High, fluctuating feed prices
2012 was characterised by unexpected high increases on soybean and grain prices.

This confirms the trend of the last years when feed prices have fluctuated dramatically, while pork prices have remained fairly stable with an upward trend.

For pig producers with an integrated production and own land for grain production, things look fairly good. For the group at the top in terms of productivity, the economy is even good.

However, for weaner producers purchasing feed, the situation is a lot more unstable. Fluctuating prices of feed and weaners put economy and cash flow under considerable pressure.

Drop in finisher production
Investments have stagnated ever since the onset of the financial crisis in 2008.

This is in particular seen in finisher production: small and run-down finisher facilities that are taken out of production are no longer replaced by new modern facilities.

Consequently, weaner exports increase leading to a vicious circle that puts pressure on the capacity utilization of the slaughterhouses and thereby on pig prices as well.

This is an extremely unfortunate development for the national economy and for the pig industry.

To reverse this trend, it is crucial that it becomes possible to establish large, efficient finisher facilities.

This requires three things:
• Environmental regulation that does not block or increase the costs of finisher production.
• Access to capital.
• Pig prices matching those of the German slaughterhouses.

Once this is settled, new finisher facilities are sure to follow.

Danish pig production is highly capable of competing on efficiency and costs – this is confirmed by the most recent analyses comparing European pig production industries.

Sow producers are ready for 2013
A survey in summer 2012 revealed that more than 80% of all Danish sows are housed in groups in the gestation unit, and the rest are working hard on converting their production.

Future environmental regulation
Though the scheme for reporting changes was a step in the right direction, there is still room for improving environmental approvals and cutting back on the red tape. Pig production should be regulated according to the impact on the surroundings rather than the number of animals sold from the sites.

This principle forms part of the first reports from a commission looking into this, and if politicians follow the recommendations in the final draft of the regulations for environmental approvals and nitrogen regulation, things look good.

Animal welfare
Animal welfare is generally developing in a positive direction. This is documented in the report “Animal welfare in the pig industry 2011”.

However, challenges still remain: DANISH audits show that the use of hospital pens and rooting and enrichment materials is still not fully implemented.

Public welfare inspections still give rise to a number of cross-compliance cases. PRC is working on more fairness in the control of de minimis thresholds and more emphasis on the general impression.

The Danish government has put forward a desire to stop castration in 2014, which now seems unrealistic. In Europe, there are simply no reliable sorting methods, and more research is therefore necessary. This is one area where Denmark must not and cannot stand alone.

Antibiotic use
The use of antibiotics in Danish pig production is an inspiration to the rest of the world.

Overall, antibiotic use has dropped by 20%, and the voluntary stop of the use of cephalosporins has succeeded. It is therefore completely incomprehensible why the Minister for Food, Agriculture and Fisheries has tightened the Yellow Card Scheme.

Antibiotics must be use restrictively, but also in the amounts necessary.

Roads to growth
The slogan of the 2012 annual meeting and congress was “roads to growth”.

A significant prerequisite for growth is ongoing access to new research results.

The DanAvl breeding system not only produces world-class genetics. Fees on genes also increasingly finance many of PRC’s research activities that are described in this report.

Enjoy reading and let yourself be inspired!

Thank you to all who participate in making this happen – without you, our work would not be possible.

Best regards
Lindhart B. Nielsen / Nicolaj H. Nørgaard
Pig Research Centre
ELECTED BY DANISH AGRICULTURE & FOOD COUNCIL – PRIMARY BOARD

Chairman, farmer
Lindhardt Nielsen
Farmer
Niels Vestergaard Salling
Smallholder
Claus Jørgensen

ELECTED BY DANISH AGRICULTURE & FOOD COUNCIL – PIG SLAUGHTERHOUSES

First Vice-chairman
Erik Larsen
Farmer
Palle Joer Knudsen
Farmer
Michael Møller

ELECTED BY DANISH PIG PRODUCERS’ ASSOCIATION

Second Vice-chairman, farmer
Henrik Mortersen
Farmer
Per Kjær Knudsen
Farmer
Torben Lundsgaard

ELECTED BY THE PIG PRODUCTION COMMITTEES

Director
Nicolaj Vanggaard, Pig Research Centre

Second Vice-chairman, farmer
Niels Aagaard Jørgensen Region 1
(Eastern part of Denmark)
Farmer
Per Brems Jensen Region 2
(Funen and Southern Jutland)
Farmer
Peter Sommer Jensen Region 3
(North and Mid Jutland)
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Pig Research Centre (PRC)
Pig Research Centre is an integrated part of Danish Agriculture and Food Council (DAFC).

The departments under Pig Research Centre employ approx. 155 people and continues as research centre safeguarding pig specific research and development activities.

Tasks and activities in Pig Research Centre are laid down by the Sector Board “L&F Pig Production” that consists of 12 pig producers:
- 3 elected by the Primary Board, DAFC
- 3 elected by Slagternforum, DAFC
- 3 elected by the three regions for regional pig production committees
- 3 elected by the Danish Pig Producers’ Association

Budget and sources of income
Activities are funded by a range of sources of income. PRC organises and manages the breeding programme in DanTVI and charges fees on genes – fees that increase as the export of genetic material increases.

In 2011, export accounted for 40% of the total fees (DKK 80 million) on genetic material.

In Denmark, the actual charging of fees amounted to DKK 44 million corresponding to DKK 1.50 per weaner.

Export contributed DKK 36 million corresponding to DKK 125 per weaner.

With the increases in fees on genetic material, it was possible to reduce funding from the Pig Levy Fund.

Strategy
The current strategy is laid down for the period 2008-2013 with the below main areas of activity:
- Competitiveness
- Environment
- Animal welfare
- Animal health and food safety
- Implementation of know how

New activities in 2013
The Board has prioritised the new activities to be implemented in 2013:
- Concept accommodation for organic weaners and finishers
- New technology for management of organic pig production
- Protein produced in Denmark
- Optimum feed production in the entire value chain
- Pig metagenome
- 100 kg in 100 days
- Protein and amino acid standards for sows
- Selection based on interactions between pigs in groups
- Genomic selection, more DNA tests and small DNA chips
- Reduction of boar taint through genomic selection
- Multiplex analysis of multiple antibodies
- PCR diagnostic of diarrhoea among newborn piglets
- Energy surveillance system
- Local extraction 2.0
- Simple slurry separation
- Optimised design of service units for loose sows
- Danish vs Dutch sow feed
- Regulation of sow behaviour through feeding
- Pigs with gastric problems
- Management of immunity and efficient weaning without diarrhoea without using zinc
- Implementation of know how
- Hyo academy – ensuring the future of the industry
- Communication through new media

<table>
<thead>
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<th>PRC budget 2012</th>
<th>DKK million</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genetic fees</td>
<td>79.0</td>
</tr>
<tr>
<td>The Pig Levy Fund</td>
<td>42.0</td>
</tr>
<tr>
<td>Funds from Rural Development Programme</td>
<td>16.2</td>
</tr>
<tr>
<td>Other income</td>
<td>113.8</td>
</tr>
<tr>
<td>Income, total</td>
<td>250.9</td>
</tr>
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Structural development
In 2011, Denmark had a total of 4,500 registered pig farms. Of these, 1,800 were integrated farms with both sows and finishers. Herd size averaged 255 sows.

There were 600 specialised sow farms with averagely 950 sows, and 2,100 specialised finisher farms with an annual average production of 6,800 finishers.

Production scope
Overall production scope (slaughter + export) in 2012 is expected to total 29,007 million, which is 1.6% lower than 2011 when production totalled 29,465 million. In the first half of 2013, production is expected to be close the level of 2012 of 28,800 million.

This shows that the Danish pig production industry seems to successfully manage the conversion to group housing of gestating sows without encountering dramatic drops in production. A survey made in summer 2012 showed that 80% of all gestating sows were housed in groups, and it was expected that a very large part of the farms that had yet not converted would do so before 2013.

Slaughters in 2012 are expected to land at an average 7% below the level of 2011, which is a reduction from 20.9 million slaughtered pigs in 2011 to 19.4 million. The first half of 2013 is currently expected to be close to the level of the first half of 2012, but the trend will depend on the development in the export of live pigs.

The export of weaners has increased over the past years – in 2012 export increased to 9,157 million weaners vs 8,039 million in 2011 corresponding to an increase of 14%.

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Slaughters</th>
<th>Export Pigs/sows</th>
<th>Export Weaners</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>21,370,409</td>
<td>789,812</td>
<td>3,578,898</td>
<td>25,739,109</td>
</tr>
<tr>
<td>2007</td>
<td>21,398,152</td>
<td>1,103,266</td>
<td>3,850,844</td>
<td>26,352,262</td>
</tr>
<tr>
<td>2008*</td>
<td>21,064,216</td>
<td>1,059,997</td>
<td>5,280,258</td>
<td>27,404,471</td>
</tr>
<tr>
<td>2009</td>
<td>19,288,591</td>
<td>1,250,173</td>
<td>7,043,720</td>
<td>27,582,484</td>
</tr>
<tr>
<td>2010</td>
<td>20,243,996</td>
<td>896,191</td>
<td>7,515,047</td>
<td>28,655,234</td>
</tr>
<tr>
<td>2011</td>
<td>20,925,925</td>
<td>500,395</td>
<td>8,039,111</td>
<td>29,465,431</td>
</tr>
<tr>
<td>2012**</td>
<td>(19,381,365)</td>
<td>(468,830)</td>
<td>(9,157,133)</td>
<td>(29,007,328)</td>
</tr>
<tr>
<td>2013**</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>(28,800,000)</td>
</tr>
</tbody>
</table>

Table 1 - Development in Danish pig production, slaughters and export of pigs.

* 53 weeks
** (projection)
Financial results

Table 1 outlines the development in production economy for full time pig farms of the last decade.

The top part of the table shows the results of full time pig farms and the bottom part shows financial key figures per production category.

The number of full time pig farms has dropped by approx. 2,850 (approx. 48%) the last ten years, while the number of sows/year per farm has increased from 193 to 273 (41%).

The number of produced finishers per pig farm has increased from 2,777 to 7,073 (159%), Land has increased from 97 to 172 ha (77%).

