RESEARCH AND DEVELOPMENT PROGRAMMES

PRODUCTION EFFICIENCY AND ENVIRONMENT

DEFINING THE BENEFITS OF NEW GENOTYPES

Research partners:	BPEX Pig Development Centre, BPEX Pork Chain Unit
Industry partners:	George Adams, UK breeding companies, ABN, Primary Diets
Sponsors:	BPEX
Project duration:	March 2006 - April 2009

The UK pig industry has traditionally used a Large White terminal sire over a Large White x Landrace dam, but producers have increasingly started using three-way crosses with Hampshire, Pietrain, Duroc or synthetic boars as the terminal sire. Such crosses are thought to increase hybrid vigour and to counteract PMWS and enhance survival and growth rate. However there has been little work to compare these new genotypes in a single controlled environment, and to provide meat quality data. This project provides an independent comparison between Hampshire, Pietrain and Large White sired pigs and has the support of the UK breeding companies. The comparison is being conducted at the Leeds site of the Pig Development Centre using indoor-housed Large White x Landrace sows.

The work also includes investigations on how each crossbreed responds to diets with varying lysine content to define optimum feeding strategies for each of the three genotypes. Pigs are being followed from birth to slaughter with carcases processed across the Autofom at George Adams so that any differences in carcase parameters can be evaluated. The results will define the benefits of the genotypes and point to their optimum utilisation.

The results will be published in four reports (Preweaning performance, Weaner performance, Grower Performance, Finisher performance) during 2008.

WEANER PIGS: PRINCIPLES OF SUSTAINABLE MANAGEMENT

Reduced feed intake, poor growth and development, and diarrhoea are common in newly weaned piglets. The associated reduction in digestive and absorptive capacity of the gut after weaning decreases overall efficiency and causes an increase in nutrient loading to the environment. It has implications for lifetime performance because overall growth rate and feed conversion are sub-optimal, extending the time taken for pigs to reach slaughter weight.

Changes in EU legislation, which took effect from 1 January 2006, banned the use of all remaining antibiotic growth promoters (AGPs) from use in livestock feed. Withdrawing AGPs and heavy metals (zinc and copper) is likely to cause deterioration in feed efficiency and exacerbate environmental impact through increased nitrogen and phosphorus excretion, with additional concerns for pig health and welfare, and food safety.

For these reasons, and in response to the ban, a major research programme began in 2003, investigating ways to optimise health and growth performance of the weaned piglet, without a reliance on AGPs and zinc/copper based supplements. The programme consists of three packages: Agewean, Nutwean and Gutwean, which are summarised in the following sections.

AGEWEAN

Research partners:	University of Newcastle, ADAS, BIOSS, Harper Adams University College, MLC and SAC
Sponsors:	Defra
Project duration:	2003-2007

The objectives of the work were:

- To determine whether increasing weaning age gives significant health and performance benefits when all dietary AGPs are removed and heavy metals (zinc, copper) are reduced
- To determine the implications for production economics and environmental impact at a whole systems level for different weaning ages

Weaning ages of 4, 6 and 8 weeks have been compared in multi-site trials involving nearly 600 sows and representing both outdoor and indoor production. Key evaluations included lifetime sow productivity over 4 parities, performance of piglets after weaning at these different ages, and monitoring of sub-samples (25%) of the progeny for growth performance from weaning to slaughter. Trials have been completed on schedule with the following major conclusions.

- There were significant benefits from later weaning in terms of piglet performance during the immediate post-weaning period. These were reflected in later weaned piglets having significantly better feed intakes and daily liveweight gains, and a more favourable gut microflora (assessed by faecal lactobacilli:coliform ratio). Pigs weaned at later ages were also significantly less likely to be removed from trial or die during the weaning to slaughter period. However, when progeny performance was considered over the full period from birth to slaughter, no overall benefits of later weaning for survival, health or growth rate were seen.

In terms of sow productivity, there was a significant production penalty to be paid by later weaning. Sows weaned at 8 weeks of age produced the equivalent of 4 fewer piglets per year than sows weaned at 4 weeks of age.

- The feed cost per weaner up to the point of weaning was obviously greater for the later weaning ages but, despite the different qualities and costs of diets used in the post-weaning phase, the overall lifetime feed cost per kg progeny live-weight gain (including all sow feed inputs) did not differ significantly between treatments.
- Modelling of the overall system economics to take account of pig performance and resource requirements in the form of both fixed and variable costs, indicated a lower production cost for the 4-week weaning system in comparison with the 6- or 8-week weaning system (by approximately 3 p/kg carcase weight in July 2007, or 2.8%).
- Nutrient budget calculations, based on overall feed inputs (eaten plus wastage) and diet analyses for each treatment, indicated that feed nitrogen and phosphorus inputs per kg pig produced were significantly greater for the later weaning ages, suggesting the potential for greater environmental impact. Pigs in the 8-week weaning system received over 10g more phosphorus and over 500g more nitrogen in feed inputs to reach slaughter weight when compared to the 4-week weaning system.
- Under current UK conditions, and with appropriate nutrition and management, later weaning of piglets at 6 or 8 weeks of age therefore appears to offer no significant benefits for health or performance of the progeny which outweigh the reduction in sow output when compared to the current industry norm of 4 week weaning.

NUTWEAN	
Research partners:	Scottish Agricultural College (SAC), Universities of Leeds, Newcastle and Nottingham, and MLC
Industrial partners:	ABNA, Frank Wright, Primary Diets, Provimi
Sponsors:	Defra (LINK) HGCA and MLC
Project duration:	2003-2007

Nutwean's objective was to develop sustainable systems for the management of weaner pigs through nutrition, in the absence of reliance on antimicrobial growth promoters, whilst maximising use of home-grown cereals and oilseeds. This aim was achieved by modifying pre- and post-weaning pig nutrition in ways which exploit the potential of dietary components to enhance gut health and improve food intake. Different nutritional treatments were tested under different management systems, where weaning age and/or lactation environment (outdoor versus indoor) varied. Work was carried out in a large number of controlled studies, including large-scale commercial trials. The main results are summarised below.

Strategies for creep feed provision

- Providing sodium butyrate in feed enhanced gut development and improved feed conversion.
- Inclusion of sodium butyrate or inulin in creep feed did not deliver added benefits in post weaning performance or microbial indicators of gut health beyond that provided by high quality, commercial-specification creep.

Source and processing conditions of raw materials on their in vitro characteristics and nutritional value

- Soft wheat differs in hydration characteristics between batches, which shows the importance of characterising hydration and physicochemical properties of cereals in trials. As starch needs to hydrate for effective hydrolysis, difference in hydration patterns can affect digestibility.
- Endogenous alpha-amylase activity may influence both in vitro rheological and in vivo digestibility data. In vitro data may be used to predict in vivo small intestinal starch digestibility.
- Wheat processing (especially extrusion) may increase its nutritional value for weaned piglets.
- Soft wheat may be associated with higher nutritional value, which can increase the confidence in using wheat of particular backgrounds in piglet diets.

The role of 'functional fibre' on enteric health

- To minimise the risk of post weaning diarrhoea whilst maximising performance, diets containing sources of predominantly soluble NSP, which do not lead to increased digesta viscosity, such as inulin, might be recommended. This will be particularly beneficial in diets containing high levels of crude protein and on farms with increased disease risk, although under commercial conditions with a low infection pressure, such benefits may be minimal.

The role of protein nutrition on enteric health

- Diets lower in crude protein content may be beneficially fed to newly weaned pigs to maintain gut health and decrease the risk of post weaning diarrhoea, especially in younger pigs and under increased disease challenge.
- Under commercial conditions, the small penalty on performance in pigs fed lower protein diets in the immediate post-weaning period does not seem to affect long-term performance, carcase weights and quality at slaughter.

NUTWEAN main results *(continued)*

Acid buffering characteristics of the post-weaning diet

- In this study formic acid or phytase did not affect gut health or performance, although phytase may be a viable alternative to adding inorganic phosphorus.

Utilisation of rapeseed as a home-grown protein source

- Micronised whole rapeseed has the potential (at low inclusion levels) to be a cost effective home-grown protein and energy source in diets for weaned piglets, since inclusion levels greater than previously accepted can be used without adversely affecting feed conversion ratio or feed cost per kilogram gain. However, studies on how to overcome the detrimental effect on intake need to be further developed.

Consequences of lactation environment and weaning age on health and performance

- Compared to indoors, outdoor reared piglets performed better post-weaning, although pre-weaning mortality rate was somewhat higher.
- Delaying weaning until 6 weeks of age disadvantaged indoor reared piglet performance, but may not be disadvantageous to outdoor reared piglets, depending upon the subsequent feeding regime. Regardless of rearing environment all pigs responded positively to both zinc oxide and antimicrobial growth promoters.
- Outdoor rearing improves gut development post-weaning, possibly due to the opportunities to forage and consume substrates prior to weaning.

Translating experimental finding into commercial applications

- Under commercial conditions, high quality diets (cooked cereals and animal protein sources) led to improved health and performance immediately post-weaning compared to low quality diets (raw cereals and plant protein sources). There was however no long-term effect of post-weaning diet on pig health and performance.
- Under commercial conditions, wheat extrusion improves weight gain and feed intake in the immediate post-weaning period but these benefits were not apparent any more some four weeks post-weaning. Extrusion did not improve pig performance under low levels of amylase, but resulted in increased weight gain and intake at high levels of amylase. These benefits were still apparent by day 26 post weaning.

Expected benefits

The expected benefits from Nutwean's outcomes include:

- Decreased occurrence of post-weaning diarrhoea leading to improved pig health and welfare
- Increased profits as a result of improved post-weaning performance
- Improved feed efficiency resulting in a decrease in nitrogen output and reduced environmental impact
- Potential increase in market for UK cereals and oilseeds and decrease in protein imports
- Reduced environmental burden of minerals and chemical residues
- Reduced dependency on antimicrobial agents

GUTWEAN	
Research partners:	University of Bristol, Rowett Research Institute
Sponsors:	Defra, SEERAD, MLC
Project duration:	2005-2009

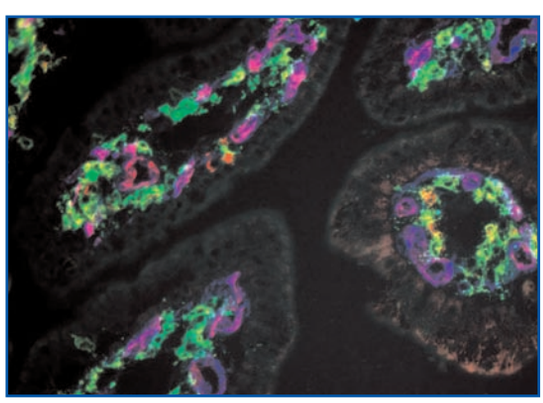
The overall aim of this project is to determine the effect of weaning age and environment on the development of the mucosal immune system, and on the ability of piglets to make "appropriate responses" to microbial and dietary antigens at weaning.

Specifically the project will evaluate and identify genomic and immunological techniques that are capable of detecting differences in the development of the mucosal immune system that correlate with the piglet's ability to mount appropriate responses to microbial and dietary antigens at weaning, and determine the effect of microbial flora on the development of mucosal immuno-competence.

