cross-fostered. The other half of the cross fostered piglets were all in heaviest 80%. These piglets were fostered later in lactation than the light ones, and their birth weight was not associated with whether they were fostered or not. Interestingly, there was a tendency for the average daily gain of piglets with a heavy birth weight to increase after cross fostering, whereas for the ones with a low birth weight it stayed around the same.

Summary

Although these results may seem contradictory there were different management practises applied in each experiment. In experiment 2, when cross-fostering was only carried out when piglets were perceived at risk of dying, it was beneficial to cross foster piglets that had been born heavy. However for piglets of a lighter birth weight there were minimal benefits. The first study however found that widespread cross fostering actually hampered the growth of larger piglets. Further work with a larger number of animals is needed to determine how to identify which piglets will benefit from cross fostering.

Strategies to optimize gilt lifetime performance (GiltLife)

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Efficient and profitable pig farming is hugely dependent on the lifetime performance of breeding sows. In turn, lifetime performance and profitability of a sow is dependent upon longevity; in fact, a sow only becomes profitable after her 3rd litter. Worryingly, approximately 32% of Irish sows are culled before this point, and in fact Irish sow longevity is declining. How long a sow remains in the herd is determined primarily by whether she has good reproductive performance and health. Indeed the two most common reasons for involuntary culling are infertility and lameness. Thus to optimise output, rearing strategies that promote long term good health and reproductive performance of sows must be identified.

Irish replacement sows are commonly reared with finishing animals, 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. Previous work at Moorepark has found that limit feeding, mineral supplementation, and adjusting the lysine:energy ratio of the diet during rearing reduces the incidence of lameness and improves claw health in gilts. Slowing gilt growth rate also reduces the severity of joint lesions. However, limit feeding could have negative consequences for reproductive performance; sows with a slow growth rate during development have smaller litters, and worse subsequent reproductive performance, than those with high growth rates. This project will identify nutritional strategies to reduce the occurrence and severity of developmental associated lameness in gilts, while optimising mammary development and reproductive performance.

As well as longevity, other factors such as the numbers of piglets sold per sow per year, and kilograms of pig-meat sold per sow per year contribute to lifetime performance of a sow. Nutrition of the developing gilt plays a significant role in not only her future health and reproductive performance, but has the potential to affect the performance of her offspring. Mammary development, which is becoming more important due to increases in litter size, is negatively affected by limit feeding, which can have a lifetime positive effect on milk yield, and reduce the ability of the sow to rear heavy piglets. A second hidden cost of sub-optimal gilt nutrition is the effect that it has on her future health and stress levels. Maternal stress and sub-optimal health can have life lasting effects on the resulting offspring's growth, efficiency, and reproductive performance, and is known as prenatal stress. The effects of prenatal stress on piglets include reduced body weight, reduced ability to cope with stress, and alterations to the immune system. This project will not only monitor the effects of rearing strategy on the gilts/sows, but also the effects on productivity parameters of their piglets, utilising a variety of physiological and behavioural measures.

Targeted low cost strategies for Salmonella control in finisher pigs and in the slaughterhouse

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Salmonella carriage in pigs is a significant food safety concern in Ireland and cost-effective practical solutions for Salmonella control at key stages of primary production and at processor level are required. The objectives of this study were to: 1. investigate strategic pre-slaughter administration of commercially available organic acid-based feed additives for control of Salmonella in finisher pigs; and 2. evaluate different cleaning and disinfection regimes for the control of Salmonella in the lairage of the slaughterhouse.

On-farm trials

Three trials were conducted in finisher pigs on two commercial pig farms with a history of high Salmonella seroprevalence. In all trials, there was a control group fed finisher feed without additive and a treatment group fed the same feed supplemented with an organic-acid based feed additive (*either sodium butyrate at 3kg/tonne or a formic-citric acid-essential oil blend at 4 kg/tonne*). The duration of feeding was 24-28 days prior to slaughter. On one of the farms where sodium butyrate was fed, Salmonella shedding was reduced compared to the control group at the end of the trial (*30% vs. 57% probability of detecting Salmonella; $p<0.001$*) and seroprevalence was lower in treated pigs (*70% versus 89%; $p<0.001$*). However, no effects were observed on the other farm where sodium butyrate was fed, possibly explained by the detection of Lawsonia intracellularis, which causes ileitis. No differences in Salmonella recovery from the gut were observed. Numerical improvements in weight gain and FCE were found with sodium butyrate, but only on one of the farms, giving a cost benefit of €0.04/kg of live-weight gain. The formic-citric acid product, reduced Salmonella shedding compared to the control group (*28% versus 52% probability of detecting Salmonella; $p<0.05$*) but only mid-way through the trial. Seroprevalence was lower in the treated pigs (*64.5% versus 89%; $p<0.01$*). Again, no differences in Salmonella recovery from the gut were observed. Feed intake, carcass weight and kill-out yield were lower in the formic-citric acid supplemented pigs ($p<0.05$) and lean meat yield was higher ($p<0.01$). This feed additive was not cost beneficial.

Lairage study

Different cleaning/disinfection steps were evaluated in lairage pens of a commercial pig abattoir. The two-step protocol routinely used at the end of each day (*cold water power-wash, followed by disinfectant*) was compared to an intensive 4-step protocol comprising cold water power-wash, followed by

application of a foaming detergent, disinfection and then drying for 24-48h. Two different disinfectants were evaluated; the quaternary ammonium compound (QAC) product currently used by the abattoir and a chlorocresol product. The lairage pens were highly contaminated with Salmonella (*88% of all pen floor samples positive*) and power washing alone did not reduce this. However, disinfection after power washing reduced Salmonella prevalence, as only 14% and 34% of samples were Salmonella-positive after use of the chlorocresol and QAC disinfectants, respectively with the chlorocresol being most effective ($p=0.001$). Even further reductions were found with the combined use of detergent and disinfectant, and again the chlorocresol was most effective (*2.2% of samples Salmonella-positive versus 17.1%;* $p<0.001$). Subsequent drying of pens greatly reduced Salmonella, with only 3.8% of swabs positive 48h after application of detergent in combination with the QAC disinfectant; while complete eradication of Salmonella was achieved 24h after intensive cleaning and disinfection with detergent and the chlorocresol disinfectant ($p<0.001$).

Conclusions

Strategic feeding of sodium butyrate or a formic-citric acid-essential oil blend, to finishing pigs for a targeted period prior to slaughter can reduce Salmonella shedding and seroprevalence, but the response may be affected by the presence of other pathogens. However, there were no reductions in intestinal carriage and no improvements in growth performance. Despite this a cost-benefit was found with sodium butyrate use on one farm. In the lairage of the abattoir, disinfectant use is critical for Salmonella control and the choice of disinfectant is also important, with chlorocresol more effective than the QAC-based disinfectant currently used. Moreover, drying of the pens is critical for complete elimination of Salmonella.

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The long and short of it: Irish farmers' experiences of tail biting

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In order to develop a greater understanding of pig farmers first hand experiences of tail biting, last autumn a phone survey was conducted on the topic. The questions that were asked were related to management, experiences of tail biting, perceived triggers, remedial measures conducted during outbreaks and finally a section related to enrichment. Fifty eight farmers took part in the study providing some invaluable information about their first-hand experience, of a problem, that as one respondent described is one of the "biggest negatives of pig production."