Gross margin incl. land has increased from approx. DKK 1.5 million to approx. DKK 3.5 million from 2002 to 2012. In 2011, gross margin/year increased to DKK 3.5 million as a consequence of rising grain prices and pig prices.

Economy per production unit

From 2002 to 2012, gross margin per sow/year averaged DKK 3,575, while gross margin of finisher farms averaged DKK 112 per produced finisher.

In 2011, gross margin on sow farms increased to DKK 4.153 per sow/year, while for finisher producers, it remained largely unchanged at DKK 132 per produced finisher.

Trend in terms of trade

Terms of trade dropped from 7.29 in 2010 to 6.16 in 2011 averaging 7.15 over the last decade.

The increases in grain and feed prices seen during harvest 2010 were reflected in 2011 when feed prices remained high all year. However, pork prices also increased. Terms of trade tended to increase in the first half of 2012, and soy prices soared in summer 2012.
Large progress on sow farms in 2011

Data supplied by the local pig advisory centres includes 664 sow farms with a total of 425,000 sows/year; 574 weaner farms with a total production of 9.4 million weaners; and 746 finisher farms with a total production of 4.9 million finishers.

Sow farms weaned averagely 28.8 pigs per sow/year, which is an increase of 0.7 pig/year compared with last year. Herd size averaged 640 sows/year.

Weaner farms produced an average 15,372 pigs/year. Data shows an FCR of 1.95 FLpp per kg gain, a daily gain of 443 g and an average mortality of 2.9%. These figures are almost identical with 2010 figures.

Finisher farms produced 6,537 pigs/year. Daily gain averaged 898 g and FCR averaged 2.87 FLpp per kg gain. Mortality averaged 3.5% and culled pigs averaged 0.2%.

Top 25%

The top 25% of all sow farmers are 4-5 years ahead of the average farms. The top 25% farmers in weaner and finisher production have a performance level that is approx. 10 years ahead of the average farms. This demonstrates that with a dedicated effort in weaner and finisher production it is possible to significantly improve productivity on the average farm.

Will progress continue?

Analyses of progress in annual productivity often concern mainly progress among the top 25% farmers, which averaged 31.5 in 2011. This document shows that many farms have an unexploited potential, which is in particular found in areas such as liveborn/litter and non-productive days. Consequently, it may be possible to improve productivity levels improvements in management.

When litter size increases, more nursing sows are generally required, which in turn requires more work and more farrowing pens. Consequently, the value of one more liveborn piglet will drop long-term.

There is no doubt that the increase in weaned pigs per sow/year will continue for years, but the annual increase may slow gradually. If feed prices remain high, efficiency rather than productivity will be the central element. High feed prices will also direct attention to feed conversion and mortality. A high feed price will result in a higher finisher price and thereby an increased loss on dead pigs. Danish pig producers have at all times been highly adaptable as times have changed.

Genetic progress in LPS (live pigs 5 days after farrowing) is expected to continue to improve the potential for more weaned pigs per litter partly through an increase in liveborn and partly through reduced mortality. However, the economic value of a marginal pig at weaning drops if the effort of producing the pigs increases.

Figure 1: Trend in liveborn and weaned pigs per sow/year.

- Weaning age drops from 7.5 to 4 weeks
- L-sows replaced by LY sows
- Breeding for litter size
- LP5
- Weaned per sow/year
- Liveborn
Denmark – Germany
Weaner exports increase annually with the majority being exported to Germany. The long term and short term competitiveness of Danish finisher producers was compared with German finisher producers using model calculations.

Results
Danish finisher production is competitive in the long term. Short term, however, analyses showed that German finisher producers are more competitive particularly when the supply of weaners is low whereby weaner prices increase. Exports will consequently increase.

Demand for weaners
Short term, demands depend on existing housing capacity and the expected positive contribution to earnings when weaners are moved to the house. Contribution to earnings is defined as financial result before interest and depreciation on housing facility. Once we know the pig price, feed prices and other financial costs, before interest and depreciation, related to producing a finisher, it is possible to calculate the maximum that producers are willing to pay for a weaner.

Weaner market
The pool price of a Danish weaner is also controlled by German demand for Danish weaners.

When demand exceeds supply, the market value of a weaner is controlled by the accumulated maximum that all finisher producers in a given geographical area are willing to pay. This knowledge is used in the following scenarios.

Scenarios
The expected “normal” level of demand for weaners in 2013 is expected to correspond to 20 million Danish and 55 million German finishers. The implications for Danish pig producers of a 3 or 5% drop in the supply of weaners in 2013 are calculated in the following price scenarios.

Price prerequisites

<table>
<thead>
<tr>
<th>Price scenario</th>
<th>0</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed price, DKK/kg</td>
<td>1.70</td>
<td>2.15</td>
<td>2.15</td>
</tr>
<tr>
<td>Settlement, DKK/kg</td>
<td>11.80</td>
<td>11.80</td>
<td>13.00</td>
</tr>
</tbody>
</table>

Scenarios – results
Results are shown in Figure 1. Generally:
- High feed prices is an advantage for Denmark
- High settlement prices are an advantage for Germany

A 5% drop in the supply of weaners will result in 3.75 million fewer slaughterings in Denmark and Germany put together. This will drop to 2.4 millions if the supply of weaners only drops by 3%.

Despite the fact that the Danish finisher industry is relatively smaller than the German, a price scenario 0 combined with a 5% reduction in weaner production in Denmark and Germany in 2013, will result in 2.4 million fewer slaughterings in Denmark, i.e. a greater reduction in slaughterings in Denmark than in Germany. With price scenario 1, the number of slaughterings drop in Denmark, while with scenario 2 export of weaners to Germany will increase. This despite the fact that increases in feed prices are not quite covered by increasing settlement in scenario 2.

The overall German advantage in the short term is attributed to the German tax regulations for agriculture “Pauschal”, that favour German finisher producers enabling them, short term, to pay more for a weaner than a Danish producer.

Future competitiveness
Long term, competitiveness is the ratio between production costs and settlement in a given area. Analyses show that production costs are almost identical in Danish and German finisher production. Provided settlement is identical and the supply of weaners has been brought to a “normal” level, Danish finisher production will still be able to match the German production.
Weaner prices are peaking

German finisher producers include the normal seasonal variations in finisher prices. However, this does not make the German finisher producers able to predict the price of a finisher. Only the regular seasonal variations are included in the expected finisher price.

The development in weaner prices can thereby not be used for predicting the future price of finishers.

Seasonal variations in pig prices in Germany averaged DKK 1.75 per kg from top to bottom vs DKK 1.17 per kg in Denmark. This means that prices may be slightly higher in Germany in peak season than in Denmark without the annual price necessarily being higher in Germany (Figure 1).

Pig prices 2004-2012

Over the past years, prices have increased from a low level of approx. DKK 9-10 per kg to above DKK 11 per kg in 2012. Prices have fluctuated in brief cycles and each time they peaked slightly higher (Figure 2).

Weaner market

Pool prices are higher usually higher than the calculated price in the first half of the year, while the calculated price historically is higher from the beginning of summer until the end of autumn. As an average of several years, the difference between the calculated price and the pool price is insignificant (Figure 3).

Economy in German pig production

When finisher producers buy weaners on the basis of their expectations to the pig price by the time they are going to sell the pig as a finisher, GM per pig becomes more stable than for finisher producers buying weaners at the calculated price. Seen over an entire year, weaner prices are fairly similar, and differences in overall GM for a year will therefore not differ significantly.
GENETIC PROGRESS AND SALE OF BREEDING STOCK

Genetic progress
Table 1 shows the genetic progress per trait for each of the three breeds in the breeding programme in the period 2008-2012 and the average for a D(LY) finisher for that same period.

Progress in feed conversion is 0.036 for a finisher mainly attributed to progress in Duroc.

Production level
In the past year, 4,672 boars were performance tested at Bogildgaard of which 2,164 were Duroc boars. In nucleus breeding herds, more than 32,000 boars and 43,000 females were performance tested. Average production levels are shown in Tables 2-4.

As shown in Table 5, Large White produced 12.9 live piglets on day 5 (LPS) vs 12.1 for Landrace. The figures are based on an average of purebred litters used for breeding.

Table 1 - Genetic progress 2008-2012 for each trait and breed and average of a D(LY) finisher.

<table>
<thead>
<tr>
<th>Breed</th>
<th>Year</th>
<th>Daily gain (30-100 kg), g/day</th>
<th>FCR, FLp/kg gain</th>
<th>Lean meat %</th>
<th>LP5, no.</th>
<th>Conformation, points</th>
<th>Daily gain (8-30 kg), g/day</th>
<th>Killing out %</th>
<th>Longevity, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duroc, av</td>
<td>4 years</td>
<td>10.7</td>
<td>0.046</td>
<td>0.17</td>
<td>0.02</td>
<td>-1.5</td>
<td>0.01</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Landrace, av</td>
<td>4 years</td>
<td>10.5</td>
<td>0.029</td>
<td>0.24</td>
<td>0.03</td>
<td>-0.5</td>
<td>-0.06</td>
<td>-0.025</td>
<td></td>
</tr>
<tr>
<td>LargeWhite, av</td>
<td>4 years</td>
<td>6.3</td>
<td>0.024</td>
<td>0.06</td>
<td>0.06</td>
<td>0.06</td>
<td>0.01</td>
<td>0.023</td>
<td></td>
</tr>
<tr>
<td>Average, 3 breeds</td>
<td>4 years</td>
<td>12.7</td>
<td>0.036</td>
<td>0.10</td>
<td>0.03</td>
<td>-1.0</td>
<td>-0.02</td>
<td>-0.001</td>
<td></td>
</tr>
</tbody>
</table>

Table 2 - Nucleus breeding herds – average production results for boars, 2011/12.
* Daily gain (30-100 kg) is based on live weight, ie differences in killing out percentages between breeds are not included.