During the past twelve months a major study in young pigs has been carried out to determine the effect of rearing environment and early weaning on gut microbial populations and on the development of the innate and adaptive mucosal immune systems. Litters of piglets born either on indoor or outdoor units were allowed to suckle for the first 24 hours, and then either allowed to remain with the sow or transferred to a very clean (SPF) isolator facility and fed on a liquid sow milk replacer. To investigate further the effect of microbial flora on gut immune development, half of isolator-reared piglets were injected (day 1-5) with broad spectrum antibiotics. Piglets were killed at 5, 28 and 56 days of age and tissues collected for immunological, genomic and microbiological analysis. Whilst the animal part of the study is now complete the laboratory analyses are ongoing and therefore the results reported must be considered as preliminary.

Gut Microbiology

Initially we have concentrated our analysis on the treatment extremes, ie piglets taken from the sows reared indoors that were transferred to the isolator and injected with antibiotics with piglets remaining with sows reared outdoors. The results showed that there were differences in the number of bacterial species present. Between the two treatment "extremes" there were significant differences in the number of Bacteroidetes, Bacilli, Clostridia and Proteobacteria. Different cell types are recognised by staining with different antibodies tagged with different coloured markers.



Different cell types are recognised by staining with different antibodies tagged with different coloured markers

Host Genomics

Differential gene expression is largest in the comparison between sow-reared piglets and isolator + antibiotics treated piglets, and this effect is stronger in the indoor environment. Early results show that the differentially affected genes are linked to specific pathways related mostly to cell cycle, metabolism and immune response.

Immunology

Because of their pivotal role in immunity, initial studies have focused upon dendritic cells. Preliminary results have shown that there are differences in the numbers of mature and immature dendritic cells along the small intestine. There were also significant differences in the number of these cells between treatment groups (sow vs. isolator vs. isolator + antibiotics), and between the two origins (indoor vs. outdoor farms). Current data would suggest that the numbers of mature and immature dendritic cells in the mucosa of the early gut may be associated with the development of immunocompetence in later life.

The results obtained to date have clearly shown that rearing environment dramatically affects the gut microbiota and that this is associated with significant differences in gut gene expression and the development of the piglets' mucosal immune system. These results might indicate that the differences in microbial populations associated with the extremes of different rearing environment may impact on the piglet's ability to respond to the challenges of weaning.

AN INVESTIGATION INTO THE EFFECTS OF MILK SUPPLEMENTATION USING A MILK LINE SYSTEM ON PERFORMANCE AND BEHAVIOUR IN NATURALLY SUCKLED PIGLETS

Research partners:	Harper Adams University College
Sponsors:	BPEX, Volac, The Universities Federation for Animal Welfare (UFAW)
Project duration:	2007-2008

Given the large litter size now expected from sows and the competition at the udder, there is renewed interest in the potential of the 'Milk Line System' where piglets have access to milk replacer ad-lib from birth. Anecdotal evidence from two commercial systems suggest higher numbers weaned (+0.4 pigs/litter from before to after the introduction of milk line) and lower within litter variation in systems where 10.7+ pigs are weaned per litter. It is also noted that the benefits at weaning are seen to continue post-weaning. If this level of improvement can be verified then there are major potential benefits to the industry.

The objective of this project is to establish the benefits of the milk line system under controlled trials and provide producers with information of how it is best utilised. There are three overall questions to be addressed:

1. Do the benefits of the milk line stem from the availability of milk from farrowing?
2. Does the provision of liquid milk affect the creep intake or the sows' milk output?
3. What are the post-weaning benefits of the milk line and is there an overall economic benefit of the system?

Two trials are underway. In total 248 litters are being recorded over 8 batches from birth to 28 days post- weaning. Individual performance and litter feed efficiency are being measured.

Trial 1: Three treatments either with supplementary milk being available from birth or day 7, or no supplementary milk.

Trial 2: Four treatments in a factorial design, including treatments with or without supplementary milk available from birth or creep feed available from day 14.

Supplementary milk is provided to piglets via the 'Milk Line System'

Students funded from a UFAW scholarship have carried out additional behaviour studies. The full data set will be reported in the next annual report and through the knowledge transfer activities of BPEX.

DEVELOPMENT AND EVALUATION OF LOW-PHYTATE WHEAT GERMPLASM TO REDUCE DIFFUSE PHOSPHATE POLLUTION FROM PIG AND POULTRY UNITS

Research partners:	Harper Adams University College, University of Nottingham, University of Reading, NIAB, University of Idaho
Industry partners and in-kind contributors:	Anglian Water Services, Deans Foods Ltd, The Environment Agency, British Poultry Council Ltd, Frank Wright Ltd, Lloyds (Animal) Feed Ltd, Sun Valley Food Ltd, Velcourt LTD, BPEX, Advanta Seeds UK Ltd
Other industry partners:	USDA Agricultural Research Service, ABNA Ltd
Sponsors:	Defra, HGCA
Project duration:	April 2006–March 2010

The aim of this project is to provide adapted germplasm and tools for marker assisted breeding of High Available Phosphate (HAP) wheat, which will have the potential to reduce diffuse phosphate (P) pollution when used in the diets of pigs and poultry. In addition, the effect of P fertilizer treatment on P metabolism within the wheat plant and grain and on grain composition of other important nutrients and micronutrients will be determined.

Currently available mutations, in non-adapted UK wheat germplasm give a 30% increased P availability but this has not been tested in animal feed trials. Maize and barley lines have already been reported to reduce phosphate excretion in feeding trials from between 30-55%.

In 2007 the cost of feed phosphate used in formulated diets increased to over £600/t due to the demand from the fertilizer industry. Making plant phosphate more available to rapidly growing young animals in combination with phytase enzymes will have an increasing cost benefit, improve animal welfare, and reduce phosphate pollution levels.

Thus far:

- 20 tonnes of HAP wheat has been produced for feeding trials to commence in 2008
- After initial broiler feeding studies, pig trials will commence to determine the reduction in P excretion obtained by feeding HAP wheat compared to conventional wheat. Results will be reported in 2009
- UK adapted material produced using the HGCA recommended variety Zebedee, was sown in 2007 for selection and harvest in 2008
- New and improved sources of HAP wheat have been developed and are currently being adapted for UK farmers
- Plant populations needed for the development of marker-assisted plant breeding tools for rapid selection by the wheat breeding industry have been produced

It is anticipated that this work will be exhibited at the British Pig and Poultry Fair 2008 and the Grassland and Muck 2008 show.

VIDEO IMAGE ANALYSIS TECHNOLOGY FOR RAPID PIG WEIGHT ESTIMATION

Research partners:	Silsoe Livestock Systems Ltd, Osborne (Europe) Ltd
Industry partners:	Pig producers
Sponsors:	BPEX
Project duration:	2005-2008

Background

Video Image Analysis (VIA) was evaluated at Stotfold PDU for monitoring the weight and growth of finishing pigs within a dynamic pen environment, without physical intervention to weigh the pigs. The trials demonstrated that dimensional information collected by VIA is able to estimate liveweight of finishing pigs to within 3 kg and can provide accurate pen growth data on a daily basis.

Phase 1

The equipment was developed following trial work and discussions with pig producers highlighted the need for a rapid device to accurately assess pig weight in the pen during the selection for slaughter process avoiding the need to weigh every individual pig, but achieve at least the same number of pigs satisfying grading specification. This will save time, and improve farmer returns through reduced penalties.

This gave rise to development of a portable *hand-held* VIA device. The operator holds the camera above a pig and triggers the camera; the computer processes the image and displays the estimated weight. Early farm trials were encouraging, but a number of difficulties were soon encountered. These related to: Lighting, pig behaviour and positioning in relation to the camera, ability of operator to hold the camera at the correct height and orientation to the pigs, computer processing power, and muddy pigs.

The combination of these difficulties meant that the system was not going to be a practical proposition for identifying pigs for slaughter as a hand-held device. Farmer enthusiasm for the concept was however encouraging and methods were sought to develop the technology into a commercial proposition for selecting pigs by weight without human intervention.

Phase 2

The device was fitted with an ink jet dripper and mounted above a drinker or feed trough. The dripper is activated when the processed image calculates that the pig weight is within a pre-determined range. After several hours all those pigs within the weight band are identified and can be drafted by non-skilled labour accurately. This eliminated most of the difficulties relating to pig behaviour and orientation; however, a few problems remained relating to lighting, mounting the device, and protecting the equipment from the pigs.

The processor can now manage up to four cameras, allowing more pigs to be recorded for little additional capital cost so the device can be placed in a room and left, minimising labour inputs. Trials have continued on commercial units seeking to establish the ideal ratio of pigs to cameras, and optimum observation time.

Mounted VIA equipment fitted with an inkjet dripper

Developments from this project have assisted commercialisation of VIA equipment for growth rate monitoring of finishing pigs on a number of commercial units. Users are reporting improvements in performance as a result of being able to manage the pigs proactively in response to growth rate changes.

COMMERCIAL PIG UNIT ENERGY MONITORING PROJECT

Research partners:	Farmex
Industry partners:	Pig producers
Sponsors:	BPEX
Project duration:	2005-2008

Producers seeking to control production costs are aware of rising energy costs but find it difficult to identify potential improvements. There has been no detailed study of energy use on pig farms in recent years and consequently there is little up-to-date information either for bench-marking, or for identifying key areas to improve.

The objectives were:

- To monitor, in detail, electricity use on a range of farms
- To understand the factors determining how much electricity is used
- To identify opportunities for efficiency gains and improve performance

Improvements in energy used per kilogramme of meat produced require in-depth monitoring of each stage of production. The application of remote monitoring technology to track, in real-time, pig and building activity offers to the industry real opportunities for efficiency gains.

Farms were invited to participate in the project, and a range of representative systems was selected. Participating farms were not 'typical' as they either already had monitoring systems in place, or had expressed interest in the technology. Data can therefore be taken as indicative of potential, rather than representative of industry practice.

The average overall electricity cost per pig produced decreased during the course of project on the farms involved, demonstrating the potential for savings across the sector as a whole.

