

RESEARCH AND DEVELOPMENT PROGRAMMES

PRODUCTION, EFFICIENCY AND ENVIRONMENT

Defining the benefits of new genotypes	
Research partners:	BPEX Pig Development Centre (University of Leeds) BPEX and Pork Chain Unit (University of Bristol)
Industrial partners:	Primary Diets, AB Agri
Sponsors:	BPEX
Duration:	2006–2009

Until recently, the most common breeds of pig in UK production were the Large White and Landrace with crosses between these forming the bulk of slaughter pigs. Recently there has been great interest in other terminal sire breeds, for example Duroc, Pietrain and Hampshire, particularly the latter two.

Reasons are connected with greater resistance to disease and improved productivity in hybrid pigs from a diverse genetic background. The objectives of this study were:

- To provide an independent comparison of three different terminal sire breeds and hence to provide an impartial assessment of the major intrinsic differences between modern sire breeds for the use of British farmers
- To provide general information which can be used in decision making by British farming in determining appropriate breeding strategies for their particular unit
- To investigate the response of different genotypes to dietary lysine in the weaner, grower and finisher rations
- To compare lean meat yield and meat quality from each of the different genotypes
- To make recommendations on whether the current basis of payment for slaughter pigs should be revised to reflect the different carcass structure of new genotypes

Breed types chosen were those most commonly in use in the UK at the start of the trial: Large White type (control), Hampshire type and Pietrain type.

The trial comprised a series of experiments:

- 1 Pre-weaning performance
- 2 Weaner performance
- 3 Grower performance
- 4 Finisher performance
- 5 Carcass and meat quality assessment

A total of 425 litters were evaluated in this study comprising 140 Pietrain type, 145 Large White type and 140 Hampshire type. All piglets born were included in the pre-weaning study, and these then went on to participate in one of the three lysine requirement assessments, ie weaner, grower or finisher. No

pig was used in more than one of these three trials. Regardless of which trial the pigs had participated in they were reared to 100 kg slaughter weight and slaughtered at the George Adams plant in Spalding. Twenty loins from each Genotype x Gender group resulting from the weaner trial were vacuum packed and despatched overnight to the University of Bristol for assessment for meat quality.

The study is now complete. The different genotypes were characterised by the following features:

Hampshire type:

- Rapid growth
- High feed intake
- Reduced days to slaughter – particularly suitable for attaining higher slaughter weights
- Robust
- Good and tender meat
- Moderate carcase composition – meat yield underestimated by current carcase assessment

Large White type:

- Moderate growth
- Low feed intake
- Less robust – may reflect reduced heterosis due to back cross to maternal line
- Good carcase composition – particularly for conventional payment method
- Good meat
- Good FCR

Pietrain type:

- Moderate growth
- High feed intake
- Robust
- Good carcase composition
- High meat yield, especially prime cuts – particularly suitable for outlets interested in better yield or using the autofom
- Good meat
- Carcase not adequately assessed by current conventional payment system

In terms of lysine requirement the trials did not identify a need to feed different feeds to different cross breeds. Therefore existing feeds are suitable for all the crossbreds considered here. The industry can utilise the findings to choose an appropriate breed type best suited to their own production system.

Defining the behaviour of different pig genotypes

In a complementary student project, differences in genotype behaviour were studied. The following observations were noted:

- Large White-type pigs were consistently found to be the most confident genotype when faced with human contact, being the most willing to approach humans, and easiest to drive through two movement courses constructed to test fear of surroundings. Large White-types accrued relatively high numbers of lesions, particularly to the shoulders
- Conversely, Hampshire-type pigs were the shyest genotype, and proved most difficult to manage when driving, due to a lack of willingness to move. They were found to accrue far fewer lesions post-mixing in comparison to the other genotypes, and those lesions found focused on the ears.