All respondents commented on the sporadic, unpredictable nature of outbreaks and the fact that there was no definite solution when it does occur. For many the" biggest negative is seeing a good pig destroyed" with condemnation being the most destructive element for 79% of those surveyed, closely followed by loss of productivity. A clear pattern emerged in terms of when biting most commonly occurred. Ear biting was reported to occur most often during the second stage, with few incidences of it occurring once the pigs had entered the finishing stage. In contrast, tail biting while still observed in the first and second stage, was observed by the majority of respondents to be most common in the finishing stage. In the majority of cases, tail and ear biting wasn't continuously occurring on farms and instead occurred sporadically, at certain times of the year or amongst certain batches. Certainly, most of respondents felt that it was a "symptom of another problem" with pig health, density, feed and ventilation felt to be the biggest triggers.

It has been suggested that tail biting behaviour is redirected exploration behaviour accelerated by the frustration of being denied the ability to perform natural behaviours such as rooting. Many of respondents believed that "boredom has a big effect on tail biting" and have found various methods successful in reducing it. Indeed, research has shown that even small changes in welfare standards can have significant results. The majority of those surveyed had found enrichment of paramount importance in both reducing the incidences of tail biting and stabilising it when it does occur, with 65% of respondents adding additional enrichment such as wood following an outbreak.

Certainly tail biting is sporadic with multifactorial causes, but while outbreaks may be rare on some farms, even small occurrences are associated with considerable stress, increased labour and housing restrictions. It is therefore integral that as much information as possible is obtained on this abnormal behaviour, in order that triggers and successful mitigation can be identified that will realistically be implemented, and which are compatible with existing farming practices.

The last straw: An investigation into the effectiveness of compressed straw blocks in reducing abnormal behaviours in growing pigs

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Since 2003 the provision of manipulable material has been a legal requirement for all pigs in the EU. Subsequently there has been extensive research investigating the potential of a number of different enrichment materials, particularly on their beneficial effects in reducing abnormal behaviours such as tail biting. Through this, the optimum characteristics of successful enrichment have been identified (*ingestible, odorous, manipulable and destructible*) and straw is a material that has all of them. However, slatted systems still predominate in Ireland, restricting the utilisation of loose straw. This is because straw is difficult for most vacuum slurry system pumps to handle, and these are the most common types used in Ireland. Therefore alternative manipulable materials need to be identified which are as effective as loose straw, but compatible with slatted systems. Compressed straw dispensers providing a limited amount of substrate could be a good alternative to loose straw, as they still allow pigs to direct nosing, rooting and chewing activity towards an 'appropriate' stimulus. This could help to dis-encourage the development of undesirable harmful social behaviour such as tail-biting, while not interfering with the slurry system.

In November 2015, a trial began to investigate the effectiveness of compressed straw provided in vertical tube dispensers attached to the pen walls on a commercial Irish farm. Cylindrical compressed straw blocks were dropped into the top of the dispenser, and was held in position at the bottom by a metal bar. Pigs had access to approx. 4 inches of straw between the bottom of the dispenser and the bar. A total of 880 pigs were used in the experiment. There were 55 pigs/ pen in the 1st and 2nd stage (*n = 16 pens*), and 25 pigs/ pen in the finishing stage (*n = 32 pens*). Half the pens held female, and half held male pigs. Half of the female pens, and half of the male pens were given straw enrichment (*n=25 pigs per dispenser*). The remaining pens were provided with a commercially available hanging 'Porcichew' toy and a chain in the first stage and an 'Easy fix' rubber hanging toy, as well as a chain (*n = 25 pigs per device*) thereafter. Harmful (*e.g. tail, ear biting*) and aggressive behaviour, as well as the amount of interaction with the enrichment material, was recorded weekly. On a fortnightly basis pigs were scored for ear and tail damage. Salivary cortisol samples, to monitor stress levels, were taken from a sub-sample (*n=10 per pen*) of pigs from each pen. Pigs were individually weighed between each stage.

Ear and tail biting behaviour were observed to be highest in the 1st stage but lesions associated with ear biting reached their peak during the second stage. There was no difference in the occurrence of tail biting lesions

between stages. There was a tendency for higher levels of aggression in the straw group, compared with the toys, and in males, compared with females. Females however displayed more harmful behaviours, particularly ear biting, with a higher level of ear biting lesions also observed in female groups. There was no significant difference in tail biting lesions between treatments but there was a tendency for ear biting to be higher in the straw groups. No difference between weights and average daily gain was observed between treatments. Straw usage was at its highest in the second stage with usage going from 0.33 kg (*1st stage*)-2.04 kg (*2nd stage*) per day. This would equate to a cost of approximately 0.33 cent per pig for the first stage and 2.01 euros per pig for the 2nd stage. As there was no difference in tail biting lesions between treatments, the results imply that compressed straw using this type of dispenser is not a viable solution to reducing tail biting in growing pigs and other alternatives should be sought.

Environmental enrichment and nutritional strategies to reduce tail biting (ENTAIL)

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Pigs are highly motivated to perform exploratory behaviours. When there is a lack of a substrate for them to investigate, this normal behaviour can become redirected towards other pigs, resulting in harmful tail and ear biting. Thus provision of appropriate materials (*environmental enrichment*) to provide an outlet for exploratory behaviour can help prevent harmful behaviours. An ideal environmental enrichment material should not only maintain or improve levels of health and welfare, but should also improve the economics of the production system, and be practical to employ. Unfortunately, in slatted systems it can be difficult to provide effective materials that won't clog up the slurry system. The ENTAIL project aims to address how to provide pigs managed in slatted systems with effective environmental enrichment. The project started in April 2015, and funds both a post-doctoral researcher and a PhD student.

To date a survey on farmers' opinions on tail biting and enrichment has been completed and the results suggest that wood could be an appealing option for farmers in Ireland. However, there are concerns that depending on the type of wood, there could be damage to the pigs' mouths and/or viscera. This could have implications for the production performance of the pigs, and whether the carcasses can be accepted for processing. We have also completed a pilot study on positioning of wood dispensers, which has helped us to design an experiment that is currently underway in Moorepark; positioning the wood dispensers so that the wooden chew posts are diagonal, as opposed to vertical, appears to result in the wood being used more by the pigs. This is likely because they don't need to twist their heads to the side to bite the wood. The Moorepark study that is currently on-going includes a comparison of three wood types (*Beech, Larch and Spruce*), and a rubber floor toy. Beech is a hardwood, Spruce a softwood, and Larch is a softwood, but harder than Spruce. As well as measures of tail and ear damage and performance, we are recording damage to the mouth and any condemnations, to determine whether the type of wood affects pig health and/or processing. In addition to this work, we have also almost completed two on-farm experiments, one investigating use of compressed straw, and the other wood dispensers with chains attached. This second study with wood includes the same wood types as the Moorepark study, as well as Red Deal (*Scots Pine, a softwood*). The results of these experiments will be used to select the most effective enrichment materials and method of delivery, which we will provide to pigs with undocked tails in future experiments.

New insights into the complex relationship between pig behaviour and welfare and pig health

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Good pig health and good pig welfare are often considered synonymous. Good health is certainly the most basic requirement for good welfare. However, physical and mental 'comfort' is as important to an animal's welfare as its physical health. Hence, it is possible that a pig which is physically well and which may be thriving could also have poor welfare. Our research across a number of current projects at Moorepark is helping to elucidate the complex relationship between pig health, behaviour and welfare performance.