Figure 10 Mean electrical energy consumption per pig reared

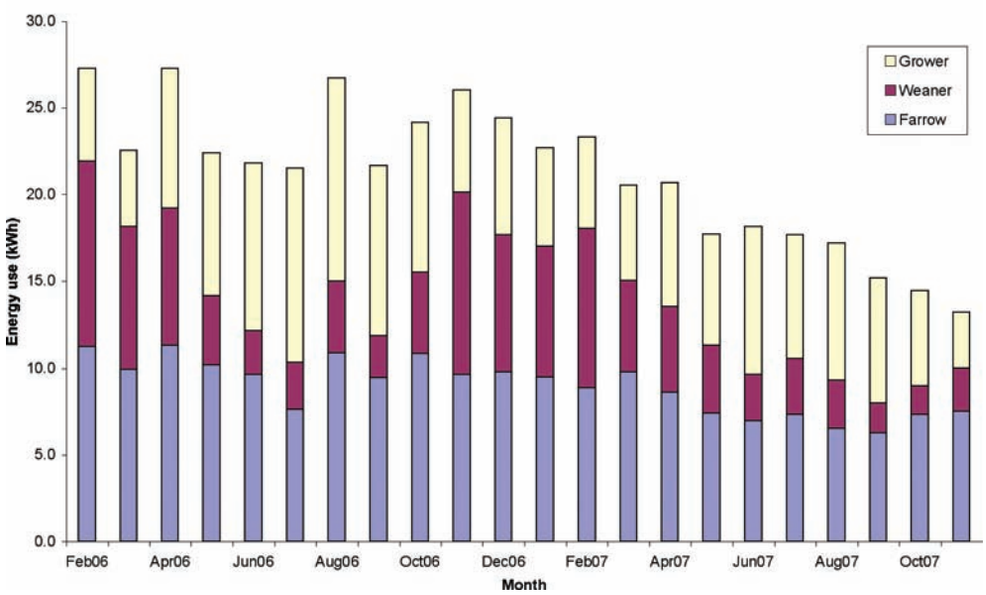
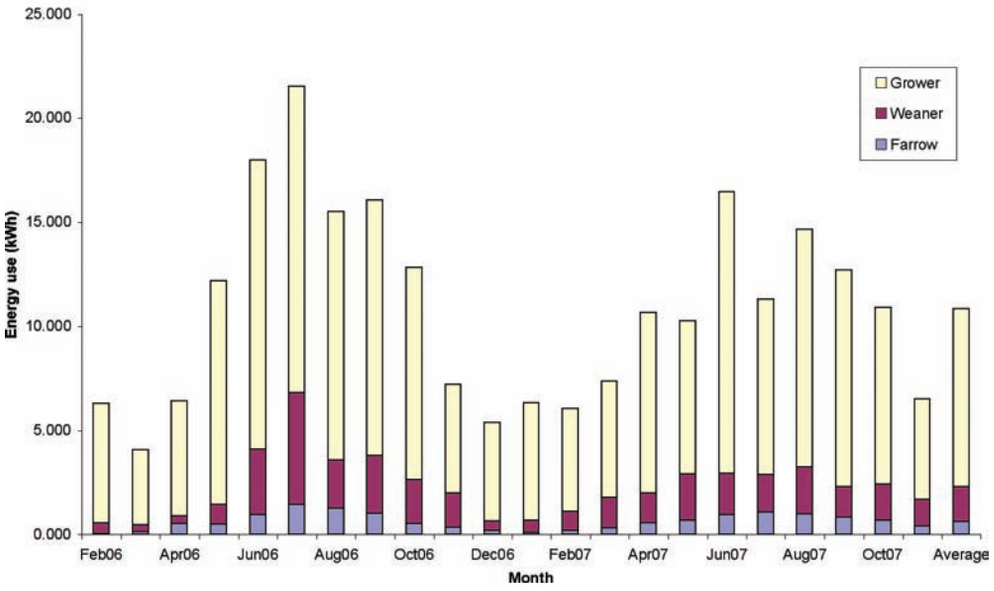


Figure 10 shows the average electricity consumed on each of the farms involved in this project. Note: some producers came on-line part way through the study; this may have reduced averages to some degree. ***Figure 11*** includes buildings with both fully controlled (fan) and Automatically Controlled Natural Ventilation (ACNV). Results to date indicate that ACNV of grower/finisher buildings significantly reduces total energy use, both in ventilation and lighting cost, compared to fully controlled ventilation. In direct comparison, on a single farm, the fan-ventilated building cost £1.30 per pig, compared to £0.05 using ACNV. But using ACNV for younger pigs has no clear cost benefit.

Figure 11 Mean fan energy consumption per pig

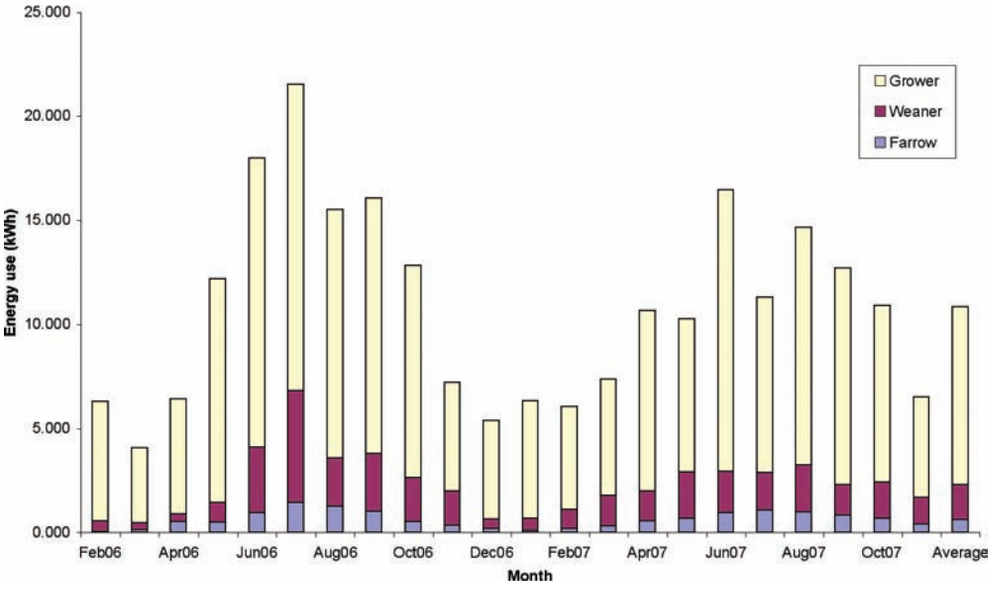


Weaner accommodation

Energy savings during the project were most marked in weaner rooms, where minimum ventilation rates are often set higher than necessary, exhausting heat and increasing supplementary heat demand. This seems due to health concerns but when participating farmers reduced minimum ventilation rates, there was no negative disease response reported by producers.

Figure 12, shows mean heating energy consumption (kWh) per pig produced assuming four weeks in the farrowing house and six weeks in the weaner accommodation. Heat energy consumption per weaner pig across the range of farms in this study is thought to be lower than is typical in the industry. This is because as soon as logging was introduced savings were identified and implemented immediately!

Figure 12 Mean electrical energy consumption (heating)



Farrowing accommodation

Farrowing-room electricity use varies surprisingly little during the year, even though it is mostly used for heating. The trial results showed little difference in energy consumption between heat pads and heated creeps. On one unit, creeps were modified so that they were enclosed more effectively and temperature better regulated in a piglet microenvironment. Electricity used for heating was halved and weaning weight of the pigs increased.

Lighting

Lighting has a significant impact on pig behavioural patterns. But in almost all cases it is manually switched to suit the working habits or preferences of workers – not pigs.

Feed systems

Electrical energy for feed delivery in the wet feed systems studied cost up to 30p per pig whereas in the dry feed systems running costs were insignificant. This cost difference can however be justified through improved performance seen from liquid feeding. Trials on feeding finishing pigs at Stotfold PDU demonstrated a cost of production reduction worth more than £2.50 per pig.

From monitoring energy use on many farms it has become apparent that there is wide variation between apparently similar units. Also, there can be large differences in energy consumption between similar rooms on the same farm. A strong influence on electricity use is how systems are used, rather than what they are. In practice, the decision makers in this regard are end-of-line operatives.

Energy saving messages are usually addressed to owners and managers and tend to emphasise technical and equipment-oriented aspects, such as choice of fans for efficiency, lighting and heating methods and the importance of insulation. Though equipment-oriented solutions may be significant, they have less impact on electricity consumption than how the equipment is used on a day-to-day basis. This is a function of staff training and motivation.

Once sufficient data has been collected and analysed, advice on improving energy efficiency, along with farm examples and case studies, will be communicated to the industry through printed material and producer workshops. This will help the industry improve its efficiency and reduce costs of production.

LUPINS IN SUSTAINABLE AGRICULTURE (LISA)

Research partners:	IGER, University of Newcastle
Industry partners:	PGRO, TAG, Germinal Holdings, MDC, MLC, ABNA, Kelvin Cave
Sponsors:	Defra (LINK), BPEX
Project duration:	2004-2008

This project is addressing the use of spring-sown lupins (*Lupinus luteus* cv. Wodjil and *Lupinus angustifolius* cv. Prima) in UK agriculture. Lupins potentially offer a home-grown high protein feed source comparable to Soya. Initial results are already suggesting that lupins have the potential to provide a high protein grain of known provenance that could provide the UK with a useful source of oils, energy and secondary metabolites.

The genetic improvement aspect of LISA (carried out at the Institute of Grassland and Environmental

Research (IGER)) is being undertaken in yellow and narrow leaf (blue) lupins and is focusing on enhancing yield, modifying crop architecture, achieving earlier maturity and improving tolerance of alkaline soils.

Lupins growing at IGER

Agronomic development of the crop has been carried out by the University of Newcastle, the Processors and Growers Research Organisation (PGRO) and The Arable Group (TAG). This work has looked to improve the understanding of the crop and to further develop the agronomic package available to support lupin production in both conventional and organic systems.

Feeding studies have been carried out with pigs at the University of Newcastle and have indicated that, compared to Soya, lupins offer both opportunities and challenges. Lupins have a protein content at least 10% greater than peas or beans, with a reasonable amino acid balance. They also have a higher oil content, but a relatively high fibre content offsets the potential benefit of this for digestible energy. The composition and nutritive value also varies between varieties, with white lupins having higher nutrient density but poorer palatability and digestibility than narrow leaf lupins. To assess their potential for inclusion in pig diets, two different varieties of lupin (Wodjil, a yellow lupin, and Prima, a narrow leaf lupin) were compared with Hiprosoya in a metabolism study with 49 growing pigs of 40 kg initial live weight. The apparent digestibility of dry matter, nitrogen and phosphorus were measured, together with urinary excretion. The lupin varieties were included as 10 or 20% supplements to a barley-based diet. The samples used in this study showed a crude protein content of 35% (Wodjil) and 28% (Prima). Results indicated that dry matter and nitrogen digestibility were poorer for both lupin varieties than for Soya (Wodjil; 83-84% of that of Soya and Prima; 90-91% of that of Soya). These values indicate only the apparent digestibility, which may overestimate true amino acid contribution because of the activity of other factors affecting utilisation. The other element influencing the use of lupins in pig feeding is their effect on feed intake. There are reports that inclusion of lupins makes diets less palatable and it was noted that feed refusals were greater with diets containing lupins. This suggests that careful diet introduction would be necessary.

IMPROVED UTILISATION OF FARM MANURES AND BIOSOLIDS THROUGH THE DEVELOPMENT OF RAPID ANALYSIS VIA NEAR INFRARED REFLECTANCE SPECTROSCOPY (NIRS)

Research partners:	ADAS, IGER, Eurofins Laboratories
Industrial partners:	MDC, HGCA, EBLEX, BPEX, BPC, GrowHow UK, Bruker Optics UK, Grampian Country Pork, Buckie, Agrivert, Spreadwise, Severn Trent Water, Yorkshire Water
Sponsors:	Defra (LINK)
Project duration:	2007-2010

Photograph kindly supplied by David Chadwick

The project addresses the need for practical guidelines for the management of nutrients following application of manures to land - essential for economically and environmentally sustainable use of manures and compliance with the requirements of NVZs, Water Framework Directive and other environmental regulations. The research involves the innovative development of Near Infrared Reflectance Spectroscopy (NIRS) to provide a rapid, reliable and low-cost analysis of organic manures for a wide range of nutrients.