<table>
<thead>
<tr>
<th>Breed</th>
<th>Number</th>
<th>Daily gain, g/day*</th>
<th>Lean meat %</th>
<th>Conformation, points</th>
<th>Scanning weight, kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duroc</td>
<td>6,815</td>
<td>394</td>
<td>61.1</td>
<td>2.89</td>
<td>7.6</td>
</tr>
<tr>
<td>Landrace</td>
<td>13,219</td>
<td>375</td>
<td>62.2</td>
<td>2.95</td>
<td>8.4</td>
</tr>
<tr>
<td>LargeWhite</td>
<td>12,628</td>
<td>360</td>
<td>61.8</td>
<td>3.11</td>
<td>8.3</td>
</tr>
<tr>
<td>Total</td>
<td>32,662</td>
<td></td>
<td>6.3</td>
<td>7.6</td>
<td>9.3</td>
</tr>
</tbody>
</table>

Table 3 - Nucleus breeding herds – average production results for females, 2011/12.

<table>
<thead>
<tr>
<th>Breed</th>
<th>Number</th>
<th>Daily gain, g/day*</th>
<th>Lean meat %</th>
<th>Scanning weight, kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duroc</td>
<td>9,156</td>
<td>396</td>
<td>61.3</td>
<td>7.3</td>
</tr>
<tr>
<td>Landrace</td>
<td>18,876</td>
<td>382</td>
<td>62.5</td>
<td>8.0</td>
</tr>
<tr>
<td>LargeWhite</td>
<td>15,524</td>
<td>362</td>
<td>61.7</td>
<td>8.5</td>
</tr>
<tr>
<td>Total</td>
<td>43,556</td>
<td></td>
<td>8.6</td>
<td>9.2</td>
</tr>
</tbody>
</table>

Table 4 - Average production results from performance testing at test station Bogildgaard, 2011/12.

<table>
<thead>
<tr>
<th>Breed</th>
<th>Number</th>
<th>Gain (30-100 kg)</th>
<th>FCR, FLp/kg gain</th>
<th>Lean meat %</th>
<th>Killing out %</th>
<th>Scanning weight, mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duroc</td>
<td>2,164</td>
<td>1,079</td>
<td>2.33</td>
<td>60.2</td>
<td>26.8</td>
<td>69</td>
</tr>
<tr>
<td>Landrace</td>
<td>1,253</td>
<td>1,016</td>
<td>2.48</td>
<td>60.2</td>
<td>25.1</td>
<td>7.9</td>
</tr>
<tr>
<td>Yorkshire</td>
<td>1,255</td>
<td>937</td>
<td>2.39</td>
<td>61.1</td>
<td>25.1</td>
<td>7.9</td>
</tr>
<tr>
<td>Half</td>
<td>4,672</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5 - Nucleus breeding herds – litter size of purebred litters, 2011/12 (litters with code 100).

<table>
<thead>
<tr>
<th>Breed</th>
<th>Litter size</th>
<th>LP5</th>
<th>Per cent first litters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duroc</td>
<td>94</td>
<td>-</td>
<td>67.8</td>
</tr>
<tr>
<td>Landrace</td>
<td>154</td>
<td>12.1</td>
<td>53.6</td>
</tr>
<tr>
<td>Large White</td>
<td>153</td>
<td>12.9</td>
<td>52.4</td>
</tr>
</tbody>
</table>
Al boars
Average time in production for all three breeds remains largely the same as last year. The average index level for Duroc boars has dropped by 0.2 index points, while the index levels for Landrace and Large White boars have increased by 2.2 and 3.9 index points, respectively.

Sale of semen
A total of 4,580,000 doses of Duroc semen were sold in Denmark in 2012, which is a slight increase from 2011 (Table 7). Sale of Duroc semen outside Denmark continues to increase; in 2012, sales reached 714,000 doses, which is an 8% increase from 2011.

Sale of semen from the white breeds is calculated in the number of production sows that are inseminated with semen from DanAvi boars. This segment has increased drastically over the last years, and in 2012 Danish Landrace and Large White boars serviced 250,000 sows abroad.

Sale of breeding stock
Sale of hybrids is increasing nationally as well as internationally. Export of hybrid gilts increased by 17% whereby the export of hybrid gilts now accounts for more than 50% of the total sales (Figure 1).

Royalties
The total income from gene fees currently amounts to DKK 83 million a year. These fees cover a large part of the research activities in PRC.

Nearly 50% of the fees originate from sale of genetic material abroad and there are no indications that this percentage is about to drop. Put differently, a large part of the research activities and the administration of the breeding programme is financed by foreign pig producers (Table 7).

Table 6 - Index and time in service of Al boars.

<table>
<thead>
<tr>
<th>Breed</th>
<th>Boars entered, 2011/12</th>
<th>Active boars, August 2012</th>
<th>Index for active boars, August 2012</th>
<th>Months in service of boars departed in 2011/12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duroc</td>
<td>2,530</td>
<td>2,239</td>
<td>111.0</td>
<td>107</td>
</tr>
<tr>
<td>Landrace</td>
<td>590</td>
<td>370</td>
<td>123.9</td>
<td>64</td>
</tr>
<tr>
<td>Large White</td>
<td>876</td>
<td>460</td>
<td>125.1</td>
<td>58</td>
</tr>
</tbody>
</table>

Table 7 - Sale of genetic material from DanAvi in 2011 and 2012 in Denmark and abroad.

a) Price year converted to calendar year, which explains why 2011 figures are based on the last three quarters of 2011.

b) Figures are projected on the basis of the first half of 2012.

c) Abroad, sale of semen is not listed in doses, but in number of production sows using semen from DanAvi boars.

<table>
<thead>
<tr>
<th></th>
<th>2011a</th>
<th>2012b</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DK</td>
<td>Export</td>
</tr>
<tr>
<td>Purebred females</td>
<td>4,640</td>
<td>22,007</td>
</tr>
<tr>
<td>Hybrid females</td>
<td>236,121</td>
<td>271,144</td>
</tr>
<tr>
<td>Dd and XX boars</td>
<td>1,093</td>
<td>1,780</td>
</tr>
<tr>
<td>LL and YY boars</td>
<td>5</td>
<td>997</td>
</tr>
<tr>
<td>Dd and XX semen, doses</td>
<td>4,568,000</td>
<td>675,000</td>
</tr>
<tr>
<td>LL and YY semen, doses</td>
<td>242,817</td>
<td>-</td>
</tr>
<tr>
<td>On-farm commercial sows abroad</td>
<td>-</td>
<td>220,000</td>
</tr>
</tbody>
</table>

Figure 1 - Sale of hybrids from Danish multiplication herds in Denmark and for export, and from foreign multiplication herds in the period 2009-2012.

- Price year converted to calendar year.
Breeding objective
The most recent revision of the breeding objective for Duroc, Landrace and Large White took place in March 2011 when the traits included in the objective and the weighting of them were revised. The traits currently included in the breeding objective are shown in Figures 2 and 3.

**Figure 2** - Composition for Landrace and Large White - economic contribution.

We will continue to improve genomic selection, and we are in particular working on DNA testing as many candidates as financially possible while at the same time selecting the right candidates.

Genomic selection
Genomic selection enables an increase in genetic progress for all traits and, at the same time, reduces inbreeding. In practice, Genomic selection enables - through information from DNA testing - a more accurate estimate of an animal’s breeding index than previously.

Genomic selection has undergone a dramatic development in the past few years. In 2010, genomic selection was introduced for Duroc and we were the first in the world to apply genomic selection in pig breeding. In 2011, Landrace and Large White were included, and a new calculation method developed by Research Centre Foulum at Aarhus University was implemented.

The full potential of genomic selection is not yet achieved as that would require DNA testing of minimum 40% of the breeding candidates vs 10% today. However, several activities are aimed at bringing us closer to the full potential - among these is a new project that will deliver more DNA tests at the same costs.

**Future activities**
Genomic selection in DanAvi is based on a chip that examines 60,000 points on the DNA strand. However, it is now being investigated whether it is possible to use a smaller and cheaper chip that only examines 7,000 points on the DNA strand and subsequently use these points to analyse what is stored on the missing points. This would make it possible to DNA test more pigs largely without compromising the accuracy of the breeding values.

Genomic selection improves the possibilities for breeding for traits that traditionally are highly difficult to breed for, such as improved sow longevity and maternal traits. However, to include these traits in selection, they must be measurable either in nucleus breeding herds or in commercial...
In order to improve sow traits, PRC is currently analysing data from large commercial herds with LY sows. Throughout winter 2012/13, we expect to evaluate the value of using data from commercial herds. Overall, incredible progress has been made with genomic selection and in just a few years the results will be reflected in Danish pig herds. However, we are still working on optimising the work and producing even better breeding candidates.

Breeding against boar taint

In the EU, a voluntary agreement has been made to abandon castration in 2018 in order to improve pig welfare. It is therefore currently being investigated how to reduce the prevalence of boar taint in Danish pig breeds through breeding and genetics. Boar taint is primarily attributed to the chemical compounds androstenone and skatole, while indole is less important. Research has documented that part of the Danish pig population carries genes that cause boar taint in meat from slaughtered male pigs. Several studies have confirmed that heritability of skatole in Danish populations varies from 0.19 to 0.33 across the breeds. Two Danish studies demonstrated that heritability of androstenone for Danish Landrace varied from 0.54 to 0.59. It is essential to stress that breeding is the only way to generally reduce androstenone levels and thereby reduce boar taint.

In a three-year project, genetic correlations between traits for boar taint and the economically most important traits included in the current breeding objective are being mapped. Preliminary results for Landrace indicate faint or slightly favourable genetic correlations between boar taint and production traits, which is also confirmed by foreign studies. If a decision is made to breed against boar taint, it is crucial to be particularly aware of boar fertility, which is why data from all Danish AI stations is now systematically being compiled for further analysis. Genomic selection is also a cornerstone in this project. The future breeding index for boar taint will be determined on the basis of genomic information with this method, which is already incorporated in DanAvl's evaluation of breeding values. One of the pros of this method is that phenotypic data from genotyped and non-genotyped animals can be handled in the same analysis. The project is also aimed at detection of rare gene variants. Researchers expect that these genes, or SNPs, that heavily affect boar taint will improve the prediction of a boar’s genetic value through a greater accuracy across breeds.

PRC leads the way to sustainability and improved animal welfare in pig production as it is possible to quit surgical castration in the long term provided the genetic correlations to fertility traits are not predominantly negative. Overall, the aim of the project is to enable pig producers to produce meat from entire male pigs that is free of boar taint whereby Danish consumers will be able to enjoy an odour-free meatball.