A recent PIGWELFIND study conducted across 31 Irish pig farms involving +17000 pigs found that in pens with fewer sick pigs (*i.e. lameness, poor body condition, hernias etc.*), more pigs were affected by tail lesions. This is supported by recent data from a longitudinal PSP study following over 1000 pigs on a commercial farm, whereby pigs that reached slaughter weight at 90 days, were more likely to have tail and ear lesions than pigs of the same age which took several weeks longer to reach slaughter weight. The latter animals had more health problems both during the production cycle and at slaughter (*pericarditis and enzootic pneumonia*). These data suggest that on Irish farms the performance of abnormal behaviours (*e.g. tail and ear biting*), which are classic indicators of poor welfare, may be related to the stresses associated with thrive and/or fast growth rates. These 'stresses' likely include higher stocking density, higher activity levels and more competition for access to feed therefore leading to more aggression. Indeed our WELPIG study which compared performance, behaviour and welfare in pigs with and without in-feed medication illustrated that the faster growing pigs (*i.e. those with in-feed medication*) were involved in more fights during competition for feed compared to pigs without in-feed medication. Furthermore, faster growing pigs engage in more aggressive interactions and have higher skin lesion scores (*PIGWELFIND and WELPIG*). Such pigs are also more susceptible to lameness (*caused by fighting*). It appears that animals suffering from ill-health are less active and avoid aggressive encounters and tail and ear biting behaviour and thus sustain fewer skin, tail and ear lesions. Other PIGWELFIND study found a higher prevalence of condemnations for pleurisy, pneumonia and pleuropneumonia in batches of pigs with a higher overall tail lesion score and we know that higher tail lesion scores are also a risk factor for carcass condemnation. Hence, even though pigs may appear to be well and growing fast the presence of skin, ear and certainly tail lesions could still indicate underlying health problems.

Our work on tail lesion scoring at factories combined with data from

PigSys reveals that the higher the mean batch tail lesion score the lower the weight of weaners at transfer to the finishing stage and the longer the number of days to reach slaughter due to lower average daily gain in the finishing period. Unsurprisingly, the percentage of pigs with any and severe tail lesions in a batch tends to be positively correlated to farm finisher mortality.

Hence at pen level even thriving pigs are susceptible to poor welfare as reflected in lesions arising from the performance of abnormal behaviours. Efforts should be made to minimise the performance of such behaviours as they clearly compromise performance at farm level and even in the absence of overt signs of ill health, increase the risk of viscera and carcass losses due to condemnations.

PIGWELFIND: The relationship between the status of Irish slaughter pigs detained ante mortem and their meat inspection outcome

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Temporary Veterinary Inspectors (*TVIs*) detain slaughter pigs ante mortem (*AM*) for closer inspection if they have concerns regarding their health and welfare. The aim of this study was to investigate if there was a relationship between the AM status of detained pigs and their condemnation status post mortem (*PM*). Data on all pigs detained over 104 slaughter days in one Irish abattoir was compiled from handwritten AM and PM reports into a Microsoft Excel file. The 1st data collection point was at AM inspection, where reasons for detaining pigs were recorded by the TVI on duty. All detained pigs in this factory were tattooed with a 'special attention' (SA) number for identification on the slaughter line. The 2nd data collection point was at the PM TVI station where the result of the PM meat inspection e.g. condemnation status and reason for condemnation, was recorded by the TVI on duty. The % of detained pigs that were condemned PM, both fully and partially, was calculated. The primary reasons for AM detention and PM condemnation were also evaluated. Due to the variety of terminology used to record reasons for detention and condemnation, the authors reclassified the reasons into a more standardised format to facilitate analysis.

Data was available on 2084 detained pigs, of which 2083 (*99.95%*) were passed as fit for slaughter. 57.6% of detained pigs were fully passed as fit for human consumption, 27.6% were partially and 14.8% fully condemned. Lameness was the main reason for detaining pigs AM (*47.3% of detentions*), followed by recumbent (*fully or down-behind*) "down" pigs (*10.8%*), stress (*10%*), "sick" (*7.5%*), hernia (*7.4%*) and tail lesions (*5.4%*). Abscess(*es*) were the most common (*38%*) reason for full or partial condemnation of detained pigs, followed by arthritis (*17%*), bruising (*10%*) and peritonitis (*9.6%*). Abscess, peritonitis and arthritis were the top three reasons for full condemnation and abscess, arthritis and bruising were the top three reasons for partial condemnation. Certain conditions had high condemnation rates. 88% of pigs detained for abdominal distension were condemned (*both fully andpartially*), followed by 84% of pigs detained for external abscesses and 65% of pigs detained for tail lesions. Significant relationships were found between the reasons for AM detention and the likelihood of condemnation. For example, pigs detained in lairage for external abscesses were 6 times more likely to fully condemned and 9 times more likely to be partially condemned than pass post mortem meat inspection. Similarly, pigs detained for tail lesions were 5 times more likely to be fully condemned whilst pigs detained for lameness were 2.4 times more likely to be partially condemned than pass post mortem meat inspection.

Conclusion

Euthanasia of casualty animals on arrival at the slaughter plant was uncommon. Lameness, "down" and stress were the most common reasons for detaining pigs AM. Abscess(*es*) were the primary identified reason for PM condemnation. Finally, significant relationships were found between reasons for detaining pigs AM and the likelihood of full or partial condemnations. Recording and informing pig producers on reasons for AM detentions has, together with PM information, potential to enhance herd health programmes and be a highly valuable tool in improving pig health, welfare and performance.

PIGWELFIND in Practice: Recording and reporting meat inspection outcomes to improve pig welfare, health and performance

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Currently in Ireland, ante and post mortem meat inspection (*MI*) of pigs has the primary objective of protecting public health. Pig carcasses are partially or fully condemned upon detection of disease that poses a risk to public health or severe welfare conditions that cause animal suffering e.g. fractures. This incurs direct financial losses to producers and processors. However, valuable information on pig health and welfare could be gleaned from MI records and contribute to reduced carcass losses as well as to improvements in pig health and welfare on-farm. Its purpose has been extended by a number of EU member states to encompass disease surveillance and prevention that pose negligible risks to public health. Additionally MI data has been used extensively in epidemiological studies investigating the occurrence of common lesions found at slaughter such as pneumonia, pleurisy, abscessation, ascariasis and tail-biting injuries.

PIGWELFIND research indicates that ante mortem and post mortem MI could be developed as a health and welfare diagnostic tool and thereby act as an aid to improving pig health and welfare on farm, reducing carcass losses and ultimately improving profitability of the Irish pig industry. A protocol for extending the MI process to include health and welfare lesion checks is proposed and a practical interpretation of this protocol developed into a software prototype to demonstrate how PIGWELFIND's ideal protocol would evolve into a standardised recording system should it be incorporated into every pig slaughter plant. Ideally, information collected will be instantly available to pig producers and their vets and will also feed into a centralised database that will act as an aid to assess the health and welfare of the national pig herd as well as serving as an early warning system for emerging diseases.