Hampshire-type pigs were difficult to control when loading into weighing apparatus, and hard to contain

- Pietrain-type pigs' behaviour fell between these two extremes. They tended to bolt away from human contact when being driven, which gave them the quickest time to complete courses, but made management more difficult. They accrued similar numbers of lesions as Large White-type pigs and again to the shoulders. They were however difficult to load into weighing apparatus; this improved with the implementation of white painted screens

Genetics of litter size and foetal loss in pigs

Research partners: The Roslin Institute and Royal (Dick) School of Veterinary Studies, University of Edinburgh

Sponsors: BPEX

Duration: 2006–2009

Female reproductive performance is a critical component of sustainable pig production systems. The low heritability of traits such as litter size and prenatal survival and their expression only in females limit improvement of these traits through traditional selective breeding programmes. However, there is abundant evidence of genetic variation in these traits between pig breeds. The aims of this project are to identify quantitative trait loci (QTL) affecting reproductive traits including litter size and embryo survival and to characterise candidate gene(s) underlying the QTL.



A genome scan of the Roslin Meishan × Large White F2 QTL mapping population revealed QTLs for: litter size (total number born); number born alive; embryo survival; total ovulation rate; and for total teat number. QTL for embryo survival and litter size on chromosome 8 identified in an earlier study and confirmed in these analyses have been mapped to higher resolution by genotyping additional markers in the region. The pig genome sequence will be inspected for potential positional candidate genes.

GUTWEAN	
Research partners:	University of Bristol, Rowlett Research Institute
Sponsors:	SEERAD, BPEX
Duration:	2005–2009

Losses that result from infection during the immediate post-weaning period represent a major financial penalty to the pig industry. Until recently, methods of disease control relied heavily on the use of antibiotic growth promoters, zinc oxide and copper sulphate. However, these substances cause environmental pollution and have potential effects on food safety due to the development of bacterial resistance. Identification of alternative methods of health promotion and disease control is now recognised as a priority in pig production.

Natural methods of promoting immunity and diseases resistance are clearly favoured by today's environment/food safety conscious society. Growing evidence exists supporting the role of the gut microbiota in the development of the mucosal immune system particularly in early post-natal life. The microbiota has many important functions including improving nutrient availability, preventing pathogen colonisation, and promoting the development of both mucosal and systemic immunity.

GUTWEAN investigated the interactions between rearing environment, post-weaning nutrition, microbial diversity and immune function in piglets. The main aim of this project was to establish whether microbial colonisation in early life can impact on immune competence of the developing pig. Project goals included identification of bacterial groups/species that drive the functional maturation of the immune system and candidate molecular markers of the "healthy gut".

Microbial diversity in the gastrointestinal tract of pigs raised on intensive and extensive farms was characterised. Animals in an outdoor environment showed a dominance of lactobacilli species, whereas animals in indoor environments were colonised by potentially harmful bacteria belonging to Clostridia and Proteobacteria.

Given the observed differences in gut microbiota associated with rearing environment, gut-specific responses in gene expression patterns were also determined. Analysis of all gene data confirmed that the differences in microbiota between pigs reared in indoor and outdoor environments was also associated with significant difference in immune response genes.

In conclusion, rearing environment, whether indoor or outdoor, has a profound impact on the type of bacteria that colonise the pig gut in early life. These effects are 'sustainable' and also apparent in the adult animal gut.

Large numbers of lactobacilli were found in outdoor reared pigs. Importantly, many of these bacteria have not been previously investigated in terms of their health promoting properties. The increase in these bacteria in outdoor reared pigs was associated with a reduction in the numbers of pathogenic bacteria in the gut. Significantly, the outdoor reared animals also had enhanced immune function and gut barrier effects. The functional effects of the bacterial strains identified in outdoor farms may provide avenues for development of new probiotics. Furthermore, some of the genes that were observed in the outdoor pig gut may provide “healthy gut” biomarkers useful for assessing new dietary interventions or new rearing regimes for young pigs.