EVA

Genetic progress is inextricably linked with inbreeding. However, failure to reduce inbreeding will in the long term reduce genetic progress and increase the risk of genetic diseases and defects. All breeding companies therefore apply methods for limiting inbreeding.

In 2012, DanAvl implemented a new tool called EVA for Duroc, which aims at minimising the increase in inbreeding. With EVA, it is now possible to achieve the same level of genetic progress, while at the same time minimising the increase in inbreeding. When inbreeding drops, genetic progress will increase. EVA could therefore be seen as an insurance that guarantees continued genetic progress for many years to come.

The challenge to implementing EVA is to match theory and practice. Together with researchers at Research Centre Foulum, Aarhus University, PRC has analysed how to adapt EVA to the real world, while still gaining full benefit of EVA. Results demonstrated that we can make a range of adjustments of EVA without compromising the ability to reduce inbreeding.

The project is financially supported by the Danish National Advanced Technology Foundation in cooperation with the Group for Quantitative and System Genetics at the Scientific Faculty of Health at the University of Copenhagen.
EVA was implemented on a trial basis for Duroc in 2012, and will be implemented for Landrace and Large White in 2013 after a thorough evaluation.

**Breeding improves FCR**

The outcome of a recent study shows that breeding does improve FCR. Feed costs drop by DKK 3.10 per finisher annually and the environmental impact is reduced.

FCR was always an important trait in Danish pig breeding, and the sub index for FCR therefore carries great weight in the overall breeding index. The aim is to reduce FCR by reducing the total average amount of feed eaten by a finisher. This will reduce the financial costs and environmental consequences of finisher production.

**Breeding for FCR**

FCR is measured individually on all pure bred boars that are performance tested at test-station Bagildgård. At Bagildgård, feed intake is recorded with feeding machines that record individual feed intake of each pig in a pen.

FCR is not recorded in the on farm performance testing that takes place in Danish nucleus breeding herds. On farm testing includes recording of daily gain, lean meat percentage and the exterior of the pigs only. However, we know the correlation between FCR, daily gain and lean meat percentage from data obtained at Bagildgård, and with this information it is possible to determine the expected FCR of pigs in on farm testing. Therefore, both data from Bagildgård and on farm testing is included in the calculation of the breeding index. This way, we achieve the greatest genetic reduction in FCR, compared to not including data from the on farm testing in the index calculation.

For years, annual genetic progress for FCR in the breeding system has averaged approximately 0.03 FLugp/kg gain.

**The project**

The aim was to establish whether genetic progress for reduced FCR could also be found in a herd where feed consumption is recorded at group level in pens accommodating 20 boars each. Over a two year trial period, average FCR dropped by 0.2 FUGp/kg for 20 boars in a double pen from av. 2.5 to av. 2.3 FUGp/kg. This reduction was attributed to a combination of management, genetics and randomness. The genetic component of the total reduction was determined on the basis of the genetic reduction in sub index for FCR of related animals in the breeding system.

**Results**

Results demonstrated that 93% of the genetic progress for FCR was found in the herd. Thus, the impact on FCR is determined at 0.93, which is not significantly different from 1 representing the full impact of the genetic gain of FCR. Pens housing pigs with a low average sub index for FCR had a lower FCR than pens housing pigs with a high average sub index for FCR. If the difference in average sub indexes between two pens each holding 20 pigs is 0.1 sub index point, the difference in FCR will be 0.093 FUGp per kg gain. In conclusion, the sub index for FCR that is based on recordings for individual pigs at Bagildgård can be documented in FCR recordings at pen level in a commercial herd.

**Social interactions**

An entirely new method of selection will make it possible to breed for more “sociable” pigs, i.e., pigs that affect their pen mates positively – or at least not negatively – by virtue of, for instance, their behaviour or disease resistance traits. These may be pigs that do not compete for feed or that do not carry infections. With this method, it will be possible to achieve further progress in production traits.

In 2011, PRC initiated a new project to establish whether this method can be applied on DanAvt breeding stock. It will be investigated whether genetic progress for, for example, daily gain can be improved and perhaps – as a spin off – make the pigs less aggressive and less prone to tail biting.

The method may potentially be revolutionary as it does not require routine recordings of additional traits such as behaviour and disease resistance. Instead, through statistics and recordings of which pigs are housed in which pen, it is possible to utilise the fact that the daily gain of the pigs in a group does not simply express the genetic potential for daily gain. It is also an expression of the “social” abilities of the pen mates. A pig with a low daily gain may, for instance, have aggressive pen mates or pen mates carrying disease, which causes the pig to eat less or to become sick, which will slow its growth rate.

As a minimum, the project will run until 2015, and in 2014 we hope to demonstrate both the expected genetic progress in daily gain and the welfare related spin-offs.
Sale of semen
Sale of semen from DanAvl AI stations increased by 0.4% compared with sales in 2011. Sales amounted to 5.4 million semen doses corresponding to approx. 95% of all matings in Denmark being made with semen purchased from an AI station.

Quality control
Sperm fertility is assured through quality control of semen as well as materials. Upon collection, each ejaculate is subject to quality control at the AI stations. Quality control procedures also include analyses of:
- Sperm number in semen doses
- Materials used at the AI stations – are they sperm-toxic
- Quality of semen from Landrace and Large White boars on day 3 after collection.

Today, Computer Assisted Sperm Analyses (CASA) is used for quality control (QC) of semen from Landrace and Large White boars as well as QC for materials used in semen production. Data from these analyses is now used for culling 5% of Large White boars displaying the poorest semen quality, thus having the greatest risk of reduced fertility. It is currently being investigated whether to introduce this for Landrace as well.

Audit of AI stations
Pig Research Centre conducts a range of unannounced audits of Danish DanAvl AI stations. The aim is to ensure that AI stations comply with the guidelines for sperm number in a semen dose. Procedures for unannounced audits are described in Guidelines for AI stations.

In December 2011, unannounced audits were performed at Hatting AI departments Ringsted, Ministergården, Billund and Horsholm.

In March 2012, unannounced audits were performed at Hatting AI departments Ringsted, Ministergården, Viborg, Ålborg and Horsholm, and of boar stations Mors 1, 2 and Vestsjælland.

In June 2012, unannounced audits were performed at Hatting AI departments Ministergården, Viborg and Odense, and of boar stations Mors 1 and 2.

All audits demonstrated compliance with the guidelines.

Recording of sperm quality
Recording of sperm quality involves several activities ranging from recording of sperm defects and motility to advanced analyses of biochemical markers on the sperm. The aim is to improve the projection of sperm motility through objective methods – methods that do not depend on a person evaluating sperm in a microscope. Pig Research Centre has developed an instrument capable of recording whether sperm are normal and motile. The instrument is currently being tested on an AI station, and results are expected at the beginning of 2013. Together with Copenhagen University Hospital, Pig Research Centre is also working on developing new methods for analysing sperm quality. The aim is to develop a range of analyses to predict semen fertility before the semen is sold to Danish pig producers.

Stimulation and oestrus detection
It is possible to reduce the time spent on service. Results from Pig Research Centre have previously demonstrated that it is not actually necessary to stimulate the sow during insemination. It is now being investigated whether it is possible to reduce the time spent on stimulation before insemination as well.

Sows in the control group are stimulated and subject to oestrus detection according to the 5-point plan for duration of 1 minute and subsequently stimulated as the technician sits on the back of the sow during insemination. In the trial group, stimulation is initiated with the 5-point plan that stops once the technician is convinced will display standing oestrus. Results are expected by the end of 2012.

All activities are co-financed by DanAvl AI stations. The projects are also financially supported by the EU and the Rural District Programme under the Danish Ministry of Food, Agriculture and Fisheries. Journal no. 3663-D-10-00461.
New tool for formulation of finisher feed

A current project under Pig Research Centre (PRC) called “diet of the month” demonstrated that the cheapest standard diet is not necessarily the economically optimum diet. Feed prices and pig prices both influence the economically optimum amino acid level for finishers.

On the basis of multiple research activities with phosphorus, amino acid and crude protein, PRC determined dose response functions. With these, it is possible to estimate average daily gain, FCR and lean meat percentage for finishers independently of amino acids, phosphorus and crude protein levels. It is also possible to determine gross margin per place unit and livestock units with different calculation masks for lean meat percentage. When this information is combined with a feed formulation programme, feed can be formulated to maximum gross margin per place unit rather than simply the lowest price per FUg.

The calculation mask is essential

Dose response functions show that low levels of protein and amino acids result in a poor lean meat percentage. However, a cheap diet low in protein and amino acids may in some cases lead to savings substantial enough to cover the reduced pig price caused by lean meat percentage. This depends to a large extent on the calculation mask used, though. If lean meat percentage is low, deductions from the pig price will be higher with the calculation mask of Tican and Danish Crown producers with a UK contract than the regular calculation mask of Danish Crown (DC). It is therefore rarely profitable for suppliers to Tican and for producers with UK contracts to feed below the amino acid and crude protein standards.

Feed formulations with the current prices and pig prices in August 2012 show that suppliers to DC can save approx. DKK 1 per place unit by feeding 7.2 g st. dig. lysine per FUg (Figure 1), whereas suppliers to Tican need 7.6 g lysine.

The ratio between grain prices, protein price and pig price affects the economically optimum amino acid content, and as protein prices are currently soaring, there may be some savings to be had (Figure 2).

Sound economy in standards

In the first half of 2012, grain prices increased — for periods — relatively more than soy prices. For a long period, there was consequently a benefit in “feeding above” the standard (7.6 g lysine).

Looking at the average prices and pig prices in weeks 1-34, 2012, it is clear that the best economy is obtained by feeding above the standard. However, considering the soaring protein prices of the last months it seems that the average economically optimum content of amino acids and protein is close to the recommended standard.

The system is being tested by a group of pig advisors in 2012/2013, and the interface will subsequently be adjusted accordingly. The system will be available at www.vsp.lf.dk.

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**Figure 1** - GM/place unit/year at different levels of lysine.

**Figure 2** - Price trends in % of beginning 2012.
Pig Research Centre has constant focus on feed quality through:
- Revision of nutrient standards
- Updating of analysis values for ingredients
- Follow-up on the feed evaluation system
- Screenings for toxins in grain

New standards
Amino acid standards for weaners were revised in April 2012 (brief no. 1207). The new standards are based on an economic optimum and on a desire to reduce treatments for diarrhoea triggered by high-protein feed. Standards for lysine as well as ideal protein were revised along with a few more revisions:
- Weight intervals for weaners.
- Phase-feeding standards for finishers were adjusted.
- The standard for Vitamin E is reported in international units (IU).