Posters

Growth and intestinal microbiota of pigs ranked on feed efficiency across three European sites

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As feed accounts for >70% of the costs of producing a pig, optimal feed efficiency (*FE*) is critical in commercial pig production. The intestinal microbiota is known to play an important role in nutrient digestion and consequently may impact FE. Therefore, identification of an "optimum" intestinal microbial profile in pigs may reveal potential biomarkers for FE, which could potentially be targeted and manipulated in order to improve FE, ultimately reducing production costs. The objective of this study was to investigate the growth performance and intestinal microbiota of pigs ranked on residual feed intake (*RFI*) across three sites (*Ireland, Northern Ireland and Austria*). Residual feed intake was calculated as the difference between observed feed intake and expected feed intake, with expected feed intake based on the animal's growth rate and body back fat. Animals with lower RFI are most efficient. Thirty-nine sows across the three sites were inseminated using MAXGRO semen (*Hermitage Genetics, Ireland*) from a total of 16 boars, where one common boar was used across the three sites to account for genetic variation. The resultant 409 progeny were reared to slaughter using standardised management and dietary practices across the three sites. Feed intake, weight, back-fat and muscle depth were recorded fortnightly between day 42 and 91 post-weaning (*pw*) for the calculation of RFI. Pigs were stratified into high and low RFI within litter on each site, with 60 pigs in each RFI rank. Faecal samples were collected at day 42 and 105 pw, and ileal and caecal digesta were collected at slaughter. These are currently being analysed by DNA sequence-based methods in order to evaluate the composition and diversity of the intestinal microbiota.Weight and average daily gain (*ADG*) did not differ between RFI ranks ($P>0.05$), as expected. However, pigs in Austria had a better ADG compared to pigs on the other two sites ($P<0.05$). Average daily feed intake (*ADFI*) was lower and feed conversion efficiency was improved in pigs with low RFI ($P<0.001$), as expected, and pigs in Ireland and Austria had higher ADFI than pigs in Northern Ireland ($P<0.05$). Pigs housed in groups tended to have lower body weight compared to those penned individually ($P<0.10$).Results from this study show that it is possible to distinctly rank pigs on feed efficiency even when common genetics, nutrition and management are used. Differences in RFI across geographic locations were also found. Any intestinal microbiota differences found between high and low RFI pigs could potentially be exploited as biomarkers for feed efficiency or targeted by dietary means in order to improve feed efficiency.

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The intestinal microbiota varies in pigs ranked on feed efficiency

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The intestinal microbiota of pigs plays an important role in nutrient digestion and, as such, its potential to influence feed efficiency cannot be underestimated. As feed accounts for >70% of pig production costs, ways to improve feed efficiency are continually being sought. Dietary manipulation of the intestinal microbiota is one approach. The aim of this study was to examine the variation in intestinal microbiota between pigs screened for good versus poor feed efficiency in order to investigate its potential to impact feed efficiency in pigs.

Residual feed intake was calculated as the difference between observed feed intake and expected feed intake, with expected feed intake based on the animal's growth rate and body back fat. Animals with lower RFI are most efficient. Composition and diversity of the intestinal microbiota were investigated via 16S rRNA gene sequencing. This was performed on faeces at weaning, days 42 and 139 post weaning (*pw*) and on caecal and ileal digesta from pigs of high (*HRFI; n=10*), medium (*MFRI; n=10*) and low RFI (*LRFI; n=12*). Bacterial richness was highest in the caecum; however, no significant differences between RFI ranks were found. Bacterial diversity clustered by sample/time point but not by RFI rank. Distinctive bacterial profiles were found, including differences in the relative abundance of bacterial types by RFI rank and sample type. For example, Firmicutes and Bacteroidetes were the most abundant phyla in the faeces and caecum, while in the ileum Actinobacteria predominated over Bacteroidetes. Significant differences between HRFI and LRFI pigs ($p<0.05$) were detected for two phyla (*Fusobacteria and Candidate division TM7*) and 18 bacterial families and genera belonging to five other phyla. These included those detected at high relative abundance i.e. decreased Rhodococcus spp (*Actinobacteria*) and increased Fusobacteria in the ileum of LRFI pigs, and increases/decreases of members of Clostridiales (*Firmicutes*) in the faeces at day 139pw. The low abundance taxa of Clostridiales were higher in LRFI pigs at day139pw and Erysipelotrichales and Lactobacillales were lower in LRFI pigs at weaning and day 42pw, respectively. Bacteroides spp. (*from Bacteroidetes*) increased by 0.14% at day 139pw in LRFI pigs. Overall, the intestinal microbiota changed as the pigs matured, and compositional shifts occurred between HRFI and LRFI pigs. However, bacterial richness and diversity did not vary with RFI rank. The increase of Bacteroides spp. and some Clostridiales suggests a higher metabolic efficiency in LRFI pigs and these could be potential biomarkers for feed efficiency in pigs.

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ECO-FCE: Effect of carbohydrase use and soaking of cereals on the growth of liquid fed finisher pigs

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Carbohydrases enzymes are exogenously supplemented to pig diets to increase non-starch polysaccharide (*NSP*) digestibility. Mixing the cereal fraction of pig diets with water prior to feeding (*soaking*) may increase the activity of exogenous NSP-degrading enzymes. A 2x2 factorial design was used to assess the effect of soaking the cereal fraction of the diet with or without supplementation of a carbohydrase enzyme (*xylanase and β-glucanase; XB*). A total of 252 pigs (*31.0 kg; ±0.65 SEM*) housed in same sex pens of 7 pigs/pen were allocated to 1 of 4 dietary treatments: (1) Fresh liquid diet (*FLD*) where the diet was mixed with water immediately prior to feeding, (2) FLD + XB, (3) Soaked liquid diet (*SLD*) where the cereal fraction (*35% wheat, 38% barley and 11% pollard*) of the diet was soaked for 3h before feeding the diet and (4) SLD + XB. The experiment lasted 71 days during which growth and feed intake were recorded. At slaughter, cold carcass weight, muscle depth and fat depth were recorded. The data was analysed by the MIXED procedure of SAS. All pigs finished the experiment at a similar live weight (*98.4±0.65 kg SEM; P>0.05*). Pigs fed the soaked cereal diets had higher ADG than pigs fed the fresh liquid diets (*731 vs. 669±24.9 g/day SEM; P<0.10*) and a 4% numerical improvement in FCR during the first week of the experiment. For the entire experiment, ADG, ADFI and FCR were not significantly affected by enzyme supplementation. At slaughter, fat depth was increased by enzyme supplementation (*13.0 vs. 12.3±0.20 mm SEM; P<0.05*) and lean meat yield was reduced (*57.3 vs. 56.6±0.17 % SEM; P<0.01*). In conclusion, carbohydrase supplementation reduced lean meat yield in finisher pigs and whilst differences were not significant, tendencies indicate that soaking cereals before feeding may increase ADG. Both of these effects warrant further investigation.

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Nurse sow strategies: an effective way to rear super-numerous piglets?

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In recent years, genetic selection to increase litter size has resulted in sows often delivering more piglets than they can rear. One of the strategies that can be used to rear these 'extra' piglets is by using a 'Nurse Sow' system. This is a type of fostering strategy that aims to optimise piglet pre-weaning survival, and minimise competition between piglets. However, there is little information about the growth and nursing behaviour of fostered compared to non-fostered piglets, nor about the best nurse sow strategy to employ. For instance, a one-step nurse sow system, where piglets from a sow over 21 days into lactation are weaned, and she is given newly born piglets, minimises transfer of piglets between sows, so should minimise aggression between piglets. Alternatively, when using a two-step nurse sow strategy, new born piglets are moved to a nurse sow which is only a week or less into lactation, and her piglets are moved onto a sow that is later on in lactation. Thus the yield and quality of the milk of the nurse sow in the two-step strategy is more closely matched to the age of the piglets that she is given. This experiment aimed to evaluate the effects of both systems on both sows and piglets, with regard to production performance and welfare.