The developed NIRS technology will be applied to study the variability of manures in storage and during field spreading.

Current interest in managing manures as a nutrient source in cropping systems is strong:

- Statistics show that almost 70% of farms apply some manure to their land
- In crop area terms, manures are applied to some15% of cereals, 90% of forage maize, 50% of grass leys, and 30% of potatoes
- Currently 11% of farms import manures onto their land (this is likely to increase with cross compliance)
- Export of manure occurs from 20% of pig units (with some, all is exported)
- Manures are valuable sources of plant nutrients - N, P, K, S and organic matter, which enhance soil fertility, soil structure and water retention

- At recent fertiliser prices (December 2007), potential nutrient values of manures can be estimated at £4.00/m^3 for pig slurry, £7.50/t for pig FYM
- Manure production from a 1000 place finishing pig unit might be worth more than £17,000 per year

Savings in fertiliser applications to a cereal crop in excess of £100/ha are not difficult to achieve from a well-timed application of slurry or solid manure. Nevertheless, statistics on fertiliser use show that little allowance is made for the contribution from manures when considering crop nutrient requirements and fertiliser inputs. This results in excessive nutrient inputs, reduced profitability, increased risk of environmental emissions and potential for crop yield and quality problems.

Conventional laboratory analysis of manures is expensive, slow and, for solids, can give unreliable results. NIRS has greatly improved precision and reliability in the analysis of forages and is now routinely also used for the analysis of grain. In developing NIRS for the analysis of manure nutrients, the project aims to address some of the major concerns of farmers regarding the sustainable use of manures in cropping and grassland systems:

- Reliable information on nutrients applied in manures
- Their fate following application
- Imprecision during manure spreading

For more information about this project, or if you would be interested in supplying samples of pig manure or slurry to assist further development of the research during winter 2008, please contact Dr Lizzie Sagoo, ADAS Boxworth (Tel: 01954 267666; email: Lizzie.Sagoo@adas.co.uk).

Slurry top dressing

RAISING AWARENESS OF CLIMATE CHANGE WITH FARMERS AND LAND MANAGERS

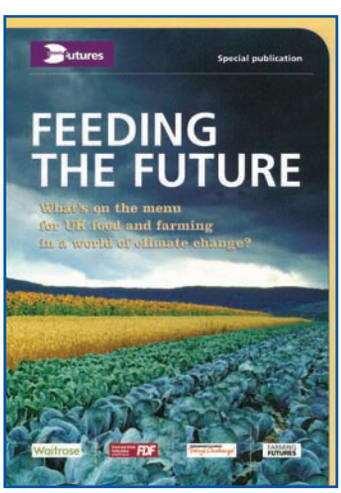
Research partners:	NFU, CLA, AIC, ARF, Defra
Industrial partners:	Defra
Project duration:	2007-2009

The MLC has been involved with the Farming Futures project since it began in January 2007. The project provides information and inspiration to farmers and land managers who want to find out more about the opportunities and risks presented by climate change. It suggests ideas on how to tackle farm responsibilities so farmers can be ready for new government legislation when it comes into force. By taking action to adapt business practices to mitigate climate change now, livestock farmers are more likely to be able to handle the impacts and have a more successful business in the future.

Farmers and land managers are already using the Farming Futures resources to improve the sustainability of their business. Sector specific fact sheets explain the likely impacts of climate change, the opportunities and challenges it presents, as well as ideas on how to take action to protect land and improve business.

The Farming Futures website (www.farmingfutures.org.uk) also gives case histories of farmers who are already taking action on their farms to adapt to, or combat, climate change. The events list is regularly updated and during 2008 the project will be running on-farm regional and sectoral workshops to help prepare farm business for climate change.

For more information or to share your story please visit ***www.farmingfutures.org.uk*** or contact Katie Zabel, project manager on ***k.zabel@forumforthefuture.org.uk*** or ***07825 204434***.



HEALTH AND WELFARE

IMPLEMENTATION OF EXISTING KNOWLEDGE ON TAIL BITING BY THE DEVELOPMENT AND EVALUATION OF PREVENTION AND OUTBREAK HUSBANDRY ADVISORY TOOLS

Research partners:	Universities of Bristol and Newcastle
Industrial partners:	RSPCA, Pig producers
Sponsors:	BPEX
Project duration:	2006-2009

This project will help producers identify and prevent the risks from husbandry, environmental and behavioural factors that may contribute to tail biting behaviour. The scientific literature reviewed at the start of the project established a number of potential risks for tail biting. This information has formed the basis of a husbandry advisory tool (HAT) that provides a farm-specific analysis of the potential risks on an individual pig unit. A key meeting of individuals with practical and scientific experience in January 2007 helped to develop the HAT further by ranking the risks according to severity and their priority for possible modification. The information has also been condensed into a critical review of tail biting data, which also introduces the concept of three potential forms of tail biting. This approach helps to explain why existing prevention methods are not currently successful on all farms.

The next stage of the project involves visiting farms to validate the husbandry advice. Ninety farms of varied types will be involved in the project. All farms will be monitored for tail biting by a researcher from the University of Bristol and some farms will receive additional support by highlighting the relevant risk factors on each farm. The BPEX Knowledge Transfer Team (and for those Freedom Food units involved, RSPCA Farm Livestock Officers) are participating in this visit programme. Producers and farmers are showing keen interest in the project and in helping to progress knowledge on tail biting and its prevention. Results obtained throughout the data collection and advice visits will be used to refine the HAT in order to disseminate the most useful information to veterinarians, producers and farms at the end of the project.

In collaboration with RSPCA a similar approach is being used to devise an outbreak advisory tool, which will investigate methods to reduce the impact of outbreaks and to identify risks and triggers that may have contributed to the behaviour. To validate this approach, the intention is to visit farms that are experiencing tail biting problems from Spring 2008.

Project partners are keen to work with producers from all types of finishing systems whether they have a tail-biting problem or not. Producers interested in being involved in the project are encouraged to contact the BPEX KT Team for further details.

EFFICACY OF SOME DISINFECTANT COMPOUNDS AGAINST PORCINE BACTERIAL PATHOGENS

Research partners:	Scottish Agricultural College
Industry partners:	BPEX
Project duration:	2006-2007

Effective prevention and control of infectious diseases in piggeries rests on a series of key factors including herd biosecurity, management of pig flow in combination with cleaning and disinfection, maintaining a good general level of hygiene, vermin control, vaccination, prompt treatment of infectious diseases and isolation of infected animals.

Cleaning and disinfection of buildings between batches of pigs is one of the most important critical control points, both in everyday prevention of diseases and in controlling the spread of infection during disease outbreaks. However, there is limited information in the scientific literature on the efficacy of disinfectants against bacterial pathogens that are endemic in the UK pig industry.

The objectives were:

- To test selected recent bacterial isolates, representing a range of common endemic diseases, against a number of disinfectants recommended for agricultural use
- To contribute to existing information on the range of susceptibilities of bacterial pathogens to disinfectants
- To optimise the benefits of the cleaning and disinfection procedures on farms and maximise the cost-benefits of these procedures

Seven chemical disinfectants were tested against 10 species of porcine bacterial pathogens that are common in UK pig units, using the British Standard method BS EN 1656:2000. A range of temperature conditions, two contact times and two levels of organic soiling were included.

The bacterial pathogens showed widely different susceptibilities to the different disinfectants and none of the compounds was universally effective. *Salmonella enterica* Typhimurium, *Salmonella derby*, *E.coli* (Abbotstown strain) and *Yersinia enterocolitica* generally showed poor susceptibility to disinfectants whereas *Brachyspira hyodysenteriae*, *Actinobacillus pleuropneumoniae*, *Bordetella bronchiseptica*, *Pasteurella multocida*, *Haemophilus parasuis*, *Streptococcus suis* and *Staphylococcus hyicus* were all susceptible to multiple disinfectants under low organic matter conditions. Under high organic matter conditions, the efficacy of disinfectant compounds was markedly reduced in most tests. Low temperature and short contact times adversely affected results in some tests.

This project has provided useful information of the susceptibilities of recent field isolates of porcine bacterial pathogens against a number of disinfectants deemed suitable for farm use. Unfortunately the limit on time and resources did not allow testing of a more diverse range of products or higher numbers of bacterial isolates. Extending the range of disinfectants tested and increasing the number of field isolates tested are the suggested directions for future work.

There are many factors that influence the choice of disinfectant compounds used on farms. Knowledge of the likely efficacy of compounds against the target infection and the conditions under which they will be used, are highly important. Additional factors to take into account are:

- Environmental temperature (the possible need for higher concentrations of disinfectant under cold conditions)
- Contact time (allowing 60 minutes or more wherever possible)
- Effectiveness of removal of organic matter before disinfection

Most disinfectants are hazardous to operators and the provision of training, protective clothing and equipment is important for health and safety reasons. Factors such as corrosiveness of compounds, environmental impact, fish toxicity and suitability for discharging run-off into drains and water courses all require careful consideration before use.

AERIOLOGY, PATHOGENESIS AND IMMUNOLOGY OF PORCINE POST-WEANING MULTI-SYSTEMIC WASTING SYNDROME: GENETIC ENVIRONMENTAL INTERACTIONS

Research partners:	Royal Veterinary College
Industrial partners:	Pfizer Ltd (UK), BioBest, BPEX
Sponsors:	BBSRC, BPEX, Pfizer Ltd (UK), BioBest
Project duration:	2007-2012

Since entering England in 1999, porcine post-weaning multi-systemic wasting syndrome (PMWS) has spread throughout the UK, reaching Scotland in 2002. Currently BPEX estimates that approximately 6000 units in the UK were affected with PMWS in 2006, and an estimated 83% of British pig units were affected in March 2007. PMWS is a common disease of young pigs in the UK. It is extremely debilitating, causes considerable suffering and poor welfare, and has a high mortality of up to 30%. It is estimated that the disease costs the UK farming industry £30m per year.

The overall aim of this project is to determine the genetic and environmental factors that cause wasting disease in pigs, thereby identifying novel preventive or therapeutic treatments to improve the health and welfare of growing pigs. The project will focus initially on post-weaning multi-systemic wasting syndrome (PMWS).

Pigs showing symptoms of PMWS

The objectives were:

- To elucidate the multi-factorial aetiology, epidemiology and pathogenesis of PMWS on commercial UK farms using a case-control study and to assess the potential benefits of preventive measures using epidemiological models
- To determine the cellular and/or genetic components of porcine circovirus 2 (PCV2) and secondary pathogens of PMWS that affect immune defences through *in vitro* experiments
- To develop an *in vivo* model of PMWS in order to understand the biological mechanisms that affect the pathogenesis of the syndrome
- To improve the health and welfare of growing pigs, thereby raising the competitiveness of the British pig industry
- To undertake a comprehensive programme of knowledge transfer to the British pig industry about PMWS and its prevention and treatment
- To develop new pharmaceutical products that may be used to prevent or control PMWS
- To develop a new diagnostic test for PCV2 suitable for use by veterinarians and others in Britain

This project comprises a unique interdisciplinary approach to investigate this endemic disease and will integrate modern scientific techniques from epidemiology, genetics, microbiology, pathology, molecular immunology and environmental science to identify why PMWS occurs, leading to new control methods.