The revised standards are available in Danish and English at www.vsp.lf.dk.

Phytase
Together with scientists at Aarhus University, Pig Research Centre investigated the effect of increasing inclusion of three phytase products to establish how many phytase units of a given product are required to obtain identical effects. Results revealed that 500 units Phyzyme XP phytase or 1,250 units Ronozyme-NP phytase were required to replace 500 units Natuphos phytase – these inclusion rates are defined as “100% inclusion”. Results also demonstrated that the same response can be expected if the inclusion is changed; i.e., the same effect is expected if the inclusion of these three phytase products is doubled.

I factor / EDOMi
A comprehensive analysis was made on four laboratories concerning determination of energy in feed. Additivity (the calculation of energy in a purchased diet based on analyses of ingredients in proportion to analyses of energy in purchased diets) was also analysed. Results revealed good additivity across laboratories for feed units in purchased feed.

The I factor, which is the relation between EDOMi and EDOM (I factor = EDOMi * 100 / EDOM), can be determined for ingredients and purchased feed on the basis of multiple analyses of EDOM and EDOMi values of the ingredients. It has been decided to apply the I factor in the Feedstuff control rather than EDOMi. Both methods produce the same analysis accuracy for energy concentration. The feedstuff table available at www.vsp.lf.dk is recommended for control of declared I factors in purchased diets.

Energy in purchased feed
Pig Research Centre analysed correspondence between the declared and the analysed levels of feed units (FU) in 59 samples of purchased feed from four large feedstuff producers. Results showed that the analysed level was close to the declared level.

Results showed that ATR, Danish Agro and HEDEGAARD agro varied in terms of excess as well as deficiency compared with the declared level, whereas DLG had most samples with fewer FU than declared. Analysed feed units were significantly fewer in the samples from DLG than declared. The largest variations in energy – positive as well as negative – were found in the samples from Danish Agro. This investigation was conducted as a spot check, and is therefore not necessarily representative of these companies over a longer period of time.

Ochratoxins
The 2011 harvest was extremely wet. In March/April 2012, samples of grain were collected from pig producers who harvested wet grain and stored the grain themselves for feeding purposes. Analyses revealed a very low prevalence of the toxin ochratoxin A. Some samples had a water content above 16%. This means that the grain is not sufficiently dry for storage unless you keep a close eye on grain temperature and subsequently aerate the grain.

The wet harvest in 2011 generally did not cause problems with high contents of ochratoxin A.

The project was financially supported by the EU and the Rural District Programme under the Danish Ministry of Food, Agriculture & Fisheries. Journal no. 3663-D-10-00460.

The 2011 harvest was extremely wet. In March/April 2012, samples of grain were collected from pig producers who harvested wet grain and stored the grain themselves for feeding purposes. Analyses revealed a very low prevalence of the toxin ochratoxin A. Some samples had a water content above 16%. This means that the grain is not sufficiently dry for storage unless you keep a close eye on grain temperature and subsequently aerate the grain.

Slaughter data from before and after the 2011 harvest reveal no increase in the occurrence of porcine nephropathy (kidney failure), which is triggered by feed with a high content of ochratoxin A. The occurrence of porcine nephropathy is stable and low. This corresponds with the low findings in grain.

The project was financially supported by the EU and the Rural District Programme under the Danish Ministry of Food, Agriculture & Fisheries. Journal no. 3663-D-09-00354.
ON-FARM MIXING OF FEED

Management of on-farm mixing
Management of on-farm mixing is a tool to help the pig producer ensure that their on-farm mixing system is running efficiently. It consists of 25 fact sheets describing the most essential processes in feed production — from ingredients to the finished diet. It also includes a range of checklists and work plans that can be tailored to each farm to assist in the organizing of everyday routines. It is best to start using the tool together with an advisor who is also an expert in this area.

An expert group consisting of 8 local pig advisors and 3 employees from Pig Research Centre ensures that qualified advice is available for pig producers and that the tool is further developed.

Mini user guides were made in cooperation with producers of on-farm mixing equipment (Big Dutchman, Skold and ACD Funki) covering the most common feed processors. The mini user guides describe the most frequently used 67 functions.

Management of on farm mixing is currently being tested by the expert group in cooperation with 11 pig producers across the country.

Grinding of grain
In cooperation with energy suppliers EnergiMidt A/S and EnergiNord A/S, Pig Research Centre tested six feed mills for on-farm mixers. The investigation comprised hammer mills from Skold; President, Moderne Kornbehandling.

At fine grinding, hammer mills used on average 1.03 kWh per 100 kg wheat and 1.53 kWh per 100 kg barley. This demonstrates that it requires approx. 50% more energy to grind barley than wheat. Mill capacity at fine grinding averaged 2600 kg/h for wheat and 1800 kg/h for barley.

With these three levels of grinding of barley, 56%, 63% and 84%, respectively, of the ground particles had a particle size below 1 mm. Energy consumption increased on average 0.24 kWh per 100 kg barley when the percentage of particles below 1 mm increased by 10 percentage units. At the same time, mill capacity dropped by 400 kg/h, which further increased the overall energy consumption as trough augers, elevators, grain cleaning equipment and mixer must operate correspondingly longer in the feed barn.

Based on the outcome of this study, the increased energy use required for fine grinding is estimated to constitute approx. 10% of the overall saving in feed consumption. It is still recommended that grain mixed on farm be ground sufficiently fine to achieve a good FCR without being so fine that gastric changes reach unacceptable high levels.

The project was financially supported by the EU and the Rural District Programme under the Danish Ministry of Food, Agriculture & Fisheries. Journal no. 32101 U 12 00195

Tests revealed small differences in energy consumption between mills.
Fermented rapeseed cake
The inclusion in weaner feed of fermented rapeseed cake produced by the Fermentation experts A/S was investigated. The purpose of fermenting rapeseed cake is to improve the digestibility of protein and reduce the content of antinutritional factors.

Results revealed that fermented rapeseed decreased production value by 7-9% compared with soybean meal (15% inclusion) or rapeseed cake (11% inclusion) to weaners (9-30 kg live weight). Weaners fed fermented rapeseed cake had a poorer FCR and lower gain, and no effect was observed on health. Production value did not differ between control and the group fed rapeseed cake.

To be able to cover the reduction in productivity, the diet with fermented rapeseed must be DKK 11 cheaper per 100 feed unit (FUgp).

The reduction in productivity can be attributed to several factors:
• Degradation products formed from glucosinolates in the rapeseed cake used, which adversely affect pig growth.
• The included digestibility rate of crude protein of 85% declared by the manufacturer was too high wherefore pigs experienced a protein deficiency. Normally, digestibility of rapeseed cake is 76% (9 percentage units lower).

Each feedstuff producer nominated a starter diet and a weaner diet for the trial. All diets were formulated pursuant to the current recommendations for ‘protective’ diets (2011).

Diet from Vestjyllands Andel yielded a significantly higher production value than the other diets in the trial. The diets from DLG yielded a significantly higher production value compared with the diets from Danish Agro.

If choosing the diets from Vestjyllands Andel, a pig producer can pay DKK 30, 54 and 35 more per 100 kg for these diets than for the diets from DLG, Danish Agro and Hornsyld Købmandsgård and still achieve the same production value.

Grinding and xylanases
The effect of grinding and the addition of two xylanases on weaner productivity were investigated. Two different degrees of grinding (70% and 50% particles below 1 mm) and two xylanases (carbohydrate-splitting enzymes) from Danisco (BS3 Xylanase and Porzyme 9302) were studied. Weaners in these trials were fed meal feed from 8 to 30 kg.

Weaners fed finely ground feed (index 100) vs coarsely ground feed (index 94) had a significantly higher production value. Daily gain was approx. 3% higher and FCR approx. 3% better. The lowest frequency of treatments for diarrhoea was seen in the group fed coarsely ground feed. However, culling rates in this group were also higher, which may be attributed to the fact that more small pigs were moved from the pens.

BS3 Xylanase had a significantly positive effect of 2-3% on gain and FCR. This led to a higher production value compared with the pigs given feed without xylanase. The costs of adding BS3 Xylanase were fully covered by the improved productivity. No significant effect was observed from adding Porzyme 9302. The addition of xylanase had the same effect on productivity regardless of grinding.

Commercial diets
Commercial weaner diets purchased in Mid- and East Jutland (season 2011/2012) from the below producers were compared (production index written in parenthesis):
• DLG (105)
• Danish Agro (100)
• Vestjyllands Andel (112)
• Hornsyld Købmandsgård (104)
Restricted ad lib feeding

When finishers are fed dry feed ad lib, particularly when fed from tube feeders, there is a risk that the feed intake towards the end of the growth period gets so high that especially castrates start depositing fat instead of protein. This may reduce FCR as well as lean meat percentage. On two farms where pigs were fed dry feed from tube feeders, Pig Research Centre therefore studied the effect of restricted feed intake towards the end of the finisher period.

Research revealed that restricted ad lib feeding improved lean meat percentage, but not FCR, and the increased lean meat percentage was offset set by a lower daily gain. Impacts on productivity of restricted feed intake:

- Lean meat percentage improved by 0.4-0.6 percentage units.
- Daily gain dropped by 35-70 g a day.
- FCR was reduced by max. 0.03 FUs/g/kg.

It is therefore not recommended to practise restricted ad lib feeding in tube feeders for neither females nor castrates in the last part of the finisher period unless the wish is to optimise lean meat percentage while at the same time accepting that it takes longer to reach optimum slaughter weight.

Liquid or dry feeding

On three farms, finishers fed restricted liquid feed were compared with finishers fed dry feed ad lib. Both feeding systems were established in the sections. At the time of writing, the study was finished on two farms.

Both farms witnessed improved FCR and lean meat percentage, but also a lower daily gain, among the pigs fed liquid feed (Table 1). Both farms produced females as well as castrates. On farm 1, pens housed mixed genders and on farm 2 pigs were housed according to gender. On farm 2, the greatest difference was seen in castrate productivity, which was attributed to a higher daily feed intake among the castrates in the last part of the finisher period when they were fed dry feed ad lib. This shows that castrates benefited the most from restricted feeding.