The impact of weaning age, environment, nutrition and sow parity on piglet performance and microbial diversity (A studentship forming part of the Gutwean research)

Research partners: University of Bristol, Rowlett Research Institute

Sponsors: Defra, SEERAD, BPEX

Duration: 2005–2009

In relation to animal production it is plausible to suggest that the immune system may be negatively affected by the high hygiene status adopted by many intensive (indoor) rearing systems and that some of the advantages of extensive (outdoor) rearing systems may result in improved bacterial colonisation and immunological status of outdoor-reared animals. This research project investigated how microbial colonisation is shaped by environment, early colonisation and antibiotic treatment and how bacterial diversity influences the developing immune system of the pig.

To evaluate the impact of the environment on the microbiota, the bacterial composition of the gut in intensively reared animals was compared with animals that were reared extensively.

To investigate the impact of early bacterial colonisation and antibiotic exposure, 24 hour old animals were transferred into sterile isolators and treated with commercially available antibiotics.

In pigs, probiotics have been used to improve growth performance, decrease the incidence of diarrhoea and subsequent mortality rates. Protection from E.coli and Salmonella infections by lactobacilli has been reported in the pig. In the intensively reared animals, lactobacilli made up only a small percentage of the whole microbiota. In animals that were treated with antibiotics, lactobacilli were almost completely absent in the gut.

This study showed that the extensive environment favours the expansion of a natural microbiota which is dominated by lactobacilli. This could aid immune events that are beneficial for the host. On the contrary, an increase in hygiene status (from outdoor to indoor environment to isolation and antibiotic administration) leads to a decrease of lactobacilli in the gut mucosa.

An investigation into the effect of milk supplementation using a milk line system on performance and behaviour in naturally suckled piglets

Research partners: Harper Adams University College

Industrial partners: Volac, the Universities Federation for Animal Welfare (UFAW)

Sponsors: BPEX

Duration: 2007–2008

With increasing sow prolificacy, it is now common for sows to farrow litters of 14 or more piglets, although the sow herself may not have 14 functional teats. This means that the surplus piglets have to be cross fostered (if spare places are available) or artificially reared. Both have welfare implications for the piglet and an economic impact on the production system. The sow's ability to produce a sufficient quantity of milk to sustain these litters in late lactation and the competition at the udder for teat space in early lactation can lead to a high variation in individual piglet performance. This may have an impact on lifetime performance and individual health and welfare.

Systems for delivering supplementary milk have been used by a minority of farmers for over 30 years. Given the large litter size now expected from sows and the competition at the udder there is a 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 would suggest higher numbers weaned (+0.4 pigs/litter from before and 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 is major potential saving to the industry as a whole.

The objective of this project was to establish the benefits of the milk line system in a controlled scientific environment and provide producers with information of how it is best utilised. Three overall questions were addressed:

- 1 Do the benefits of the milk line stem from the availability of milk from the time of 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 were started in summer 2007 on the pig unit at Harper Adams. Data collection was completed in October 2008:

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.

Additional behaviour studies have been carried out by students funded from a UFAW scholarship.

Although Trial 2 was generally inconclusive, taken together these trials indicate that supplementary milk from farrowing has a beneficial effect on late lactation mortality of between 0.5 and 1 pig per litter depending on sow parity and level of output. There is little evidence for effects on long-term performance although performance and behaviour in the initial five days post weaning may be enhanced by supplementary milk.

Further work is needed to determine whether the benefits of supplementary milk can be maintained once creep feed is introduced and the provision of milk is reduced.

The labour input was 10 minutes a day and one hour a month for cleaning the pipe work for up to 70 crates. Given that the need to deal with fading pigs is all but eliminated, the system offers major cost savings in terms of time and capital in comparison to alternative systems such as shunt fostering and specialist feeding facilities for early weaned individuals. Economically the following conclusions can be drawn.