One day after birth, the heaviest 3-4 piglets born into large litters (*i.e. over 15 piglets*) were removed from their mother (*Removal Sow (R)*, n=9) and fostered either onto a sow 21 days into lactation (*One-step nurse sow strategy (N1)*, n=10); or onto a sow 7 days into lactation (*Two step nurse sow strategy (N2-A)*, n=9). N2A's own piglets were fostered to a sow 21 days into lactation (*Two step nurse sow strategy (N2-B)*, n=9). When more than 25% of the piglets that remained on the R sow were < 1kg, cross-fostering was allowed to replace the very small piglets with heavier piglets (*Cross foster sow (CF)*, n=10). Piglets were weighed on the day of fostering, then 1, 3, 10, 17, and 24 days after fostering. They were also weighed at weaning (*W*), one week post-weaning (*W7*) and at movement to second stage weaner accommodation (*S2*). Two full nursing bouts were observed for each sow the day before fostering (*i.e. birth day*), and then on the foster day, and days 1, 2, 6, 9, 16 and 23 after fostering. Nursing bouts were never observed on the day of fostering for any of the nurse sows, due to delayed acceptance of the fostered piglets. Neither of the nurse sow strategies, nor cross fostering, affected pre-weaning survival. Treatment had no effect on piglet weight or overall growth rate, until weaning. However, piglets that stayed with their mother (*R and CF*) had greater average daily gain than N1 piglets until 11 days after fostering, and N2-A piglets until 4 days after fostering. At transfer to the second stage, R piglets were lighter than N1 piglets (*R = 11.1 kg v's N1 = 13.2 kg*), due to N1 piglets having greater average daily gain than R piglets after weaning. In all treatments the number of fights per piglet and the percentage of pigs

involved in fights during nursing were higher on the day after fostering compared to any other day, and decreased over time. Piglets fostered onto N1 had more fights than piglets which remained with their own mother (*R and CF*). For all treatments, the percentage of piglets missing a nursing bout was higher on D1 than all other days ($P<0.01$) and was associated with the number of fights per piglet ($P<0.01$). In conclusion, fostering the heaviest piglets from a litter at 1 day-old onto nurse sows following either a one or two step strategy seems to be an effective strategy to rear extra piglets that the sow can't rear.

Supplementing gestating sows with L-Arginine and L-Carnitine to optimise sow output and piglet growth.

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In an attempt to increase sow output, dam-line genetic improvement has resulted in considerable increases in litter size. However, large litters can result in problems with regard to health and growth performance with one of the major issues for piglets being low birth weight (*BW*). This study evaluated the effect of supplementing highly prolific multiparous sows with L-Arginine and/or L-Carnitine on sow and piglet performance in a commercial setting. Sows (*n=430*) were blocked on their breed, AI company who's semen they were served with, parity, back fat and previous numbers born alive before being allocated to one of 4 treatments: 1. control (*CON*), 2. CON plus 25g/day of L-arginine (*ARG*), 3. CON plus 0.125g/day of L-carnitine (*CAR*), and 4. CON plus 25g/day of L-arginine plus 0.125g/day of L-carnitine (*ARGCAR*); from d28 of gestation to farrowing. The total numbers of piglets born, born-alive, stillborn, and mummified were recorded. Piglets from a subset of 216 litters were weighed at birth (*n = 3309*) and at weaning (*n=1836*). The data was analysed using SAS. There was no interactive effect between CAR and ARG on any variable measured. There was no treatment effect on total number of piglets born, stillborn or mummified, however ARG supplementation tended to reduce BA (*14.7±0.2 v 14.2±0.2; P=0.10*). Piglets from CAR supplemented sows were 60g heavier at birth than those from sows not supplemented with CAR (*1.38±0.02 v 1.32±0.02kg; P=0.01*). However, there was a tendency (*P=0.09*) for CAR to reduce average daily gain to weaning (*243±0.006 v 236±0.005grams/day*), and because of this there was no effect of CAR treatment on piglet weaning weight (*P>0.10*). In conclusion, L-arginine tended to reduce the number of piglets born alive per litter in this experiment without influencing piglet birth weight. However the inclusion of L-carnitine was beneficial in increasing piglet birth-weight, although this weight benefit was not maintained at weaning.

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Digestible energy intake during gestation and associated sow reproductive performance

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With the modern sow now producing up to 30 pigs/sow/year; the likelihood of stillbirths and the proportion of low-birth weight piglets' increases. For this reason there is renewed focus on improving the nutrition of highly prolific sows during gestation. Sow nutrition during gestation has previously been shown to improve foetal development, numbers born alive per litter and piglet growth. The objective of the study reported here was to quantify the relationship between digestible energy intake during gestation and numbers born, born alive, born dead and piglet birth weight per sow using data collected during 8 experiments. The feeding records of 831 multiparous sows which were on trials at Teagasc, Moorepark and AFBI Hillsborough, between the years of 2005 and 2014 were used to examine the relationship between gestational digestible energy intake (*DEI*) and sow performance. DEI (*MJ/Day*) for each sow was categorised into 1) Medium (*32.0-33.0*) or Low (*29.0-30.0*) during early gestation (*day 0-24*), 2) High (*43.0-46.0*), or Low (*29.9-33.0*) during mid-gestation (*day 25-80*) and 3) High (*44.0-45.3*), Medium (*39.4-40.6*), Low (*32.2-34.7*), or Very Low (*29.9*) during late gestation (*day 81-114*). DEI in early and late gestation was not associated with total born, born alive or born dead. Average total born was 12.8 and 12.3; mean born alive was 11.5 and 10.9 while mean born dead was 1.1 and 1.3 respectively for medium and low levels of DEI in early gestation. Average total born was 12.5, 12.6, 12.8 and 12.3; mean born alive was 10.9, 11.4, 11.5 and 11.0 while mean born dead was 1.5,1.0,1.2 and 1.1 respectively for high, medium, low and very low levels of DEI in late gestation. There was a significant relationship between DEI during mid-gestation and total born, born alive and born dead, however a biological interpretation of this result was not possible as the majority of data represented the low DEI category (*Low=785 vs. High=85*). There was a significant relationship between DEI during late gestation and piglet birth weight ($p<0.05$) which was not seen with early or mid DEI. Mean birth weight was 1.61, 1.62, 1.52 and 1.55 for high, medium, low and very low levels of DEI in late gestation. Previous work thought that changing DEI in early gestation would impact numbers born (*Hoving et al., 2011*); however the results of this study suggest that changing the DEI of sows in early or late gestation has no impact on total born, born alive or born dead. Increasing DEI in late gestation may increase piglet birth weight. Cromwell et al., 1989 found that increased energy intake from day 90 of gestation, increased piglet birth weight but this contradicts more recent literature (*King et al., 2006; Gomez-Caballar et al., 2013*). Therefore this result needs further investigation. As a result of this analysis crude protein, fibre and feed intake during gestation will be analysed to explore possible relationships with subsequent reproductive performance.

