Environment and buildings study tour

Overview
Country: Denmark
Theme: Environment and buildings - reducing emissions, increasing profits and complying with legislation at the same time
Participants: Producers representing a large proportion of the pigs reared in England, vets, nutritionists, researchers and the Environment Agency
Duration: Two days

Executive summary
The aim of the two-day study tour was to look at opportunities for integrating new technologies and techniques which could improve efficiency and performance on farm. Much discussion was had while travelling between the various site visits, which resulted in knowledge generation on a wide variety of topics.

In particular, the group looked at pH reduction of slurry for breeding and finishing pigs, and robots for distributing straw as a manipulable material for bedding. In addition, the Intellifarm concept for pig buildings using the smart farm concept of building design, ventilation and climate control and air-cleaning was seen. The group also gained an insight into environmental legislation and the scale of investment in new pig buildings in Denmark. As a result of going on the tour, several producers are seriously considering implementing various aspects of the options seen.

Key observations
• Danish farmers are having to employ lower impact housing systems to obtain permits and permissions
• In Denmark, grants are available for techniques which benefit the environment in general
• Various techniques and technologies are available to improve efficiency, comply with legislation and to reduce odour and ammonia; they are equally relevant to cattle and pigs.
Limiting the environmental impact of pig production in Denmark
Presentation from Tine Marquand Zimmerman, consultant at Patriotisk Selskab

The Danes have some of the strictest environmental legislation in Europe. There is increasing pressure from the EU to reduce the amount of ammonia emitted to the atmosphere, and regulations now exist to restrict ammonia and odour emissions from farms. Targets for reduction are being set by the EU and will have to be brought into UK legislation, this will put extra pressure on livestock farmers generally, including pig producers. It may result in feeding, housing and storage and the spreading of manures and slurries being more tightly regulated. Odour is a more general issue and can be a barrier to development on farms and a point of contention.

In Denmark, apart from very small hobby farms, all farms have to be permitted and even grain stores require approval before they can be constructed. For example, there are fixed limits on the number of animals that can be kept in relation to the land available for spreading of manures, as well as detailed rules on its storage and application to the fields. Slurry stores, for example, need to be covered unless they are adopting technologies or techniques to reduce emissions, such as pH reduction of slurry.

How the regulations differ in England
Currently, only larger pig and poultry farms have to be permitted in the UK. In addition, the slurry storage requirement is only six months, compared to ten months in Denmark. Danish farmers have lower limits for the amount of nitrogen applied to the land and have to assume a minimum N efficiency of 70% for slurry, compared to 50% in the UK.
Intellifarm concept
Presentation from Poul Erik, Agri-Farm

The Intellifarm concept is a hybrid ventilation system and one of the potential tools for reducing emissions of ammonia, dust and odour on farm. The group visited a dairy farm to see the concept in a barn housing five hundred cows.

This system is a new approach and is based on a hybrid ventilation system which combines Automatically Controlled Natural Ventilation (ACNV) with fans to provide crossflow-ventilation underneath the slats. It is also possible to add an air cleaning system. Airflow has been modelled using Computerised Fluid Dynamics (CFD) at the design stage.
The design is suitable for buildings up to 65m wide for pigs and 75m for cattle. It has two-piece side inlets and a second set of controlled inlets halfway up the roof and ridge outlet. The top of the air cleaner can be seen on the right-hand side.

There is also an option for exhaust air to then go into a scrubber to remove the ammonia, dust and odour, which is extracted underneath the slats, and provide good quality air for the pigs. However, there is a cost associated with air scrubbers, and the benefits are restricted to the proportion of air extracted below the slats, but they will result in delivering reductions which may be sufficient to allow a permit to be granted.

The system is being applied in a grower/finisher farm in Denmark. The company has just obtained further EU funding to continue its development work on other farms and is seeking farmers interested in erecting a new building.

The floors and bedding were very dry, providing good conditions for the cows, and foot health was reported to be good.

**Advantages of the Intellifarm system**
- Low energy requirement
- Reduced emissions
- Improved conditions for staff and stock
- Potential for reduced levels of disease
- Remote control through computer, tablet or smart phone
- Automatic slurry plugs to empty the pits
- Option for heat recovery.
The inside of an Intellifarm shed for pigs (courtesy of AgriFarm)

A cow shed showing wide-controlled ridge outlet

Slatted passageways where a curtain of air moves from one side to the other, just below the slats, taking odour and ammonia to the air scrubber unit

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Robotic feeding and bedding systems
JH Agro, which manufactures an automatic bedding and feeding system called MiniStro.