- At 24 litres per litter the cost of the supplementary milk is approximately £6.50 per litter; this cost was more than offset by the increased output of piglets (**Table 7**)
- The Milk Line system is easily managed and removes the need for early weaning alternatives by keeping piglets on the sow in the farrowing pen
- The Milk Line system is cost effective and does not add to the work burden when compared to alternative methods of keeping poor doers alive. When averaged across the two trials the pay back period for the equipment would be 12 months; in situations where parity structure is older then the pay back period would be less than 12 months

Table 7 Economic benefit of supplementary milk from birth
(Cost and return per farrowing pen)

Extra performance pigs/litter	0.25	0.5	1.0
Capital cost of kit based on a single pump and 70 dispensers (£/farrowing pen) *	£65	£65	£65
Marginal value of one extra pig at weaning	£20	£20	£20
Cost of milk (£ per litter)	£6.50	£6.50	£6.50
Labour (£ per litter)	£0.50	£0.50	£0.50
Pay back time of equipment	24 months	12 months	6 months

* Assumes farm staff installation zero cost

The system:

- Milk replacer is pumped around a continuous circuit from a central tank and is available ad-lib
- One machine can supply up to 70 farrowing pens; each with a valve and short drop to the dispenser
- Milk is made up to the daily requirement. A ball valve in the bottom of the tank allows water to enter the system so that the pump never runs dry
- The line only needs to be washed out between farrowing groups, assuming good general hygiene is maintained



Milk supplementation using a milk line

Development and evaluation of low-phytate wheat germplasm to reduce diffuse phosphate pollution from pig and poultry units

Research partners: NIAB, University of Reading, Nottingham and Idaho, Harper Adams University College, Velcourt Ltd

Industrial partners: Nickerson-Advanta, BASF Frank Wright, Noble Foods, JSR Farms, Sun Valley Foods, A.B.N.A Ltd, J Bibby Agriculture and Trident Feeds, Anglian Water Services, The Environment Agency, Velcourt (Farm Management), British Poultry Council, Home Grown Cereals Agency, BPEX

Sponsors: This project is being funded under the Defra LINK Sustainable Arable programme

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 significantly reduce diffuse phosphate [P_2O_5] (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 the grain composition of other important nutrients and micronutrients, will be determined.

Currently available mutations, in non-adapted UK wheat germplasm, give a potential 30% increased phosphate availability but have not been tested in animal feed trials. However, maize and barley lines have already been reported to reduce phosphate excretion in feeding trials.

In 2008 the cost of feed phosphate used in formulated diets increased to over £600/t due to increased worldwide demand for this finite resource. Increasing availability of phosphate contained in feed wheat to growing young animals may have an increasing cost benefit and mitigate animal welfare issues.

EU water legislation for the prevention of phosphate pollution of water bodies means the development of HAP wheat offers significant value to the farming industry as it adapts to meet any future requirements.



UK adapted wheat lines were selected and harvested in 2008

Progress made during 2008-09

- After initial broiler feeding studies, pig trials were initiated to determine the reduction in P excretion obtained by feeding HAP wheat compared to conventional wheat
- Preliminary results have shown an improvement in apparent P digestibility in grower pigs. The full analysis and additional feeding trials will be reported in 2009
- UK adapted wheat lines, produced using the Idaho University variety, were selected and harvested in 2008. New and improved sources of HAP wheat have also been identified. These will be sown for selection and multiplication in 2009
- The plant populations needed to develop the marker assisted plant breeding tools for rapid selection by the wheat breeding industry have been produced. Testing is currently in progress

The initial wheat feeding trial showed an improvement in phosphate digestibility and the work will be extended to see if this results in reduced P excretion. Evaluation of new wheat lines, currently being adapted for UK growing conditions, has shown higher levels of available phosphate than previously reported.