British pig farmers will be involved in the project from the start, thereby guaranteeing that pigs in Britain will be the first to benefit from this research, while collaboration with a major international pharmaceutical company will ensure that new veterinary products will be made available to pig farmers worldwide.

The project is one of 10 BBSRC-funded projects in the UK that will employ cutting-edge bioscience to study endemic diseases. Together, they will contribute to improved animal health and welfare, as well as reduced economic losses. The research will generate better scientific understanding of the behaviour and spread of the diseases, which can then be used to improve their management and control.

RISK FACTORS FOR PIG DISEASE	
Research partners:	University of Newcastle, SAC, Veterinary Laboratories Agency, Livestock Management Systems
Industry partners:	BPEX, NPA, Assured British Pigs, Genesis Quality Assurance, Quality Meat Scotland and Agrosoft
Sponsors:	Defra, BPEX, Quality Meat Scotland
Project duration:	2006-2009

The objectives were:

To develop herd health strategies for the British pig industry that will promote animal health and welfare, leading to improved productivity and to a reduced incidence of foodborne zoonoses including Salmonella. More specifically:

- To perform epidemiological analysis of farm risk factors for different disease conditions of economic importance to the pig industry, by integrating retrospective information from existing industry databases containing data captured in abattoir health screening with those identifying farm production characteristics
- To design, test and implement a web-based Pig Herd Health Plan (PHHP)
- To assess the economic impact of disease in the UK industry through development and piloting of systems for capturing on-farm health and performance data

A PHHP template has been designed to include information on: standard farm details, biosecurity, current and previous basic production parameters, viral, bacterial and physical status, vaccinations and routine medications, treatments, health assessments and environmental assessments. This is uploaded onto the web via a standard PC. The web format has been trialled and launched with ten collaborating veterinary practices in England, and two in Scotland. All the medications fields in the PHHP website are linked to a database that contains the suggested route of administration, recommended dose and withdrawal time of available named UK medications. Farm specific pig data is also downloaded direct from the processors, which gives a weekly or batch update in the carcase weights, grading and condemnations from the unit.

The final component of data input has been to pilot the use of data capture forms for the quarterly veterinary visits. Data capture uses paper forms that are designed for use with digital pen technology, whereby all the information written on to the pre-designed pages is automatically uploaded via mobile phone technology to the PHHP database. The aim is to provide a system of assessment and recording during the farm visits that reduces the amount of time required by the veterinarian to write farm reports. The intention is to make the PHHP available to pig producers across the UK once any weaknesses and failures of the system have been identified and rectified.

To better use existing data sources to investigate national trends in pig health and the factors that might influence this, health information from the BPHS, Wholesome Pigs Scotland and ZAP databases has been integrated with information on farm production characteristics from the APB, GQA and QMS farm assurance databases using anonymous herd identifiers to link the relevant data. The databases are being cleaned, and missing information completed, prior to sophisticated multivariate analyses to identify risk factors for certain disease conditions. At the same time, plans for collection and integration of on-farm health data are being developed in preparation for a pilot study of an integrated system in 2008.

PIG HERD HEALTH PLANS (DIGITAL CAPTURE)

Research partners:	Livestock Management Systems Ltd
Industrial partners:	Genesis Quality Assurance, Longhandata, Innovent
Sponsors:	Defra, BPEX, Quality Meat Scotland
Project duration:	2007-2008

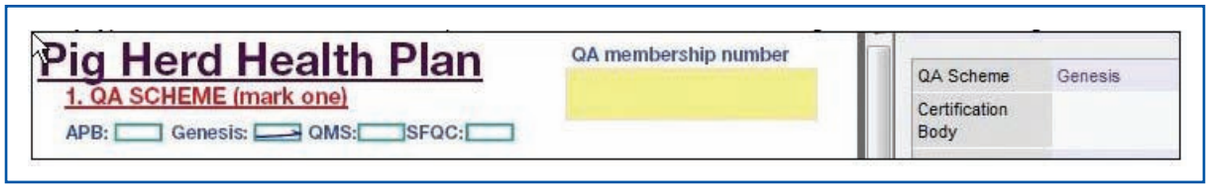
The project was designed to complement the pig herd health plan (PHHP) project funded by Defra, which has piloted the use of a standard herd health plan format on an internet base, with secure access for the producer and his veterinarian. Whilst aspects of the PHHP can be updated on-line when required, there is a need during quarterly visits for new information to be gathered whilst observing the pigs and facilities on farm. The digital capture project has piloted the use of digital pens and paper ***(Figure13)*** for health management on commercial units.

The digital PHHP form comprises 12 pages and just under 300 database fields. The forms and pens were completed and distributed to participating veterinarians in May 2007 and all technical aspects of the project work went well. Information from each completed form is transferred from the pen by Bluetooth to a dedicated mobile phone, which in turn transfers the information to a data 'warehouse'. Each PHHP form can then be viewed as a complete page-by-page electronic image (PDF) that is an automatic copy. Thereafter the written entries ***(Figure 14)*** are automatically transferred as a database entry to the farm PHHP on-line where it is updated and stored with a new date.

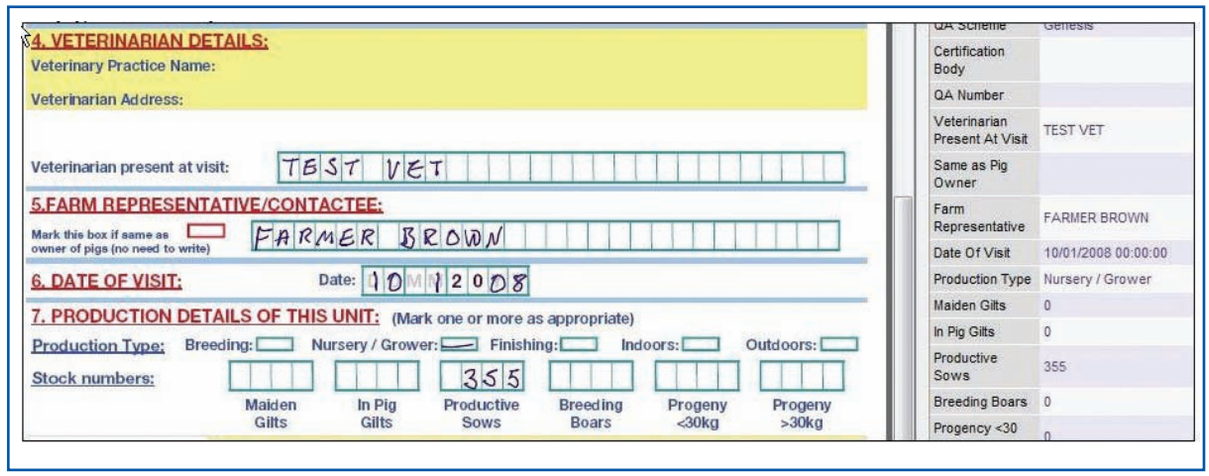
After initial population of the PHHP with farm data, the aim for subsequent visits has been to change only those fields that require change, and to eliminate continual rewriting of existing data. The digital PHHP form contains numerous fields (seen in yellow in ***Figure 14***) that can be overprinted with existing data from the farm PHHP prior to a farm veterinary visit, which provides both a check on previous information (such as action points) and a reduction in form filling (such as addresses and names).

Figure 13 Digital pen, docking port, mobile phone and sample forms

Figure 14 The digital PHHP form



Entry type: tick boxes - the user has ticked in the box 'Genesis' and on the right is the database entry.



Entry type: free text and tick box - the test text appears on the Longhand web service as an image - and on the right is the database entry - the handwriting having been digitised.

CONTROL OF PORCINE CIRCOVIRUS DISEASE (PCVD)

Research partners:	The Queen's University of Belfast, Merial SAS (France), Ghent University, Danish Institute for Food and Veterinary Research, Institute of Virology and Immunoprophylaxis (Switzerland), University of Saskatchewan, Robert Koch-Institut (Germany), Royal Veterinary and Agricultural University (Denmark), Sverige Lantbruksuniversitet (Sweden), ID-Lelystad (Netherlands), Devenish Nutrition Ltd, Centre de Recerca en Sanitat Animal (Spain), BPEX, Agence Française de Sécurité Sanitaire des Aliments, Danish Bacon and Meat Council, Veterinary Research Institute (Czech Republic), National Veterinary Research Institute (Poland), Kosice University of Veterinary Medicine (Slovakia), Szent Istvan University (Hungary), Croatian Veterinary Institute
Sponsors:	EU Framework 6
Project duration:	2004-2009

The objective is to generate scientifically sound information on the causes and the early development of Porcine Circovirus Diseases (PCVDs). This information will be used to develop control measures that will have a positive impact on the health and welfare of pigs.

PMWS and PDNS continue to have a serious economic impact on the English pig industry. Weaner mortality in some herds remains slightly higher than the baseline average before PMWS. Mortality patterns have now shifted primarily into growing and finishing pigs. Losses of animals approaching marketing weight are proving extremely costly. PCV2 associated diseases are also causing economic losses through poor growth and feed efficiency, as well as compromising animal welfare. In breeding herds, PCV2 may be associated with the reduction in litter size and in turn reduced annual sow productivity.

Pigs showing symptoms of Porcine Circovirus Disease

This EU Framework 6 funded project brings together a multidisciplinary consortium with expertise in epidemiology, pig genetics, pig nutrition, pathology, molecular biology, immunology, vaccinology, bacteriology and PCV virology to focus on the hows and whys of porcine circovirus diseases.

A key objective of the research programme is to standardise and harmonise the techniques involved in the diagnosis and investigation of this disease, so that relevant comparisons can be made between outbreaks on farms even if in different countries. This has been done through the development of reference materials, standardised operating procedures and ring trials.

Understanding the details of the molecular events following infection with PCV is a particular focus of the research programme. A second virus, PCV1, exists that is highly similar in genomic sequence but completely different in its pathogenicity.

There have been some promising results from studies that involve genotyping pigs for close to 300 microsatellite markers. The entire pig genome is covered and it should now be possible to detect the effect of a gene's influencing PMWS susceptibility no matter where in the pig genome it might be located. One region with a possible effect on PMWS susceptibility has been identified.

Different genogroups of PCV2 have been demonstrated in Denmark, Ireland, Spain and Sweden. There is preliminary evidence of an association between a "new" genotype of PCV2 and the emergence of PCVD in some countries but the association between the emergence of different genogroups and disease is less clear-cut in others.

At pig level PCV2 detection in serum, nasal secretions and faeces samples collected as part of the longitudinal study are being used to explore differences in viral load or excretion in pigs that did, or

did not, develop clinical PCVD. Studies on transmission of PCVD have demonstrated both in-contact and airborne spread. PRRSV infection has been identified as an important co-factor in airborne spread of PCV disease in Denmark.