Investment costs and operating costs must also be considered when comparing production economy between liquid feed and dry feed. The place unit in liquid feeding facilities is bigger and thereby more expensive due to a bigger trough and higher costs for heating the room, maintenance and additional amino acids. These additional costs must be set against the profit obtained through improved productivity.

On farm 3, the trial includes female and male pigs. Preliminary results reveal that female pigs perform best on liquid feed, while male pigs perform best on dry feed.

<table>
<thead>
<tr>
<th></th>
<th>Farm 1</th>
<th>Farm 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Liquid</td>
<td>Dry</td>
</tr>
<tr>
<td>Daily gain, g</td>
<td>900</td>
<td>932</td>
</tr>
<tr>
<td>FUs per g/day</td>
<td>2.49</td>
<td>2.73</td>
</tr>
<tr>
<td>FUs per kg gain</td>
<td>2.77</td>
<td>2.93</td>
</tr>
<tr>
<td>Lean meat %</td>
<td>61.0</td>
<td>60.3</td>
</tr>
</tbody>
</table>

The project was financially supported by the GUDP Programme. Journal no. 3405 10 0098.

Benzoic acid

Research has demonstrated that the addition of 1% benzoic acid to finisher feed improves finisher productivity. However, as benzoic acid is expensive, the costs were not fully covered by the improved productivity.

The effect of different inclusion rates of benzoic acid in finisher feed was therefore investigated (trial report 947): 0.5%, 1% and a phase feeding diet with 1% up to 70 kg followed by 0.5% until slaughter.

Rye

The effect of increasing inclusion of rye in pig feed is currently being investigated with and without the addition of carbohydrate splitting enzymes. Preliminary figures reveal that feed intake in finishers drops when feed contains 40% rye resulting in a lower daily gain, but a higher lean meat percentage. Preliminary results show no significant effect on FCR of a high inclusion of rye. The addition of carbohydrate splitting enzymes to a rye based diet does not seem to improve the feed value of rye.
Results showed that the addition of 0.5% benzoic acid improved productivity as much as the addition of 1%. The same level of productivity was observed in the group with phase-feeding (Table 2).

Benzoic acid improved daily gain and FCR, but reduced lean meat percentage.

Once the price of benzoic acid was included in the production economy, a profit was only achieved with inclusion of 0.5% benzoic acid. Part of this profit came from the improvement in gain. It is therefore essential that pig producers are able to utilise the increased gain in the production in the form of either an increased slaughter weight or number of pigs produced annually.

The greatest effect of benzoic acid on productivity was observed in the first half of the growth period. This is the period with the lowest feed intake, and it is therefore more profitable to add just 0.5% benzoic acid during phase-feeding in the growth period until approx. 70 kg.

In another trial (see page 27), the effect of benzoic acid on odour and ammonia emissions was investigated.

The project was financially supported by the EU and the Rural District Programme under the Danish Ministry of Food, Agriculture and Fisheries. Journal no. 3663-D-09-00365.

CLA
Conjugated linoleic acid (CLA) is naturally occurring in dairy products and meat, and several trials have revealed a positive effect on daily gain, FCR and lean meat percentage. Pig Research Centre also investigated the effect of increasing inclusion of CLA (Lutafen™ with 60% CLA) in feed for finishers.

In this trial, finishers were fed CLA from av. 62 kg live weight, and the trial comprised five inclusion rates (0-0.5% CLA). The inclusion of 0.5% CLA from av. 83 kg was also investigated.

Lean meat percentage increased when finishers were fed CLA from approx. 62 kg until slaughter at approx. 111 kg, and the effect increased as the inclusion rate increased (from 0 to 0.5%). Lean meat percentage was also positively affected regardless of whether the pigs were fed CLA from averagely 62 or 83 kg. FCR remained the same regardless of inclusion and duration of the inclusion of CLA. However, the improvement in lean meat percentage was offset by a lower daily gain when the pigs were fed CLA. Consequently, there was no financial benefit in adding CLA to finisher feed irrespective of inclusion and duration.

In conclusion, there is no profit in adding CLA to finisher feed with the current settlement for lean meat percentage.

The project was financially supported by the EU and the Rural District Programme under the Danish Ministry of Food, Agriculture and Fisheries. Journal no. 3663-D-09-00364.

Table 2 - Effect of benzoic acid on productivity.

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Benzoic acid 0.5%</th>
<th>Benzoic acid 1%</th>
<th>1%/0.5%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily gain, g</td>
<td>963</td>
<td>1006</td>
<td>1005</td>
<td>1011</td>
</tr>
<tr>
<td>FLGp a day</td>
<td>2.63</td>
<td>2.68</td>
<td>2.67</td>
<td>2.69</td>
</tr>
<tr>
<td>FLGp per kg gain</td>
<td>27.4</td>
<td>2.67</td>
<td>2.66</td>
<td>2.66</td>
</tr>
<tr>
<td>Lean meat %</td>
<td>60.5</td>
<td>60.0</td>
<td>59.9</td>
<td>59.9</td>
</tr>
</tbody>
</table>

Preliminary results reveal that feed intake and gain in finishers drop when the feed contains 40% rye (Photo: Morten Høastrup, Knowledge Centre for Agriculture).
FEEDING OF SOWS

Extra feed in late gestation
Sows require more energy in late gestation as foetuses grow rapidly in the final weeks before farrowing. On two farms, Pig Research Centre (PRC) examined the effect of feeding sows 2.5, 3.5 or 4.5 FUsow a day the last 4 weeks before farrowing. All pigs were weighed at birth and survival until day 7 was recorded.

Litter birth weight was significantly lower when sows were fed 2.5 FUsow a day the last 4 weeks before farrowing compared with 3.5 or 4.5 FUsow a day.

It is therefore recommended to feed sows 3.5 FUsow a day the last 4 weeks before farrowing to optimise litter birth weight. It is not recommended to feed 4.5 FUsow as this did not increase survival after 7 days nor birth weight significantly, but increased feed consumption.

Ideal feed for sows
Phase feeding of lactating sows is one of the areas that will be further investigated by PRC in the future.

The aim is to reduce mortality among newborn piglets by using a new feeding concept for sows in late gestation and the first week after farrowing. This concept is based on various sources of fibre and fat in sow feed, and the aim is to increase the production of colostrum.

The project, planned for completion by 2015, will also produce more information on protein supply and optimum feeding levels prior to farrowing.

The project is conducted in cooperation with DLG and Aarhus University, and is financially supported by the GUDP programme. Journal no. 3405 11.00342.

FCR on sow farms
Feed prices have soared over the past years; feed costs now constitute 65% of the costs related to producing weaners.

PRC monitored feed consumption on 8 farms with a fairly high feed consumption. Initially, the exact FCR in each section was determined and productivity levels were recorded.

Secondly, an action plan was made to reduce feed consumption, and when this action plan was implemented, FCR was recorded.

Table 1 shows the development in productivity and the reduction in feed consumption achieved on the six farms where the study is now finished. Routines on most farms generally got smoother and therefore productivity increased simultaneously with the reduction in feed consumption on most farms.

A series of recommendations were implemented on the eight farms:

- Adjustment of feed approx. 30 min. after feeding to ensure that the amount of feed is correct.
- Sows tend to as many of their own piglets as possible to reduce the number of nurse sows.
- Temperatures in the farrowing section should not reach more than 18-20°C.
- Regular USG examination for gastric ulcers. Ulcers are kept to a minimum by using feed that is medium coarse ground or by adding 10-15% grain that is not heat treated nor pelleted to pelleted feed, or — alternatively — by using expanded feed.
- Focus on efficient oestrous and gestation detection to reduce the percentage of non productive days.
- Implementation of a conscious strategy for managing oestrus in gilts to ensure that gilts are served in the second oestrous.

On all farms, sow’s weight was recorded at farrowing and at weaning. On several farms, sows’ loss of body condition during lactation was reduced through efficient management of body condition and subsequent focus on adjusting the feed dose during lactation. Results from one farm are shown in Figure 1.
Danish vs Dutch feed

PRC is currently studying whether sow productivity, FCR and longevity are affected when sows are fed according to either Dutch or Danish recommendations. Mortality rates are lower among sows in the Netherlands than in Denmark, which makes it interesting to analyse Dutch recommendations.

The Dutch recommendations are based on different mineral composition in the feed and on a higher fibre content in gestation and lactation feed. Recordings of backfat thickness are also an essential tool for managing feed curves in the Dutch recommendations.

The project will run over a period of 18 months on two Danish farms and is set to be complete in 2014.

Sow protein requirement

International research demonstrates that a sow's milk production is limited to piglet growth after the first week of lactation. In Denmark, litter size has been steadily increasing, which requires sows to produce more milk. It is therefore being investigated whether the Danish standards for protein and amino acids for sows are sufficient for production of embryos as well as the subsequent milk production. Protein and lysine standards for lactating sows were revised ten years ago, and that revision did not take into account feed intake and weight changes among sows during lactation.

The aim of these research activities is to ensure a high milk performance and nutritional balance in the sow and thereby improve sow longevity to enable it to rear its own piglets until weaning.

The project consists of two subprojects:
1. Determination of protein and amino acid standards for lactating sows.
2. Determination of protein standards for sows the final 2-4 weeks before farrowing and analysis of the effect on the sow's subsequent milking capacity, piglet birth weight and subsequent survival.

The project ends in 2015.

Ketosis is not a problem

Ketosis is a metabolic disorder primarily occurring in cattle. As the symptoms observed in sows resemble cows with ketosis, the disorder was investigated in sows.

Research revealed that two factors may trigger ketosis: a negative energy balance (primary ketosis) or other disease that adversely affects appetite (secondary ketosis).

Researchers at the Department of Animal Science at Aarhus University attempted to incite ketosis in sows by feeding farrowing and lactating sows extremely high-fat diets.

The use of 4.5% fat in lactation feed did not trigger ketosis. In order to increase the load on the sows, one trial group was fed octanoic acid, which is a medium-chain fatty acid. The sows in this group produced slightly more ketone bodies than the sows in the other groups, but since the sows’ blood glucose levels were unaffected, this was not categorised as ketosis.