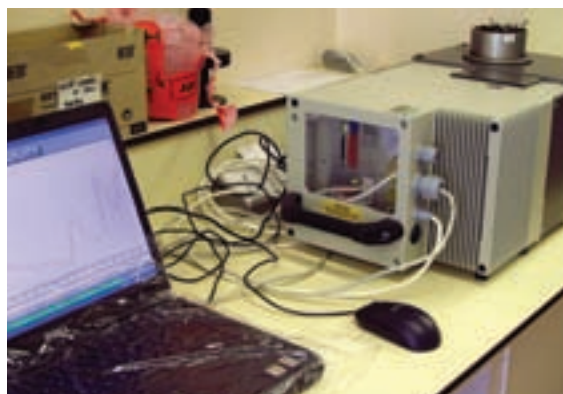
Preliminary results have shown an improvement in apparent P digestibility in grower pigs

Rapid analysis of manure and organic recyclables for sustainable agriculture	
Research partners:	ADAS UK Ltd., North Wyke Research, Eurofins Laboratories Ltd
Industrial partners:	DairyCo, HGCA, EBLEX, BPEX, Potato Council, GrowHow UK Ltd., Bruker Optics UK Ltd., Grampian Country Pork Buckie Ltd., Agrivert Ltd., Spreadwise Ltd., Severn Trent Water Ltd. and Yorkshire Water Ltd
Sponsors:	This project is being funded under the Defra LINK Sustainable Arable programme
Duration:	2007–March 2010

This project will make finding out the nutrient content of slurries and farmyard manures, so fertilizer applications can be accurately planned, easier, more reliable and, hopefully, cheaper. Using technology now widely accepted for analyzing forage and grain samples, it will soon be possible to scan a fresh manure sample and have the results within a few minutes. These new rapid tests should be available to farmers within two years.

The project addresses the need for practical guidelines for the management of nutrients following application of manures to land. This information is essential for economically and environmentally sustainable use of manures in 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. This will reduce the environmental impacts of manure use and increase profitability in crop production.

A total of 1019 samples were collected and scanned between January and June 2008. NIRS Principal Component Analysis (PCA) was used to select a total of 118 samples to represent the spectral variability and range of manure analysis, in order to assemble robust nutrient calibration models. The data from this procedure will be used to generate the first project calibration models. Initial development of NIRS calibration models for manures and soils have confirmed the potential of this technology for rapid analysis covering the common determinations.



Sample analysis

Ryegrass grown in pots has been used to track the release of N from 30 selected manures applied to three different soil types. Dry matter yield and N offtake have been recorded on five cuts of grass. It is hoped that the N release studies across a total of 180 manures will provide a basis for developing an NIRS calibration model for the prediction of the longer term N release characteristics of manures. Initial results from the large pot experiments have shown clear differences in the N release characteristics of the selected manure types, which will provide the basis for development of an NIRS calibration model for prediction of the longer term N release characteristics of manures.

The high level of industry interest in the technology at two national farming events (Grassland and Muck 2008, Dairy Event 2008) has indicated an increasing awareness of the importance of manure characterisation and of the economic and environmental benefits likely to result from improved recycling of manures.



Dairy Event 2008

Key issues to be addressed in the next year include the generation of manure nutrient NIRS calibration models. The sourcing and collection of >1000 manure samples towards the 2008-09 target, started in September 2008; this will allow calibration and N release studies to be completed by mid April 2009. Scanning of 15N labelled slurry used in Teagasc microplot studies on N recovery will also be performed to provide an independent validation of NIRS N release calibration models.

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, please contact Dr Lizzie Sagoo, ADAS Boxworth (tel: [01954 267666](tel:01954267666); email: Lizzie.Sagoo@adas.co.uk).

Lupins in Sustainable Agriculture (LISA)

Research / Industrial partners:	IBERS (Institute of Biological, Environmental and Rural Sciences, Aberystwyth University; formerly IGER), The University of Newcastle, PGRO, TAG, Germinal Holdings, BPEX, DairyCo, ABNA and Kelvin Cave Ltd
Sponsors:	This project is being funded under the Defra LINK Sustainable Arable programme
Duration:	2004–2009

LISA is a five-year project addressing the use of spring-sown yellow and narrow leaf (blue) lupins in UK agriculture. Lupins potentially offer a home-grown high protein feed source comparable to Soya. The

project is examining the crop in both conventional and organic production regimes as well as undertaking a range of both ruminant and non-ruminant feed studies. The EU currently imports around 40m tonnes of Soya products each year but this research suggests that lupins could provide a similar high protein grain of known provenance.