An important characteristic observed with pigs developing PMWS is rapid loss of important cells in the immune system. PCV2 has been found most frequently associated with white blood cells that process antigen for recognition by the pig's immune system such as monocytes, macrophages and dendritic cells. This has important consequences for the immune defences of the host, because these cells are the central, critical element for the efficient development of immune defences. It has been noted that the dendritic cells also accumulate inactivated virus antigen, as used in current PCV2 vaccines. In this case, the accumulation could provide the cells with an enhanced capacity to induce strong immune responses against PCV2.

The presence of PCV2 appears to interfere with the ability of dendritic cells to recognise the "danger" signals presented by pathogens which means that the rapid detection of a potential pathogenic threat by immune defences is impaired by PCV2 infection, leading to a weakened response and weakened defences. As a result, it is important to control PCV2 infections, which in turn will increase the potential to maintain a healthy pig population. Recent work is demonstrating that an efficacious vaccine will provide an efficient means for such control.

The outcome of PCV2 infections in pigs is a battle between the immune defences and the virus in terms of control over the situation. If the balance can be modified in favour of the host through efficient vaccination, improved management or nutritional modification the objective of control of PCVD may be achieved. Current vaccines are showing the power of this approach.

Further information can be found on the project website (www.pcvd.org) and there is also a PCVD Discussion forum that is operated jointly with the Pig Site (www.thepigsite.com).

ADDING VALUE TO FARM ASSURANCE: ON-FARM EVALUATION OF HEALTH AND WELFARE OUTCOMES

Research partners:	The Universities of Bristol and Newcastle
Industry partners:	Assured British Foods, Assured Food Standards, State Veterinary Service
Sponsors:	BPEX
Project duration:	2006-2009

The aim of this project is to examine the feasibility and benefits of including some on-farm observations of health and welfare outcomes within Assured British Pigs and Genesis Scheme inspections. Farm assurance schemes have previously focused on resource-based parameters rather than on outcome-based observations and records of health and welfare. This project is designed to achieve benefits to producers (useful management information), consumers (improved welfare assurance), regulators (maximise compliance with legislation) and industry (maintain UK competitive position).

The project is being guided by a steering group including representatives of producers, farm assurance schemes, Pig Veterinary Society, retailers and Defra. The project strategy approved by the steering group is to explore the following potential mechanisms for adding value:

1. Demonstrate legislation compliance
2. Maintain access to marketplace
3. Productivity / management tool
4. Develop potential new marketing claims

The development phase included an extensive consultation programme with producers, veterinary surgeons and policymakers on the following potential parameters: tail lesions, body wounds, oral behaviour, lameness, sick animals, qualitative behaviour, cleanliness, human-animal interaction, social behaviour, health / productivity, pig keeping score and play / positive behaviour.

The evaluation phase will address the following questions:

- What do producers think of each parameter?
- What are normal ranges for each parameter?
- What is feasibility for each parameter?
- What is consistency between assessors?
- How reliable (over time) is assessment?

Under the guidance of the steering group the evaluation phase in 2008 will include visits from the project team, farm assurance assessors and pig veterinary surgeons. The direct farm visits also provide an opportunity to link with meat quality assessments in the abattoir and with the European Welfare Quality project that has similar objectives to this investigation. The farm assurance visits will enable a large number of producers to provide feedback on the details of any modification to farm assurance. The visits conducted by veterinary surgeons will provide suggestions for the optimum relationship between producers, farm assurance schemes and veterinary surgeons. The data collected during these visits will be critical for the formulation of recommendations in the final phase of the project.

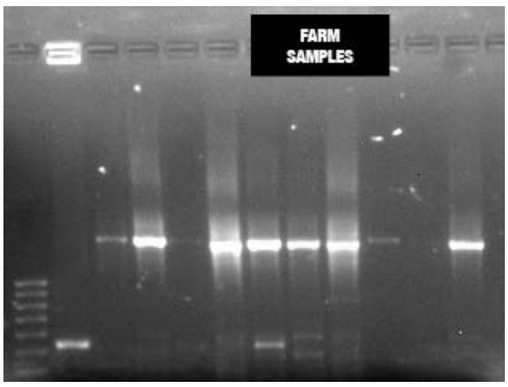
ON-FARM EPIDEMIOLOGY OF MAJOR ENTERIC DISEASES

Research partners:	University of Nottingham
Industry partners:	Elanco Animal Health
Sponsors:	BPEX
Project duration:	2006-2009

The objective is to achieve a better understanding of the transmission of diseases by vectors on pig farms by studying their role in the epidemiology and control of key diseases - *Lawsonia*, PCV 2b and *Brachyspira*.

A major component of understanding the control of pig diseases is the study of their transmission by on-farm vectors and reservoirs. While some older research has documented the occurrence of *Brachyspira hyodysenteriae* among some vectors on pig farms (such as mice can carry the agent for some 180 days), there is no recent information on *Brachyspira*, or on other key diseases such as PCV 2b or *Lawsonia*. Older concepts of disease transmission may be significantly altered in growing pigs facing PRRS, PMWS and other new challenges on UK farms. Several recent American studies have indicated that some insects, such as cockroaches, may be capable of carrying other enteric agents such as Salmonella for significant periods on commercial pig farms. Increases in organic bedding usage will also contribute to increased occurrence of some vectors and any agents they may carry around pig farms.

A positive floor trap in a farrowing house in the UK



A positive PCR result for DNA extracted from UK pig farm insects

A set of case study farms was constructed in 2007 to include the following: mixed-age farms, breeder-only farms, contract finishers, empty farms and various other scenarios. Most farms were thought to be *Lawsonia* and PCV-2b positive, but only some for *Brachyspira hyodysentariae*. Identification and access to the various farms involved was achieved via application to major British farm groups and their advisers. At each farm, numerous longitudinal vector samples and population-stratified faecal and bedding samples were collected, particularly over the summer when insects are most active. Insects and invertebrates were collected via aerial sticky traps, motorised vacuum devices, floor and pitfall traps and sweep nets and later identified.

Prominent groups, mainly of flies (Diptera - non-biting), beetles (Coleoptera), midges (Diptera - biting) and other insects - particularly cockroaches (Blatta sp) were found on at least one farm and the parts of each farm carrying the particular types of insects are being mapped. Further survey work to establish the UK prevalence of some of these insects is also underway. DNA has been extracted from most of

each group of representative vectors and PCR techniques searching these samples for *Brachyspira*, *Lawsonia* and PCV-2b is underway. A selection of PCR-positives for each agent will be tested by specialised sub-typing techniques - to try to determine the origin of the agent in each case.

To date a wide range of flies, beetles, midges and some cockroach activity has been found on pig farms. These findings have led to the development of fly and cockroach cultures at the research facility and relevant challenge exposure projects will be conducted. Preliminary studies will include the inoculation of these insects with each agent.

ASSESSING ANIMAL WELFARE ON BRITISH PIG FARMS

Research partners:	Royal Veterinary College
Industry partners:	Pig producers
Sponsors:	BPEX
Project duration:	2006-2009

Modern British pig farming requires tight product specifications to be met profitably while adverse environmental impacts are minimised and animal health and welfare are promoted, all in a way that the consumer will accept and/or demand. The pig farmer operates in a complex economic environment in which the requirements of various regulatory bodies must be satisfied.

This project aligns with the BPEX strategic priority for pig health and welfare to establish the current welfare status of the British pig herd. All sectors and stages of pig production are covered. The project's aims and our progress are:

1. To develop validated protocols for the assessment of pig welfare. This was successfully completed within the first three months of the project in conjunction with experts at the RVC, the complementary Bristol BPEX project, pig producers, pig veterinarians and contacts within assurance schemes. Welfare is assessed by observations of clinical signs of health and behaviour in individual and groups of pigs, provision of resources (eg flooring design) as specified in the Defra Welfare Code, disease incidence and treatment, and pig productivity.
2. To train veterinary undergraduates in formal assessment of pig welfare. By February 2008, the first cohort of around 220 first year students had been trained and 80 had completed the welfare assessment on British pig farms. A robust series of lectures and training sessions were devised and implemented, including a computer-based Virtual Assessment (VA) using Perception software for assessing a student's ability to observe clinical signs of ill health. Validation studies are underway using information from the VA, discrete experiments and visiting students on placement to allow us to monitor inter-observer variability and therefore the reliability of the data gathered. The second cohort of around 260 first year students will be trained during 2008.
3. To survey the welfare of pigs on British farms in an epidemiological study. Suitable epidemiological techniques are being investigated and an Access database has been constructed to handle the large data stream and to produce tailored reports and information to be fed back to the participating farmers.
4. To provide participating farmers and BPEX with benchmarks for good welfare. Results have yet to be analysed before feedback reports can be generated.

This ongoing survey of pig welfare on British pig farms will allow risk factors for welfare to be identified under farm conditions using a validated, repeatable, reliable and objective method with feedback to the farmer. It will provide benchmarks for individual farms, allow the linkages between welfare and production to be determined and enable long-term trends in welfare to be established and, potentially, goals set.

THE PREVALENCE AND COST OF TAIL BITING IN DIFFERENT PRODUCTION SYSTEMS

Research partners:	Newcastle University, BQP
Industry partners:	Pig producers
Sponsors:	BPEX
Project duration:	2007

The project:

- Brought together recorded information on carcases detained for tail biting and farm production records
- Assessed the consequences of leaving tails undocked in outdoor born pigs reared in straw based finishing systems

Data on 288 batches of pigs from 98 farms were matched for analysis. Signs of tail biting were absent in 20% of the batches when assessed in the abattoir. Of those batches affected with tail biting, 98% showed a prevalence of less than 1% within the batch, and all batches had a prevalence of less than 2.5%. A decrease in monthly tail biting prevalence from 0.6 to 0.1% was observed over the study period (November 2005 to June 2007). Tail biting in a batch was linked with reduced daily live-weight gain.

Data were also collated from a contemporary comparison of pigs which were tail docked or left undocked on two occasions (Winter 2006 and Summer 2007). In the first batch, 12 out of 28 pens of undocked pigs showed tail biting whereas none occurred in docked pigs. In the second replicate, which was a repeat fill of the same buildings, tail biting was seen in only 1 pen, which was of docked pigs. These results emphasise the unpredictability of this problem, and thus the risk of ceasing to dock.

JOINT-ILL IN PIGLETS AND ITS CONSEQUENCES FOR PRODUCTION LOSSES IN THE GROWER-FINISHER HERD

Research partners:	University of Cambridge
Industry partners:	Pig producers
Sponsors:	BPEX
Project duration:	2007

Joint infections in pigs of all ages cause significant losses due to increased mortality (euthanasia), reductions in growth performance, the need for individual housing and treatment and abattoir

condemnations. Lameness due to joint infection is also a major welfare issue in piglets, growers and finishers. This project aimed to establish whether animals treated for joint-ill as piglets suffer re-occurrence of joint problems in later life, or if cases observed later in life are actually new cases with a different cause. The results of studies on two 500 sow units and a 5000 pig finisher unit showed that a higher proportion of piglets which had joint-ill were affected by lameness as finishers. Using plastic-slatted-raised farrowing crates reduced the amount of piglet joint-ill compared to concrete crates and piglets with skin wounds were more likely to become lame with joint-ill (hock and ear-biting wounds being particularly important). The same types of environmental bacteria were found in the joints of lame piglets and finishers indicating that contamination of wounds is commonly associated with lameness in both ages of pig. The results of this study demonstrate the importance of controlling joint infections in piglets in order to reduce the risk of lameness in finisher pigs.