Secondary ketosis is observed in sows

One of the sows in this trial became sick and stopped eating. As is the case for all fasting animals, ketone levels increased. However, the blood glucose level of this sow was not affected, and it was therefore not diagnosed as suffering from ketosis. The sow likely had an infection as antibiotic treatment normalised its body temperature within approx. 10 hours. Once the sow started eating again, ketone levels in the blood returned to normal within two hours.

On the basis of this new information, PRC does not find ketosis to be a production disorder among sows.

The project was financially supported by the EU and the Rural District Programme under the Danish Ministry of Food, Agriculture and Fisheries. Journal no. 3663-U-011-00183.

<table>
<thead>
<tr>
<th>Table 1 - Effect of feed dose the final 4 weeks of gestation on piglet birth weight and survival the first 7 days post-partum.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed dose final 4 wks before farrowing (FU/sow/day)</td>
</tr>
<tr>
<td>-----------------------------------------------------</td>
</tr>
<tr>
<td>Average parity</td>
</tr>
<tr>
<td>Litters born</td>
</tr>
<tr>
<td>Piglets born</td>
</tr>
<tr>
<td>Liveborn/litter</td>
</tr>
<tr>
<td>Weight/iveborn piglet, kg</td>
</tr>
<tr>
<td>Stillborn piglets/litter</td>
</tr>
<tr>
<td>Weight/stillborn piglet, kg</td>
</tr>
<tr>
<td>Dead piglets day 7</td>
</tr>
</tbody>
</table>
New scheme for reporting changes

In spring 2011, a new scheme for reporting changes was introduced whereby it was possible for a pig producer to make minor alterations to buildings and herd without having to go through a complete environmental approval process. The scheme is often used in cases when the herd is unchanged or reduced, and, provided rules and criteria are met, case handling is quick and smooth.

Some may in certain situations find that requirements are stricter than the requirements applying for a full environmental approval. The reason is that when reporting changes it is not possible to adjust with individual requirements. The alternative is always a full environmental approval.

In 2011, 1,185 changes were reported regarding:
- 2013 requirements for sow farms
- Changed composition of herd
- Slurry tank / silage storage
- Full finisher houses with possibilities for producing more pigs in an unchanged facility

New possibilities

In autumn 2012, the scheme for reporting changes was extended:
- Conversion from conventional to organic production
- Delimitation of natural resorts
- Test of environmental technology
- Establishment of feed storages
- Adjustment of “full pig houses”

- From conventional to organic
  It is possible to convert from conventional to organic production. If the number of livestock units is halved compared with the original approval, it will not be necessary to comply with a number of tight distance requirements applying to certain types of natural resorts. It is expected that traditional finisher facilities will adapt to the rules corresponding to a “veranda facility” complying with the rules for organic production. There are a number of restrictions on spreading of manure if the site includes areas in phosphorus classes 1–3.

- Delimitation of natural resorts
  This covers two schemes. One concerns establishment of a herd housed indoor part of the year. For these, there is a maximum on manure production in the period October 1 to April 30 corresponding to 15 livestock units. The other scheme concerns livestock housed outdoor all year, where it is allowed to establish livestock corresponding to 250 livestock units.

Test of environmental technology

It is possible to perform certain sets of environmental technology that a pig producer wishes to investigate in existing livestock accommodation. Full-scale testing of environmental technology thereby made easier without first obtaining environmental approval.

Establishment of feed storages

Today, it is only possible to report erection of feed silos, but this scheme

---

Table 1 - In 2011, local authorities received 1,185 reports on adjustments. 94% of these cases were settled within the 2-month deadline, which must be considered a success.

<table>
<thead>
<tr>
<th>Number (total)</th>
<th>a (silage)</th>
<th>b (man.stor.)</th>
<th>c (welfare)</th>
<th>d (pig type)</th>
<th>f (full pig houses)</th>
<th>Settled cases</th>
<th>Settled within deadline</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,185</td>
<td>104</td>
<td>150</td>
<td>274</td>
<td>452</td>
<td>208</td>
<td>1,001</td>
<td>936</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>84%</td>
<td>94%</td>
</tr>
</tbody>
</table>
It will be possible to report establishment of feed storages.

- Adjustment of "full pig houses"
  The current scheme for full pig houses only comprise approvals obtained before January 1, 2007. It is possible to report extensions corresponding to approx. 10% of the production scope provided compliance with the described rules. The scheme is set to expire by the end of 2012, but is likely to be prolonged to 2014. Requirements for areas in phosphorus classes 2 and 3 are now more flexible. This scheme only includes finishers above 25 kg.

- "Full pig houses 2"
  For approvals obtained after January 1, 2007, a new, more general scheme "Full pig houses 2" is introduced.

In 2009, the basis for calculating 1 livestock unit was revised, and since then nitrogen emissions have dropped by 8-10% from both weaner and finisher facilities. Provided the emissions of nitrogen and phosphorus do not exceed the original approval, it is now possible to extend both weaner and finisher batches. However, maximum adjustment must correspond to the drop in nitrogen from 2008/09 standard figures to the year of the application.

When the latest standard figures from 2012/13 are used as the basis of the application, it is possible to extend the production by up to 8-10% if the original environmental approval is from the period 2007-2009.

An increased phosphorus excretion is accepted if the applicant complies with the BAT requirement for phosphorus and a range of restrictions on spreading of livestock manure on areas in phosphorus classes 1-3. The scheme expires in 2017.

Environmental board of appeal
Case handling averaged 70 days for complaints submitted in 2011. Procedures of the board of appeal were revised as of January 1, 2011, when incoming complaints were classified according to whether they could be settled quickly or whether the case was complex and required extensive analysis before a decision can be reached.

The target is to finalize a complaint within 12 months. As of August 2012, the board must solely focus on the appeal matter, which simplifies case handling further.

On January 1, 2011, 818 livestock cases submitted before 2011 had accumulated at the board. A task force was set up to bring down this backlog, and by January 1, 2012, 414 of these were settled. The remaining cases are expected to be settled by March 31, 2013.

Livestock pressure
In 2011, the Environmental Board of Appeal stated that if a pig producer wishes to increase his herd while living in an area with an increasing number of livestock in respect to the reference year 2007, nitrogen losses must not exceed that of a farmer who only grows plants and only uses commercial fertilizer. All areas of the farm, and not just those required for the extension, must comply with these “plant levels.” This will typically require 14-15% extra catch crop to neutralize the impact of livestock manure on the environment.

In effect, 53% of these livestock farming in 2012 are affected by the increased requirement. Such tight requirements make many farmers in the affected areas seriously consider whether it is profitable to extend or alter their production. Consequently, production will drop, which in turn will result in loss of jobs and export value. Adding to this, the environmental impact is minimum.

In order to maintain the same level of pig production in Denmark, annual applications concerning extensions must constitute 4-5% of production to neutralize the percentage of producers who quit the industry. For instance, a drop in applications of 1.5% of production will correspond to drop in production of 400,000 finishers the first year alone.
Environmental technology for pig facilities

Research activities related to environmental technologies include development of new technologies as well as testing of mature technologies ready for sale. Research activities take place on commercial farms in cooperation with companies and pig producers and at experimental station Grenhøj where trial facilities are available for research and development purposes.

Below, research activities relating to mature technologies are presented followed by research and development activities on products not yet ready for sale.

SKOV A/S biological air cleaner

Research demonstrated an annual reduction in ammonia emissions of 94% with the Farm AirClean BIO Flex 3 step air cleaner from SKOV A/S. Analyses of odour samples at a German laboratory revealed an 80% reduction in odour concentration in the summer and 84% in the winter.

The overall operating costs, including utilities and filter changes, amounted to DKK 35 per produced pig, of which utility costs amounted to DKK 7.40 per produced pig. An average of 17 minutes a week was spent on inspecting and operating the air cleaner.

Similar results were obtained when the air cleaner was tested in Germany. With the completion of two tests, a certificate will be issued to SKOV A/S confirming that their biological air cleaner complies with the VERA test protocol. This makes SKOV’s system the first to obtain this certification under the new test protocols.

Munter – chemical air cleaner

Pig Research Centre (PRC) is currently testing a chemical air cleaner from Munter A/S with the aim of acceptance on the Technology List. According to the VERA test protocol, the air cleaner must be tested on two finisher sites. Results of the first test revealed a 90% reduction in ammonia concentration, and the air cleaner was temporarily accepted on the Technology List in summer 2012.

Preliminary results from the second test, set to end in 2012, indicate a 90% reduction in ammonia concentrations, and Munter may subsequently apply for permanent acceptance on the Technology List.

Dorset biological air cleaner

PRC trial results previously demonstrated a 40% reduction in odour during testing of the biological air cleaner from the Dutch company Dorset. In Denmark, the air cleaner is sold by Rotor A/S.

However, analyses at a German laboratory subsequently demonstrated a reduction in odour of 73%. Rotor A/S is now applying to get the air cleaner accepted on the Technology List with this new and higher effect.

The Technology list

The Technology List of the Danish Environmental Protection Agency lists the environmental technologies with documented efficiency in reducing ammonia and odour emissions from livestock farming. In pig production, low protein feed, acidification of slurry, cooling of slurry and air cleaning affect ammonia emissions positively, while increasing the percentage of solid floor and biological air cleaning affect ammonia and odour emissions. The list is currently under revision as the documentation of the effect of the technologies is being reassessed.

J.H. Staldservice A/S

Research revealed a 71% reduction in ammonia emissions from a finisher facility annually when slurry was acidified once a day in an acidification system from Jørgen Hylgaard Staldservice. Odour emissions were reduced by 32% and hydrogen sulphide emissions were reduced by 70%. Consumption of sulphuric acid averaged 7.1 kg per produced finisher. Only few breakdowns were experienced with the system during the trial period. In order to obtain a VERA certificate, the system is currently being tested on one more farm.

EPI

Sedimentation of dust through electrostatic particle ionisation (EPI) was investigated in a smaller facility to examine the effect on air quality and production results. Using EPI, the concentration of respirable dust in the pig house was reduced by 50%. The reduction in dust did not improve production results in any measurable way nor were NH3 emissions affected significantly.

At experimental station Grenhøj, the effect of electrostatic particle ionisation on air quality in small sections houses finishers is currently being investigated.