The LISA remit covers a wide range of areas including development work to enable plant breeding, agronomic research and an examination of the utilisation of lupins within livestock systems. Genetic improvement work has identified a range of desirable crop traits; this research will be used to enable the development of DNA markers that can ultimately make the selection of improved genotypes faster and more precise. Agronomic development has looked to improve understanding of the crop and to further develop the agronomic package available to support lupin production in both conventional and organic systems; for example specific work has addressed the issues of weed control and pH tolerance.

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 hipsoya 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 experiment showed a crude protein content of 35% (Wodjil) and 28% (Prima).



Lupins offer a home-grown high protein feed source comparable to soya

Results indicated that dry matter and nitrogen digestibility were poorer for both lupin varieties than for soya (Wodjil: 83-84% of soya and Prima: 90-91% 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 factor, which will affect the use of lupins in pig feeding, is their effect on feed intake. There are reports that inclusion of lupins may make diets less palatable and it was noted that feed refusals were greater with diets containing lupins, which suggests that careful diet introduction would be necessary.

Further information on this research including pig feeding trials and agronomy advice can be found on the project website: www.lupins.ibers.aber.ac.uk/. A final report will be available later in 2009.

An environmental analysis of the consequences of using home-grown protein sources in pig diets

Research partners: SAC

Sponsors: BPEX

Duration: October 2007–September 2009

The UK pig feeding industry relies heavily on imported protein feedstuffs, especially soybean meal. Whilst soybean meal has an excellent nutritive value for pigs, there are growing concerns about the environmental impact of its use, which are particularly related to its transport. An increased use of home-grown legumes is expected to result in a reduced global warming potential arising from pig production, which would comply with government policy that promotes sustainable pig farming with reduced environmental impact.

The overall aim of this study is to assess at farm level the environmental benefits of replacing soybean meal with home-grown legumes in starter, grower and finisher pig diets. Additional (economic) benefits may arise from reduced dependency on imported feedstuffs.

A life cycle assessment framework to assess the environmental impact of pigs from starter to slaughter weight has been developed through combining a pig and crop/soil model. The pig growth model determines nutritional requirements, daily feed intake and environmental impact (eg from nitrogen excretion). The DeNitrification DeComposition crop model simulates crop growth, crop and soil interactions and environmental impacts (eg from fertilizer and manure use, and soil decomposition). Their output is complemented with environmental consequences of all processes/activities involved in the crop and pig production. The results are expressed per kg pig (the functional unit). Experimental diets have been formulated using current industry dietary specifications, eg with regards to the upper inclusion limits of home-grown legumes.

Using the current industrial constraints, it appears impossible in starter diets to replace all soybean meal with home-grown legumes; however in the finisher diets soybean meal can be completely replaced successfully. Thus, across starter to finisher diets, reliance on soybean meal may be reduced considerably (58-83% reduction) without affecting overall pig performance.



Raising awareness of climate change

Research partners: NFU, CLA, AIC, AHRF (which includes BPEX), Defra

Sponsors: Defra

Duration: 2007–2009

BPEX 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.

In September 2008 60% of farmers surveyed in England said they were already affected by climate change and more than half expect to be affected in the next 10 years. Farmers and land managers are already using the Farming Futures resources to improve the sustainability of their business. The 22 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) gives 21 case histories of farmers who are already taking action on their farms to adapt to, or combat, climate change. During 2008 the project ran 10 on-farm regional and sectoral workshops to help prepare farm business for climate change. Some of the most popular events focused on anaerobic digestion and other renewable technologies. Delegates had the opportunity to see the new technologies in action and ask the farmer hosting the event about their experiences of engaging with low carbon-farming. All events had expert speakers on hand to put climate change into an agricultural context and focus on relevant sectoral issues such as new pests and diseases or practical matters like planning permission.

For more information or to share your story please visit www.farmingfutures.org.uk or contact Claire Wyatt, project manager on c.wyatt@forumforthefuture.org or **07825 204434**.



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