TESTING FOR THE ASSOCIATION BETWEEN PLEURISY AND THE INFECTION WITH APP AND PRRSV IN FINISHING PIGS

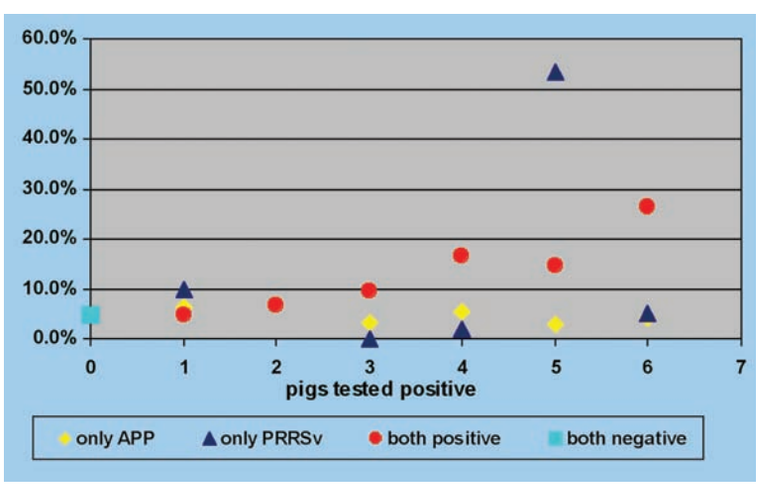
Research partners:	Scottish Agricultural College
Sponsors:	BPEX
Project duration:	2007

This study investigated the association of two main infectious agents, Actinobacillus pleuropneumoniae (APP) and Porcine Reproductive Respiratory Syndrome virus (PRRSv) with the presence of pleurisy in the pigs at the moment of slaughter.

Observed data (see ***Figure 15***) suggest that increasing number of pigs either positive to APP or PRRSv slightly augment the proportion of animals affected with pleurisy; however those batches with increasing number of pigs positive to both APP and PRRSv tend to have higher proportion of pigs affected with pleurisy. These findings were robustly evaluated with a statistical model.

Overall the results are suggestive that it is a co-infection with APP and PRRSv which increases the proportion of animals affected with pleurisy rather than infection with APP and PRRSv alone.

Figure 15 Pigs tested positive for APP and/or PRRSv and the proportion of pleurisy in the batch



MEAT QUALITY

ATTITUDES, PRACTICES AND STATE-OF-THE-ART REGARDING PIGLET CASTRATION IN EUROPE (PIGCAS)

Research partners:	Eleven core partners from across Europe, including University of Newcastle. Thirty-six participants as country contact persons, including BPEX
Sponsors:	European Sixth Framework Programme participants
Project duration:	2007-2008

The project has the objectives:

- To collect information on the attitudes of relevant stakeholders
- To collect information on the practice of pig castration
- To evaluate research work and other information to examine the various alternatives to surgical castration without anesthesia and derive research priorities
- To integrate the collected information and evaluation in a report providing support for EU policy

There is an underlying desire amongst the majority of stakeholders to reduce the need for castration of pigs in Europe with a number of countries moving towards restricting castration practice. The project is aimed at providing the European Commission with information to support decision-making. Information will be gathered on both existing practices in the EU and attitudes of consumer groups, NGOs (welfare groups) and industry stakeholders regarding castration. The project participants aim to use the opportunity to define research needs on entire males/boar taint as part of the project output.

BPEX has participated as country contact for two work packages. Stakeholders in GB have been surveyed using a questionnaire designed by the project group. A meeting of stakeholders from across Europe was held in the autumn of 2007 to discuss the issues arising from the survey and gain further insights into areas of divergence and convergence between different stakeholder groups. There was a general ambition to see castration cease but difference in opinion as to the timescale under which this was reasonable and the preferred alternatives.

BPEX has also provided scientific expertise in undertaking an update of the European Food Safety Authority report on castration.

Participation in the project has already given access to information on practice and attitudes related to castration in the EU. The remainder of the project will enable an input into the proposed research priorities that will be presented to the European Commission as part of the outcome of the project, ensuring that these include utilisation of entire males.

IMPROVEMENT OF PORK TENDERNESS AND FLAVOUR ON-FARM

Research partners:	Agri-Food and Biosciences Institute
Sponsors:	Department of Agriculture and Rural Development for Northern Ireland, BPEX
Project duration:	2006-2009

There is evidence that production practices (e.g. variation in growth rate, weight at slaughter and genotype) can influence pork tenderness and flavour but there is limited information from recent genotypes under current systems of production. Growth rate variability can be considerable between and within units and this may contribute to variability or inconsistencies in pork eating quality. In one study, average growth rate varied from wean to slaughter by at least 130g per day, and even greater growth rate variation was found between pigs within herds, in particular herds with poor average performance. 'Tempo' and Pietrain sires have now been introduced into the pig population to counteract the negative effect of post-weaning multi systemic wasting syndrome (PMWS). Their effect on production performance and eating quality of pork also merits investigation.

In the current research project the effects of variable average daily gain, breed and slaughter weight on the eating quality of pork are being investigated.

Study 1

This study was established to evaluate the effects of growth rate and slaughter weight on meat quality.

A number of significant relationships were obtained between growth rate in the finishing period and meat quality, ie drip loss, colour and cooking loss, but the variation explained by these relationships was low. There was a significant ($p<0.05$) negative relationship between average daily gain from 10 to 15 weeks and Warner Bratzler Shear Force (WBSF), but the relationship explained only 3.8 % of the variation in WBSF. Initial inspection of the data indicates that where the base growth performance is already good, there is little relationship between WBSF and increased growth rate when a final weight of 100-110 kg is considered, and comparative ADG achieved was 740 to 920 g/d over 10 to 20 weeks of age. A complete report on the findings is currently being compiled and will be available during 2008.

Study 2

Meat samples from a total of 216 pigs have been taken to evaluate the effect of breed, (Tempo, Pietrain (Austrian line), Pietrain (Pure Belgium line) and Landrace (Norwegian Line)) slaughter weight (95, 105 and 115 kg) and sex on meat and eating quality of pork. Samples are currently being analysed. Analyses will be completed by Autumn 2008 and a report will be available by Spring 2009.

REDUCTION OF BACKFAT SKATOLE THROUGH DIETARY MEANS

Research partners:	BPEX Pork Chain Unit (University of Bristol)
Industry partners:	Premier Nutrition, Bowes of Norfolk
Sponsors:	BPEX
Project duration:	2007-2008

Preparing backfat samples for measurement of skatole

Skatole, a product of fermentation in the hindgut of the pig associated with the amino acid tryptophan, is one of the two compounds which, at high levels, cause boar taint. The other is androstenone, originating from testosterone. Skatole production is affected by dietary fibre and this project will determine whether inulin, a fibre found in chicory, is effective in reducing skatole below the threshold where boar taint can occur. Chicory is expensive but it is believed that levels of skatole can be reduced significantly when chicory is included in the diet at a fairly low level for a short period immediately before slaughter.

In the first part of the work, average values for skatole and androstenone are being measured in the backfat of 50 male pigs from 30 pig farms supplying a major processor. Strips of backfat are removed immediately after slaughter and these are transported to the University of Bristol for analysis. The feeding trial will be conducted on one of these 30 farms. The plan is to introduce the test diet so that pigs consume it for 0, 1, 2 or 3 weeks, after which backfat samples will be collected on the slaughter line.

The use of chicory in the diet immediately before slaughter may have the additional benefit of reducing Salmonella levels in pigs going to slaughter. Chicory causes a change in bacterial populations in the hindgut, which may reduce the colonisation by Salmonella.

COMPARISON OF PORK QUALITY TRAITS IN FAST AND SLOW GROWING PIGS

Research partners:	BPEX Pork Chain Unit (University of Bristol), BPEX Pig Development Centre (University of Leeds)
Industry partners:	Tulip Supply Group
Sponsors:	BPEX
Project duration:	2007-2008

There is some evidence that variable growth rates cause variable pork quality and two projects currently underway will add further information to the current pool of knowledge. The meat quality traits of particular interest are toughness and boar taint. The first project is being undertaken at Leeds University, with slaughter of the pigs at George Adams and meat quality measurement at the University of Bristol.

Large White x Landrace male and female pigs are being fed *ad libitum* at Leeds University and weighed at regular intervals before slaughter at 90 kg or 110 kg liveweight. Within sex and liveweight groups, the top and bottom 35% of pigs in terms of growth rate from weaning to slaughter are defined as fast and slow growing respectively. For males at 110 kg, growth rates from 55 kg to slaughter average approximately 780 g/day for the fast group and 580 g/day for the slow group. In addition to the fast and slow growing groups, a third group of growth-checked pigs is being studied. These have undergone growth stasis or weight loss, probably because of subclinical infections. Anecdotal evidence suggests these pigs may have particularly poor meat quality.

Conventional and Autofom carcase measurements are being recorded at slaughter for comparison. ***Table 10*** indicates carcase P2 fat depth and percentage lean meat yield across sexes derived from conventional and Autofom measurements respectively.

Table 10 P2 fat depth and percent lean meat yield of pigs grown at different rates

	Fast	Slow	Growth-checked	Significant
90 kg				
P2 (mm)	10.1	9.5	8.7	***
Lean meat (%)	62.7	63.3	63.3	NS
110 kg				
P2 (mm)	10.8	10.9	9.8	NS
Lean meat (%)	62.4	63.2	64.2	**

Vacuum-packed loin joints from the pigs have been despatched to Bristol where a comprehensive evaluation of meat quality is being undertaken. Results in ***Table 11*** are for toughness, measured as the force required to cut (shear) blocks of loin muscle. The results show that the fastest growing pigs have the least tough (ie most tender) muscle.

Table 11 Toughness (shear force measured in kg) in loin muscle samples of pigs growing at different rates

	Fast	Slow	Growth-checked	Significant
90 kg	4.49	4.81	5.17	NS
110 kg	4.32	5.62	5.26	***

** Increasing shear force indicates increasing toughness*

These results will encourage producers to deliver improved pork eating quality through speed of growth as well as gain an economic advantage associated with superior growth rates.