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Associations between 'pig flow' and indicators of health and welfare on a commercial farm (WELPIG)

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Antibiotics (*AB*) can be effective tools to treat infectious diseases (*i.e. gastrointestinal and respiratory diseases*) but are unlikely to be of benefit to other production diseases and welfare issues. Hence AB should not be used as a management tool in the long term and instead housing and husbandry practices should be improved and/or new strategies adopted. A common practice in pig management is mixing of pigs between stages as well as leaving pigs behind the normal 'pig flow' because they are still too light/ weak or because they have been moved into hospital pens. Usually, such pigs stay on the farm longer taking more time to reach slaughter weight. The hypothesis is that this practice may not only have negative economic implications for the overall production of the farm but may also have repercussions for the general health and welfare of the pigs. In order to check if any health and welfare indicators are related to pig flows, a longitudinal study from farrow to slaughter was conducted on a commercial farm with an intensive AB treatment plan. All pigs born (*n=1050*) during one week (*1 batch*) were tagged and weighed. The majority of the batch was weaned at 28±2 days into 17 pens of c. 55 pigs while one pen in the same room held pigs weaned early from the following batch (*21d*). The 'left over' pigs were weaned over the following 2 weeks (*1 pen per week*). After 3 weeks, each pen was split into two pens of c. 33 pigs each, and at the end of the 1st stage (*i.e. 4 weeks*) pigs were moved into the 2nd stage for a further 3 weeks. At the end of the 2nd stage, pigs were moved into the so-called 3rd stage (*the first 5 weeks of the finisher stage*). Health and welfare checks were conducted on a weekly basis during the 1st and 2nd weaner stages and the 3rd stage for a total of 15 weeks. Pens were assessed for 10 min and the average % of pigs affected by the following conditions was recorded: tail (*TL*), ear (*EL*) and flank lesions (*FL*), lameness, hernias, poor body condition (*PBC*), sickness, bursitis and skin disorders. In addition, number of coughs (*C*) and sneezes (*SN*) per pen were counted and the number of C and SN per pig was calculated to account for the variation in number of pigs per pen. Three flows were identified during the trial: Flow 1 = pigs that followed the normal number of weeks required to reach the slaughter; Flow 2 = pigs that were 1 week behind; Flow 3 = pigs that were >1 week behind. TL and EL were higher in pigs belonging to flow 1 (*17.9% and 40.3% for tail and ear, respectively*) than flow 2 (*12.3% and 22.3%*) and 3 (*10.9% and 16.7%*) which suggests that there was more tail and ear biting in pens where the pigs were 'doing well' compared to in pens containing pigs which were 'left behind'. Such pigs are possibly more active and are likely to be in pens with a higher stocking density. Furthermore, as they are likely growing faster there is potentially more competition for access to feed. The cumulative effect of such stressors is likely a risk factor for

the performance of abnormal behaviours. However, the highest prevalence of all the other welfare and health indicators (*FL, PBC, hernias, sickness, skin disorders and wounds*) were seen in pigs belonging to flows 2 (*1.73%, 7.08%, 1.17%, 0.26%, 0.98%, 0.87%, respectively*) and 3 (*2.28%, 8.36%, 1.48%, 0.36%, 2.59%, 0.75% respectively*). These data are supported by the findings at slaughter whereby pericarditis, heart and liver condemnations and Enzootic Pneumonia scores were highest in pigs from flows 2 and 3. The frequency of coughs and sneezes did not differ between the three flows which could suggest that such health indicators are more reflective of the health of the pigs in a particular house than in a particular pen. Interestingly lameness and bursitis were higher in Flow 2 (*9.4% and 13.8%, respectively*) than in Flow 3 (*4.9% and 11.3%*) pigs. The difference in bodyweight between flow 1 and 2 pigs was negligible while flow 3 pigs were much lighter. Hence it is possible that heavy bodyweights combined with one week extra on the farm is a risk factor for lameness and bursitis. In conclusion, there is an association between holding pigs back from the normal flow and indicators of poor health as well as disease outcomes at slaughter. Thriving pigs which follow the normal flow may be at greater risk of behavioural problems.

Effect of feeding sodium butyrate in the late finishing period on Salmonella carriage, seroprevalence, and growth of finishing pigs

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Pork is an important source of human salmonellosis and low-cost on-farm control measures may provide a useful element in reducing the prevalence of this pathogen in food. This study investigated the effectiveness of strategic administration of sodium butyrate to finisher pigs for ~4-weeks prior to slaughter to control Salmonella carriage on highly contaminated farms. Two trials (*A and B*) were conducted on two commercial pig farms, which had a history of high Salmonella seroprevalence. In both trials, pens (*14 pens of 12 pigs/pen in Trial A and 12 pens of 12-17 pigs/pen in Trial B*) were randomly assigned to a control (*finisher feed without additive*) or a treatment group (*the same feed with 3 kg sodium butyrate/tonne*) for 24-28 days. Faeces were collected from each pig on days 0, 12 and 24/28, while at the slaughterhouse, blood, caecal digesta and ileocaecal/mesenteric lymph nodes were collected. Pigs were weighed at the start and end of the trials, feed intake was recorded, and carcass quality parameters were recorded at slaughter. In Trial A, Salmonella shedding was reduced in the treatment compared to the control group at the end of the trial (*30% versus 57% probability of detecting Salmonella in faeces, respectively; $p<0.001$*). This reflected the serology results, with detection of a lower seroprevalence in the treatment compared to the control group (*69.5% versus 89%; $p=0.001$*). However, no effect on faecal shedding or seroprevalance was observed in Trial B, which may be explained by the detection of a concomitant infection with Lawsonia intracellularis (*cause of ileitis in pigs*). No significant differences in Salmonella recovery rates were observed in the caecal digesta or lymph nodes in either trial. Furthermore, feed intake, weight gain, and feed conversion efficiency (*FCE*) did not differ between groups ($p>0.05$) in either trial. Numerical improvements in weight gain and FCE were found with sodium butyrate treatment, which gave a cost benefit of €0.04/kg of live-weight gain. Overall, results suggest that strategic feeding of sodium butyrate, at 3 kg/tonne of feed, to finishing pigs for a targeted period prior to slaughter was effective in reducing Salmonella shedding and seroprevalance but perhaps only in the absence of co-infection with other pathogens. However, sodium butyrate supplementation at this rate did not influence intestinal carriage, nor did it reduce seroprevalence to below the cut-off used for the high Salmonella risk category in Ireland (50%), or significantly improve growth performance.

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The effect of organic acid-based feed additives on Salmonella shedding and growth performance in weaned pig