Robot sizes vary from 0.28m³ to 3m³, according to available free space in the shed and amount of material to be distributed. This system can be installed in all types of shed and retrofitting is possible, pen divisions are not a barrier and the robot can travel between buildings. Various models can handle straw, sawdust, hay, maize silage, sand and the fibre fraction from separated manure. Distribution is fully automated and takes place several times a day.
Common features
Robots are battery powered (two or four 12 volt batteries) and have a Central Processing Unit (CPU). They have a momentum of between 2-30m/min and can be programmed up to eight times per day on a maximum of eighteen tracks. They will distribute where programmed to do so and can fill individual straw racks depending upon the model being used.

Several spreading options are possible, including discs for strawing-up floors, a transverse belt for spreading in a narrow line on a part-bedded area and freefall for dispensing straw into a rack.

Food being distributed to finisher pigs

pH reduction of slurry
Day two of the tour was spent learning about pH reduction of slurry and the systems developed to do this, courtesy of InFarm. This is a method of improving resource efficiency through improving the fertiliser value of slurry, as well as balancing the internal environment for pigs and staff; it is based on proven science. There are now 172 systems for reducing slurry pH on Danish farms (75 on pig farms) and they can contribute to a 65% reduction in ammonia emissions and 43% reduction in odour from pig housing.

A bunded tank which stores sulphuric acid and underground control centre in containing valves, pumps and control box
The process of pH reduction of slurry
1) The whole system is run by a computer and no labour input is required once set up and running, the main control computer is in the office
2) The system adds sulphuric acid to separated slurry until the pH stabilises at 5.5
3) Slurry is then pumped back into the slurry pit located inside the pig house to a pit depth of 180mm
4) Slurry remains here for a day or so while the pigs dung into the pit
5) The pH is never allowed to rise above 6.0
6) The slurry is then let out of the pit and goes either into a slurry separator or, in cases where additional odour reduction is required, straight back to the process tank
7) The slurry is separated to help odour reduction and segregate non-soluble nitrogen and phosphorous, this also reduces slurry storage volume and makes it easier to spread
8) The main slurry store does not have to be covered because ammonia emissions are almost nil
9) A proportion of the slurry is then released back into the slurry store while the remainder goes into the mixing tank for more acid to be added so that the process can begin again
10) The mixing slurry tank is covered and acid is added before the slurry pits are recharged
11) Regular flushing of the tanks is a fundamental part of emissions reduction.
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Inside the underground control centre

Slurry separation

Valve chamber
Each slurry pit is attached to the valve chamber which is situated underground and has automatic valves, this enables the system to be automated. See diagram below.

Benefits of pH reduction of slurry

- Cost neutral/positive mitigation of emissions
- Reduction of ammonia and odour in housing, storage and spreading
- Increased fertiliser value of slurry
- Better fly control
- Improved decomposition of straw in slurry
- Better handling of slurry

For example costings, see appendix 1.
**New farm construction in Denmark**
The final part of the tour was spent visiting a new construction site for a 1,000 sow unit. This will use pH reduction of slurry to provide a better environment both inside and out.

*Unit under construction*

*Individual sow feeding using free access stalls*
Many Danish buildings are built from precast concrete panels with a sandwich layer of insulation. Slurry pits are constructed from blocks which differ from those used in the UK and are dry laid.

With regard to ceiling construction, in Denmark it is popular to draw air in through the loft and a permeable ceiling material, such as wood wool lightweight board, this is combined with adjustable inlet flaps.
Participant feedback

"Helped me to think outside the box with building design" 

"A very worthwhile tour which gave me the opportunity to see and experience the application of new technology"

"The trip has broadened my understanding of the abatement system and impacts on odour and ammonia"

"Hugely beneficial trip for any forward-thinking pig producer"
Costings provided by In Farm - 500 sow unit in Denmark

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<th>Annual Expenditure</th>
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<td>Depreciation and interest</td>
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<td>Power</td>
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<td>Maintenance</td>
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<td>Liming</td>
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<td>SUM costs (Euros)</td>
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<table>
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<th>Euros</th>
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<td>Value of crop sulphur</td>
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<td>Saving labour cost to flush out slurry</td>
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<td>Saving costs of covering slurry storage</td>
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<td>Value of better working environment</td>
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<td>Total (Euros)</td>
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## Results for Danish Farm

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<th>Results</th>
<th>EUROS</th>
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<td>Expenditure</td>
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