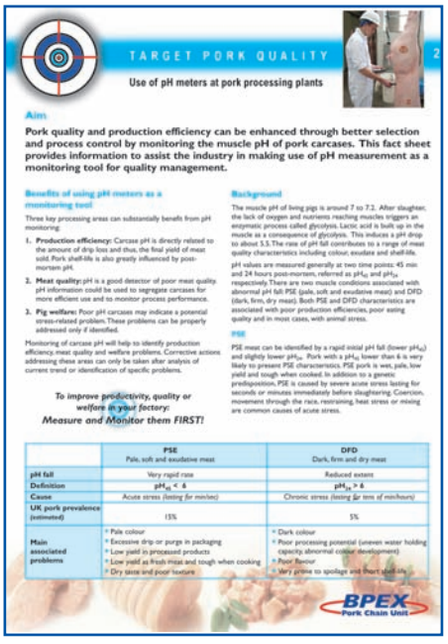
The second project on growth rate is being conducted with Tulip Supply Group on batches of pigs going through four of their units. Male pigs from the first group to finish in the batch (first pull) will be compared with those from the last to finish. Again, the focus is on toughness and boar taint. In a preliminary study, skatole and androstenone levels in backfat have been measured in 150 pigs whose growth rates and carcase weights are known. These data will give the company a benchmark for boar taint compounds.

EXERCISE TO PROMOTE THE USE OF pH METERS IN BRITISH ABATTOIRS

Research partners:	BPEX Pork Chain Unit (University of Bristol)
Sponsors:	BPEX
Project duration:	2007-2008

After slaughter, the pH in the loin muscle of pigs falls from about 7.0 to about 5.5 when the carcase is butchered. If the pH remains high or falls too quickly, resulting meat quality is poor. Usually the causes are pre-slaughter handling problems resulting in stress to the pig. Measurement of pH is therefore a useful tool for identifying affected carcases that should not be used for fresh pork and for finding out which farms or handling systems are producing product variability.

One reason that routine monitoring of pH is not widely carried out in British abattoirs is that the equipment available is considered difficult to use. A study of commercially available pH meters was therefore carried out in the PCU and a fact sheet has been produced (Target Pork Quality no. 2). Commercially available devices tested were compared in terms of accuracy, precision, practicality and price. Four of the devices had glass electrodes, which are robust if handled carefully, and one had non-glass components. Each has pros and cons, which are listed in the fact sheet. It is hoped that interest from processors will encourage the manufacturers of pH measuring equipment to develop more user-friendly measuring systems which will become more common in British abattoirs.


TARGET PORK QUALITY

Use of pH meters at pork processing plants

Aim

Pork quality and production efficiency can be enhanced through better selection and process control by monitoring the muscle pH of pork carcases. This fact sheet provides information to assist the industry in making use of pH measurement as a monitoring tool for quality management.

Benefits of using pH meters as a monitoring tool

Three key processing areas can substantially benefit from pH monitoring:

1. **Production efficiency:** Carcase pH is directly related to the amount of drip loss and thus, the final yield of meat sold. Pork shelf-life is also greatly influenced by post-mortem pH.
2. **Meat quality:** pH is a good detector of poor meat quality. pH information could be used to segregate carcases for more efficient use and to monitor process performance.
3. **Pig welfare:** Poor pH carcases may indicate a potential stress-related problem. These problems can be properly addressed only if identified.

Monitoring of carcase pH will help to identify production efficiency, meat quality and welfare problems. Corrective actions addressing these areas can only be taken after analysis of current trend or identification of specific problems.

To improve productivity, quality or welfare in your factory: Measure and Monitor them FIRST!

Background

The muscle pH of living pigs is around 7 to 7.2. After slaughter, the lack of oxygen and nutrients reaching muscles triggers an enzymatic process called glycolysis. Lactic acid is built up in the muscle as a consequence of glycolysis. This induces a pH drop to about 5.5. The rate of pH fall contributes to a range of meat quality characteristics including colour, exudate and shelf-life.

pH values are measured generally at two time points: 45 min and 24 hours post-mortem, referred as pH_{45} and pH_{24} respectively. There are two muscle conditions associated with abnormal pH fall: PSE (pale, soft and exudative meat) and DFD (dark, firm, dry meat). Both PSE and DFD characteristics are associated with poor production efficiencies, poor eating quality and in most cases, with animal stress.

PSE

PSE meat can be identified by a rapid initial pH fall (lower pH_{45}) and slightly lower pH_{24}. Pork with a pH_{45} lower than 6 is very likely to present PSE characteristics. PSE pork is wet, pale, low yield and tough when cooked. In addition to a genetic predisposition, PSE is caused by severe acute stress lasting for seconds or minutes immediately before slaughtering. Coercion, movement through the race, restraining, heat stress or mixing are common causes of acute stress.

	PSE Pale, soft and exudative meat	DFD Dark, firm and dry meat
pH fall	Very rapid rate	Reduced extent
Definition	$pH_{45} < 6$	$pH_{24} > 6$
Cause	Acute stress (lasting for min/sec)	Chronic stress (lasting for tens of min/hours)
UK pork prevalence (estimated)	15%	5%
Main associated problems	• Pale colour • Excessive drip or purge in packaging • Low yield in processed products • Low yield as fresh meat and tough when cooking • Dry taste and poor texture	• Dark colour • Poor processing potential (uneven water holding capacity, abnormal colour development) • Poor flavour • Very prone to spoilage and short shelf-life

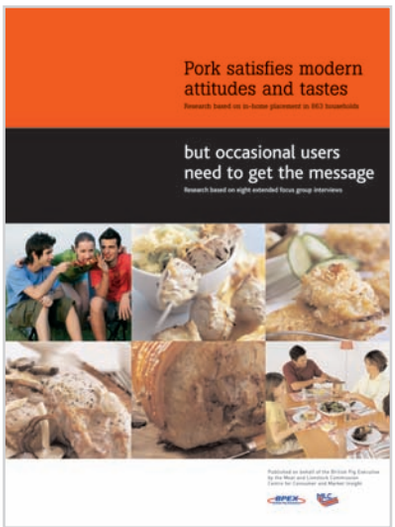
BPEX Pork Chain Unit

CONSUMER ACCEPTABILITY OF BRITISH PIG MEAT AT RETAIL

Research partners:	MLC Centre for Consumer and Market Insight, Pathway Research Limited
Sponsors:	BPEX
Project duration:	Spring 2007

In early 2007 BPEX commissioned consumer research on the quality of British pork. This comprised two elements. In the first, 880 regular pork-consuming households received pork loin steaks purchased from the standard or premium lines of four major retailers. This was aimed at establishing quantitatively current consumer acceptance of pork quality. Consumers cooked the pork to their normal cooking method. Overall the level of satisfaction with the pork was high with average scores for overall liking of 8.22 and 8.30 (on a 10-point scale) for standard and premium product respectively. When asked what they liked about the product, consumers spontaneously referred to taste, texture, flavour and level of fat. Conversely, for the proportion of consumers (21%) who said they disliked something about the pork, texture and blandness were the top characteristics. Variation in texture is therefore a key determinant of liking, with blandness being seen by some as undesirable.

The second element was qualitative (focus group) work with rare or infrequent consumers of pork. This highlighted that the key reason for not consuming pork was a lack of knowledge on what to do with it. Pork was seen as having inferior taste credentials to other meats, being bland, and consumers lack ideas on how to cook it to add flavour (eg sauces). Opportunities seen by consumers were promoting pork's "natural" image.



A full report can be obtained by contacting Lesley Jolley on 01908 844247.

REVIEW OF FACTORS INFLUENCING PORK EATING QUALITY

Research partners:	BPEX Pork Chain Unit
Sponsors:	BPEX
Project duration:	2006-2007

A review of factors influencing pork quality was undertaken by the Meat Scientist and this was used to define new guidelines which have been published as Target Pork Quality 1.

This describes the key factors through the whole production chain that are important in determining product quality.

BPEX-funded projects on-going, but thus far with insufficient results to report.

SEASONALITY IN BREEDING PIGS
Partners: BQP, BPEX PDC
Project duration: 2007

GENETICS OF LITTER SIZE AND FOETAL LOSS IN PIGS
Partners: Roslin Institute, BPEX
Project duration: 2006 - 2009

COMPARISON OF EATING QUALITY IN GLOUCESTERSHIRE OLD SPOTS AND MODERN PORK
Partners: Defra, Gloucestershire Old Spots (GOS) Pig Breeders Club, Rare Breeds Survival Trust and Traditional Breeds Meat Marketing Co Ltd
Project duration: 2007

DEFINING THE BEHAVIOUR OF DIFFERENT PIG GENOTYPES
Partners: BPEX PDC, University of Leeds
Project duration: 2007 - 2008

COST BENEFIT ANALYSIS OF HEALTH MANAGEMENT STRATEGIES IN FINISHING PIGS
Partners: BPEX, Newcastle University, VLA Thirsk
Project duration: 2007 - 2010

DOES THE METHOD OF PIG PRODUCTION AFFECT HUMAN HEALTH?
Partners: BPEX, University of Leeds
Project duration: 2006 - 2009

IMPROVING THE QUALITY OF BRITISH PORK AND BACON
Partners: BPEX, University of Bristol
Project duration: 2006 - 2009

AN ENVIRONMENTAL ANALYSIS OF THE CONSEQUENCES OF USING HOME GROWN PROTEIN SOURCES IN PIG DIETS
Research partners: BPEX, Scottish Agricultural College
Project duration: 2007 - 2008

ACUTE PHASE PROTEIN INDEX
Research partners: BPEX, SEERAD
Project duration: 2007 - 2010

THE USE OF HOME-GROWN LEGUMES AS A PROTEIN SOURCE IN PIG DIETS
Research partners: BPEX, SAC, University of Nottingham

THE MANAGEMENT OF THE WEANER PIG THROUGH NUTRITION
Research partners: BPEX, SAC

THE DETECTION OF HEALTH PROBLEMS THROUGH AUTOMATED RECORDING OF FEEDING BEHAVIOUR
Research partners: BPEX, SAC

Postgraduate studentships

Each year the MLC provides support to a number of postgraduate students who are engaged on research projects relevant to the livestock and meat industry.

- 3 year PhD
- 1 year and 2 year research Masters
- 1 year taught Masters
- Summer vacation scholarships

A postgraduate students' seminar took place at the MLC, Milton Keynes, on 20-21 November 2007. This is an annual event, which allows MLC's postgraduate students to give short presentations of their research aims and objectives, and research findings to date, to MLC staff, selected guests as well as the other students. For further information contact Heather Leask (Email: heather.leask@ahdbms.org.uk Tel: 01908 844264).

COMMUNICATIONS AND INFORMATION DISSEMINATION

A wide range of leaflets, booklets and reports have been published by the MLC on behalf of BPEX. These provide both technical and practical information to help producers tackle many of the challenges faced by the British pig industry. Some publications are one-offs while others form part of a series and where appropriate they are produced in conjunction with other organisations.

The full catalogue of publications is available on the BPEX website, many of which can be downloaded to your computer; hard copies can be obtained, free of charge, from the Technical Division (Tel: 01908 844734).

Some of the most recent publications include:

Action for Productivity These advisory notes contain targets for producers to aim for and advice on how to achieve them, along with facts and advice aimed at stockmen. From a practical standpoint, they are made of durable wipe-clean material and can be stuck on the wall as a reference tool.

1. Regular worming
2. Strawing up
3. Heat stress (indoors)
4. Heat stress (outdoors)
5. Creep feeding
6. Enzootic pneumonia
7. Factors affecting killing out percent