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Salmonella is one of the most common food borne bacteria. Salmonellosis in humans may cause diarrhoea, vomiting, fever and stomach pains for up to 72 hours. In 2013, 8.9% of European human cases of salmonellosis were linked to the consumption of pork or pork products. Supplementing pig diets with organic acids has been shown to reduce Salmonella in pigs and to improve growth. The aim of this study was to examine the effect of three organic acid products on Salmonella in pig faeces and growth performance in weaned pigs, using an experimental infection model which closely mimics how pigs encounter Salmonella naturally on the farm.Forty 7-week old pigs were penned in four groups, each with 10 pigs. Pens were previously contaminated with Salmonella by housing two pigs experimentally infected with 5 x 106 CFU of Salmonella 4,[5],12;i;- for 5 days (*one CFU is equivalent to 1 Salmonella organism*). The level of Salmonella present in the pens was found to be 103-104 CFU/g of faeces. Trial pigs received one of four diets: T1, control (*no organic acid additive*); T2, sodium butyrate; T3, benzoic acid and T4, formic-citric acid with essential oils. A further 10 pigs receiving the control diet were placed in a Salmonella-free pen, T1. Pigs were weighed and blood sampled on Days 0 and 28. Levels of Salmonella were quantified in faeces collected on Days 0, 2, 3, 5, 7, 14, 21 and 28. On day 28, 5 pigs per group were put down and intestinal contents sampled to check for the presence and amount of Salmonella. The remaining 5 pigs/pen were fed the control diet for a further 14 days to determine if any reduction in Salmonella would be maintained without feeding the organic acids. Faeces was collected on days 35 and 42. On day 42 these pigs were weighed, put down and intestinal contents tested for Salmonella levels. 96% of pigs were infected within the first 2 days of exposure to the contaminated environment. Most pigs shed Salmonella at levels of between 100 and 104 CFU/g faeces for at least 7 days after entering the contaminated pens. A significant reduction in the amount of Salmonella was observed in the faeces of pigs fed the sodium butyrate diet ($p=0.001$) and the formic-citric acid diet ($p<0.001$). End weights and average daily weight gain were increased in all treated groups ($p<0.001$). However, no differences were observed between the control and treated groups in terms of Salmonella seroprevalence (*immune response to Salmonella in blood*) or Salmonella recovery from the intestinal contents. In-feed sodium butyrate and a formic-citric acid mix are effective in controlling Salmonella in faeces in weaner pigs and also improve growth performance.

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ESBL "superbugs"…Why should we be concerned?

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Antibiotic (*AB*) Resistance (*ABR*) is a topic frequently highlighted by the media. Increasing public awareness in this way is important because information is a powerful tool and this issue affects everyone. We need to win the war against AB resistant bacteria (*bugs*) for the sake of our own health and that of future generations and of course for our animals health. Each of us can make a difference whether through prudent use of ABs for our own medication or for that of our animals. In a planet with 7.4 billion inhabitants why is one person's behaviour so important? Your actions as pig farmers are critical because you are involved in an important sector in agriculture that aims to produce more, better and safer food! When using ABs on your farm, you are potentially promoting the spread of resistance in your pigs, in the environment, and even in your family and friends even though you are not aware of it. Pigs that are produced under intensive regimes of AB use tend to carry ABR (*bacteria/genes*) that can potentially spread through the food chain and indirectly reach you and your family, friends and employees. The human and animal gut is crowded by bacteria (*some good, which help us to remain healthy, and some harmful, that may cause disease*); these bacteria can easily transfer information like ABR genes making our gut a "big pot" for cooking ABR. This has serious implications when we get sick. We may need to take a particular AB to treat the infection and that AB may no longer be effective if our bacteria have become resistant. Furthermore, ABs can lose efficacy even when we haven't been taking oral ABs because ABR genes may be present in the food and water that we have ingested. Extended spectrum β-lactamase (*ESBL*)-producing bacteria are extremely resistant to ABs commonly used to treat human and animal infections. Currently ESBL-producing bacteria are found in hospitals, farms and abattoirs (*EFSA, 2016*). Danish studies showed that ESBL-producing E. coli were present in 79% of pig farms with high consumption of cephalosporins (*a particular type of AB*) and only 20% on farms with no consumption of cephalosporins (*Hammerum et al., 2014*). Recently, ESBL-producing E. coli were also identified in all production stages in an Irish pig unit which has high consumption of ABs. As human and animal ESBL- producing E. coli share identical origins (*Ewers et al., 2012*), this is worrying as it means that treating infections in Irish pig farmers and their families and indeed in the whole community is going to become increasingly more difficult. Responsible use of ABs is essential for the maintenance of AB efficacy as they are essential instruments for treating animal and human infections; moreover human and animal welfare should be preserved at all cost. Developing and improving management and husbandry practices with your pig veterinary specialist towards more prudent use of ABs on your unit will ultimately safeguard the health of your family, friends and pigs!

On-Farm anaerobic co-digestion of pig manure and food waste

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The Green Farm project aims to assess the feasibility of undertaking on farm anaerobic co-digestion of pig manure and food waste. Food waste is known to generate significant quantities of methane when anaerobically digested, however it may be unstable when digested alone. Co-digesting with manure will lead to a more stable process with high methane yields. Farmers may benefit from gate fees for taking food waste from waste management companies, furthering the financial argument for an on-farm anaerobic digester. This might also assist Ireland in meeting EU targets of reducing the amount of biodegradable waste going to landfill and greenhouse gas emissions from agriculture. Thus far, lab-based batch and continuous digestion experiments have been completed, and a 360 L meso-scale digester is in operation in Teagasc, Moorepark. The key conclusions from this work are;

- The addition of food waste to pig manure can boost methane yields by up to 70%.
- Provided operational conditions are the same, the addition of food waste to pig manure (*within the range likely to occur in farm-scale digesters*) does not significantly affect digestate biosafety, dewaterability or N content.
- Correct selection of digester retention time and collection of residual methane from digestate storage are both crucial if on-farm anaerobic digestion is to mitigate greenhouse gases.

The highest methane yields of 20 m3 of methane / tonne of feedstock were achieved at lab scale with a 25% food waste 75% pig manure mix (*on a wet weight basis*). A large farm-scale digester would be 1000m3 in size, and would have the potential to digest effectively approx. 40 m3 of feedstock per day. If burned in a Combined Heat and Power (*CHP*) unit with 50% thermal output efficiency and 30% electrical output efficiency, the electricity sold at the current REFIT (*€0.15/kWh*) and the heat used to meet farm heating needs (*replacing 56 L Oil /day*), the gross annual income from such a plant would be approx. €141,620. A full cost benefit analysis, accounting for all capital investments and operational costs, is required to fully assess the feasibility of such a system.

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Behavioural responses of commercially housed pigs to an arena and novel object test.

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Individual variation in personality traits has been recognised in a number of species and is believed to have important consequences in terms of an animal's coping strategy and ability to handle stress. This study investigated the reaction of 80 pigs to novel arena (*NA*) and novel object (*NO*) tests at 14 weeks of age. Pigs from eight pens (*n=4 pens per experimental room*) that were part of an experiment comparing straw and plastic toys as enrichment were used. Within each pen of 50 pigs, the following 10 pigs types (*TYPE*) were selected for testing: 3 pigs that had severe tail/ear bites, 1 confirmed tail/ear biter, 1 pig that successfully gave a saliva sample each week of the experiment (*good focal, GF*), 1 pig that was unable to be trained to give a saliva sample (*bad focal, BF*), 2 pigs that consistently approached humans (*Approach+*), and 2 pigs that consistently avoided humans (*Approach-*). No pig fell into more than one TYPE. Pigs were individually placed in a novel arena, then behaviour continuously recorded for 5 minutes. Immediately following this, a novel object (*brush head*) was placed in the arena, and behaviour continuously recorded for a further 3 minutes. The floor of the arena was divided into a nine square grid, to facilitate recording of pig movement. During the novel arena test TYPE had an effect on duration of exploratory behaviour, which was lower in bitten pigs than non-bitten. More bitten pigs tended to perform high pitched vocalisations (*HPV*), and these tended to perform more HPV per pig than non-bitten. In the novel object test, there was a tendency for bitten pigs to direct attention without touching the novel object for longer than all other types. However, focal pigs spent more time physically interacting with it than all others perhaps due to additional handling during training for saliva collection. Type of pig did not affect latency to interact with the novel object. Overall, the behaviour of bitten pigs was more indicative of fearfulness than non-bitten pigs. These data imply a link between being bitten and fearful behaviour. While fearfulness may be a result of being bitten, an alternative interpretation could be that pigs may be more vulnerable to being victims as a result of fearfulness. Further work is required to elucidate the relationship.

ENTAIL: Using wood to reduce tail biting in pigs managed on slatted floors

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Tail-biting is one of the most serious issues in pig farming and has negative effects for pigs and farmers alike. Although tail-docking is employed as a last resort to control tail-biting, it does not guarantee the elimination of tail-biting. In Ireland even though the majority of commercially farmed pigs are tail-docked, tail-lesions are still prevalent. This project aims to find an economically feasible and effective solution on farms managed with liquid slurry systems to reduce tail-biting, focusing on improving the adequacy of enrichment provision.

The material chosen for investigation during the first part of the project is wood. Currently there is a trial on-going in an Irish commercial farm with a herd size of 2000 sows. In this experiment, wood is offered to the pigs in commercially available wood dispensers, manufactured by Jetwash. The dispensers consist of a vertical metal cylinder which is attached to the wall, into which wooden posts are inserted. The wood drops through the metal cylinder, and is supported underneath by a metal plate. There is approximately 20 cm of exposed wood between the bottom of the metal cylinder, and the supporting plate underneath it. Thus as pigs chew and use the wood, it drops down through the dispenser and fresh wood becomes available. A chain is attached to either side of the bottom of the cylinder, so that it hangs next to the exposed wood. Three different types of readily available and affordable wood, beech, larch and spruce, are being compared to Red Deal (*Scots Pine*) posts that are provided by the wood holder manufacturer, Jetwash. Thirty-two Trowbridge style pens of finisher pigs (*n = 25 pigs/pen*) are being used in the experiment, with each type of wood being provided to 8 pens. Currently, half of the pigs have completed the experiment, and the second half have just started.

Wood measurements such as length, weight, circumference, moisture and hardness are being taken to test the durability of each type of wood. Tail and ear lesion scores, tear-staining, tail posture and behaviour assessment of pigs are also being carried out to examine the effect of each wood type on the pigs. Carcasses are also inspected in the factory for further verification of tail damage and condemnation. Results from the first half of the study show that spruce was consumed significantly more quickly than other types of wood in terms of weight loss and length of the posts. With regard to time spent interacting with the wood, pigs were observed using the spruce more frequently than the other wood types. Moreover, as the hardness of the wood decreased, pigs chewed the wood more often than the chains. This could explain why the spruce, which was the softest wood, was used up more quickly than the other types. However there was no difference in the frequency of harmful behaviours (*tail/ear/flank-biting*) observed between

treatments. There was a correlation between ear lesions and tear-staining, indicating that as ear damage increased, so did the amount of tear staining around the eye. Thus tear-staining could have potential as an on-farm welfare assessment measure. No visceral condemnation was found in the factory related to wood use. From the current results it is not yet concluded whether different wood types will have different levels of effectiveness in reducing tail-biting. Further data collection in the second replicate aims to provide more power to the analysis.

Improved understanding of aggression in pigs to maximise welfare and productivity

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Pigs engage in post-mixing aggression as a means of establishing a social hierarchy. Left to their own devices, an established hierarchy would remain stable over time. However in commercial production pigs are frequently mixed during transitional stages of their lives; such as weaning, moving to grower and finishing houses, and transportation to slaughter. As a result most animals will engage in numerous aggressive interactions during their lives. The consequences of aggressive interactions affect an animal's welfare and productivity. In terms of welfare, aggressive interactions can cause anxiety, stress, and pain due to lesions and injuries. The physical exertion and stress can compromise productivity and growth as well as negatively affecting carcass quality. Aggression can also result in compromised immunity and reproductive performance. Therefore a solution to pig aggression is important to both pigs and farmers. Genetic solutions to pig aggression have so far been hindered by the lack of an ideal behavioural trait to select for. Although research has revealed that the number of skin lesions is genetically related to the duration of aggressive interactions, and the location of lesions is related to the type of aggressive interaction. Yet these are total measures that do not take into account the changing nature of social structures nor the impact that animals have on each other in terms of behavioural expression. In order to account for these factors, an alternative approach to understand the comprehensive nature of pig aggression is required.

Social Network Analysis (*SNA*) is a relatively novel method in the field of animal behaviour, which holds potential for clarifying the complex nature of animal social interactions. SNA maps each interaction between individuals and can reveal the role an animal plays within its network, such as being a central or periphery character.

In order to construct social networks, 78 pens of 15 single sex animals (*age seven weeks*), were video recorded for 24 hours after they were mixed. Each interaction was recorded and mapped to create network graphs (*see Figure 1*) . The aim is to use these network graphs to identify animals that are capable of settling into new social groups with minimal aggression, and target these animals for genetic selection. It is anticipated that selection for these new behavioural traits will provide economic and productivity benefits, as well as improved welfare for the pigs by providing a socially stable living environment.

Environmental enrichment, abnormal behaviour and welfare lesions on Irish pig farms

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Tail biting is reflective of impaired welfare in pigs, it is a sign that pigs are being held in suboptimal conditions and are unable to cope with their environment. The main risk factors in this multifactorial problem are boredom and stress. Though less well studied, it is possible that other abnormal behaviours such as ear or flank biting share similar risk factors. Due to the difficulty in controlling tail biting many farmers perform tail-docking to reduce the risk of tail biting. While tail docking may prevent the symptoms it does not actually solve the underlying problem of tail biting. Tail docking should not be routinely applied unless there is evidence of injuries and other preventive measurements are taken (*Council Directive 2008/120/EC*). Additionally, pigs must have permanent access to material that they can investigate or manipulate (*e.g. straw, other forms of enrichment*) and which can substantially reduce the risk of tail biting. As one of the final parts of the PIGWELFIND project we visited 31 integrated units to assess pig health and welfare. On each farm, 18 random pens of 1st and 2nd stage weaner and finisher pens (*6 pens/stage*) were observed. We recorded the number of pigs that were affected by tail, ear, and flank lesions and number of times pigs performed biting behaviours that can cause these lesions. In addition, we recorded general information regarding the housing conditions (*e.g. enrichments, space allowance*).The average number of enrichments per pig in a pen increased from the 1st weaner to finisher stage (*0.02 to 0.05 enrichments/pig*). However, tail and ear biting were observed at the highest frequency in the 1st stage weaner pens suggesting that these pens would benefit from more/better enrichment. The most common type of enrichment was provided in the form of chains (54%), followed by plastic objects (36%) and rope/wood (10%). In pens with chains as the main type of enrichment 7.4% of the pigs had tail lesions, 11.2% had ear lesions and 1.1% had flank lesions. In contrast, in pens with rope/wood a lower percentage of pigs were affected by tail lesions (6.3%), ear lesions (4.7%) and flank lesions (0.4%). However, it is important to keep in mind that other underlying factors could have influenced this. For example, in pens providing where some form of enrichment was provided the space allowance was generally larger than in pens where no enrichment was provided. Providing more and better sources (*e.g. wood, straw or natural fibre ropes*) of enrichment in the 1st weaner stage, where injurious behaviours and lesions can already be observed, could help prevent the problem from escalating. Practical issues should be kept in mind when providing enrichment. The number of enrichments per pen should be relative to the number of pigs in order to be effective and to avoid competition. Most importantly, be aware of any other factors that could influence pig behaviour as all other aspect of housing/management should be in order for enrichment to have an effect.

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