Frequent emptying of slurry

Research showed that odour emissions from finisher facilities recorded the day...
after slurry was emptied were reduced by 50% when slurry was emptied once a week compared with emptying when needed, in this case every six weeks.

Increased frequency of slurry emptying could be a cheap and efficient way of reducing odour emissions, and research therefore continued in summer 2011 on a commercial farm with 450 place units and in the climate chambers at experimental station Grønhøj.

Contrary to expectations, analyses made at a German laboratory did not reveal significant differences in odour emissions from sections with weekly emptying of slurry vs emptying every six weeks.

Development projects
In order to ensure continued development of efficient environmental technologies, a range of small-scale research and development activities have been initiated to investigate whether these technologies may at a later point in time be upgraded to full-scale use on commercial farms.

**Leca® used for air cleaning**
In a joint venture with the company Saint-Gobain Weber, an air cleaning module was developed using Leca® (expanded clay aggregates) as filter material. This air cleaning module reduced ammonia concentrations in the air from a pig facility by 96%; odour concentration by 78% and hydrogen sulphide concentrations by 26%. Durability of the filter module improved when a dust cleaning filter was mounted before the Leca® module as clotting of the air cleaning with dust was reduced. The project was financially supported by the Danish Ministry of Food, Agriculture and Fisheries under the Innovation Act.

**Cleaning air with alkaline water**
Research has shown that the concentration of sulphurous odors can be reduced by adding alkaline water to an air cleaner.

Together with Munters, PRC is therefore currently investigating whether the combination of alkaline water and acid can be used for developing a chemical air cleaner that reduces ammonia emissions as well as odour concentrations. The consumption of acid and alkaline water combined in a system is also being investigated. Both trials are conducted at experimental station Grønhøj in 2012.

**Separation of acidified slurry**
Infarm A/S manufactures the slurry acidification system "NH4+", which is approved for 70% ammonia reduction. Infarm is currently working on including separation of slurry in the daily sulphuric acid treatment to reduce odour as well.

At experimental station Grønhøj, it is being analysed whether the combination of separation and acidification reduces the emissions of odour and greenhouse gases.

**Other slurry treatment**
In the summer 2012, slurry treatment was studied in a series of activities at experimental station Grønhøj in an attempt to affect ammonia and odour emissions.

Research included the slurry additives Active-NS and Viscolight and “slurry sticks” from Re2Vit.

**Olfactometry in odour reduction**
Together with Aarhus University and SKOV A/S, PRC is running a project entitled “Olfactometry and chemical analyses for further development of environmental technology”. The project runs for three years and is financially supported by the GUDP scheme.

The aim is to develop a model that, on the basis of chemical analyses, can describe and document the effect of different technologies on odour emissions from pig houses.

For producers of air cleaners, such as SKOV A/S, it will then be possible to document minor improvements of their environmental technologies without involving extensive and expensive monitoring programmes. For PRC, this model would reduce the costs related to testing environmental technologies in terms of time as well as costs for odour analyses.
Local extraction at Grønhej
At experimental station Grønhej, it was investigated how to develop efficient local extraction in finisher pens with fully drained floors. Using local extraction, the majority of the contaminated air is collected in a small percentage of air that is subsequently cleaned.

As the ventilation air moves in a pig facility, the highest concentrations of ammonia, hydrogen sulphide and odour are found in the slurry pit below or close to the lying area, which is exactly where local extraction of installed.

Recordings at Grønhej demonstrated that min. 70% of ammonia emissions, 50% of odour emissions and 90% of hydrogen sulphide emissions were collected in what corresponds to 10% of the ventilation capacity. The remaining part of the ventilation air was released traditionally through exhaust facilities in the ceiling.

Full-scale testing
PRC is currently testing local extraction in three finisher facilities, two gestation facilities and two farrowing facilities. The aim of full scale testing is to establish how to install local extraction in different types of accommodation and to document whether it is possible to collect the same percentage of air as in the climate chambers at Grønhej in terms of ammonia and odour emissions.

Results from one finisher facility demonstrated that 80% of ammonia emissions and 50% of odour emissions were successfully collected in the air emitted through local extraction. Ventilation output of the local extraction was approx. 20 m³/hour/pig.

To document the results obtained at Grønhej, the effect of emitting 10 m³/hour/pig through local extraction is currently being investigated on the trial farms.

One of the finisher farms has 25% solid floor, one has 33% solid floor and the third 50% solid floor. In the gestation facilities, local extraction is installed in a facility with electronic sow feeding and in a facility with one crate per sow. One of the farrowing facilities is designed with traditional farrowing pens and the other with loose lactating sows.

Cleaning of extraction air
PRC is currently investigating reductions in odour and ammonia emissions with a biological air cleaner and a chemical air cleaner, respectively, hooked up to the local extraction facility in a finisher facility and a gestation facility. It is expected that air cleaners reduce odour and ammonia concentrations at the same level as seen in the trials that form the basis of acceptance of these technologies on the Environmental Protection Agency's Technology List. However, it is unclear how the air cleaners function when they are hooked up to the local extraction facility, where the air output is high all year round and where odour and ammonia concentrations are significantly higher than in facilities with traditional ventilation systems.

In this gestation facility with one crate per sow, local extraction is evenly distributed under the partially solid floor in each row of crates.

Research will reveal the potential of combining air cleaning with local extraction.
Guidelines
When a pig producer prepares an environmental application, the latest standard figures for livestock manure are included in the basis of calculation. The standard figures originate from the national average of the efficiency control and, for feed composition, from the feedstuff control of the Danish Veterinary and Food Administration. No specific feed requirements will apply provided the applicant complies with the BAT requirements without using his own values for protein and phosphorus content in the feed.

In recent years, crude protein content in pig feed has dropped radically. According to standard figures for livestock manure, the nitrogen content lowers the requirement for additional environmental technology when submitting an environmental application. If an applicant chooses more than 50% solid floor in weaner and finisher accommodation, BAT requirements are fulfilled provided it is based on the latest standard figures and provided that the extension does not exceed 300 LU. For all other pig facilities, new ones or existing ones being extended, supplemental technologies will be required for reduction of ammonia emissions.

Normally, phosphorus content in manure is close to the BAT level, which is expressed as kg P per LU. In years when standard figures are below the BAT level, environmental applications do not include requirements for feed, whereas in years when standard figures are higher than the BAT level, phosphorus requirements will apply. It will therefore be highly beneficial if pig producers in general buy feed that complies with BAT for phosphorus. This is important for pig producers who wish to extend or renovate their pig facilities or to explore the new schemes for reporting changes that make it possible to produce more pigs in existing facilities.

The table illustrates the content of phosphorus per LU according to the standard figures in relation to the BAT requirements that were introduced in 2010. It is clear that sows and finishers do not quite meet the BAT requirements in the new standards, and consequently, documentation of phosphorus in feed is required in new environmental applications.

Benzoic acid
Research of the effect of benzoic acid on odour and ammonia emissions demonstrated that the addition of 1% benzoic acid to pig feed reduced odour emissions significantly by 17% (trial report 948). This is in line with the outcome of another trial that revealed a tendency to a 17% reduction in odour emission when adding 1% benzoic acid.

It was also investigated whether the addition of 1% benzoic acid combined with reduced sulphur content in pig feed might enhance the effect of benzoic acid on odour emissions. However, no effect was observed despite the fact that hydrogen sulphide emissions dropped when sulphur content in the feed dropped. Hydrogen sulphide and similar sulphurous substances are assumed to be responsible for part of the odour emitted from pig facilities.

Results revealed a 14% reduction in ammonia emissions per pig. Part of this effect is attributed to the increased gain resulting from the addition of benzoic acid (see p 17). The increase in gain saves 3-4 productive days of the growth period, and the corresponding shorter stay in the unit reduces ammonia emissions by 4-5%.

The project was financially supported by the EU and the Rural District Programme under the Danish Ministry of Food, Agriculture & Fisheries. Journal no. 3663-D-09-00365.
Tube feeders
Research comparing five different tube feeders for finishers revealed no significant differences in production results between the feeders. Daily gain varied from 1,040 to 1,094 g/day, and FCR varied from 2.69 to 2.73 FL/gg per kg gain.

When results were pooled to a function index, no differences between the feeders were found. All feeders scored 3 out of 4 in a function index.

Fittings for covering the gaps
From 2013, new requirements apply to slot and slot widths in pens with fully slatted concrete flooring: max slot width 18 mm and min slot width 80 mm.

As of July 1, 2015, fully slatted flooring is prohibited in group housing systems, which means that half of the flooring in weaner pens must be solid or drained. In finisher pens, one third of the floor must be solid or drained. It is possible to convert existing accommodation to drained flooring by closing part of the slots. In drained flooring, slots constitute max 10% of the open area. PRC is currently investigating the products available for closing the slots in terms of durability and how easy they clean. The price of materials and costs for assembly compared with replacing the floor with a drained floor are also evaluated.

Three products are included in the trial:
- Plastic rails
- Epoxy products
- Concrete products

Preliminary experience indicates that all three are durable and fairly easy to install and clean. However, it is recommended that professionals put down epoxy products as several safety precautions in relation to working environment must be observed.

There are alternatives to epoxy products, such as different types of DIY mortar products, that do not require compliance with various working environment precautions.

The costs of the epoxy and concrete products investigated are approximately half of what a drained floor would cost. Materials for establishing drained flooring with plastic rails are slightly more expensive than concrete drained flooring. However, assembly of the plastic rails is cheaper.

Production of runts
Weaners and finishers must be produced under all in all-out management. Some pigs grow slowly or are small at transfer to the finisher section, and do not fit into all in all-out management if production must be efficient and the utilization rate of the section high. Instead, these pigs must be handled in separate facilities. If some of the biggest pigs are moved from the weaner section a week before the majority is moved and if the smallest are moved to a separate facility, it is possible for the main production to reach optimum slaughter weight as the weight spread at transfer is reduced. The shorter the period

<table>
<thead>
<tr>
<th>Table 1 - Evaluation of functionality of tube feeders for finishers.</th>
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<tbody>
<tr>
<td><strong>Feeder</strong></td>
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<tr>
<td>Feed/water wastage</td>
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<tr>
<td>Easy to adjust</td>
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<tr>
<td>Easy to learn to use</td>
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<tr>
<td>Bridging</td>
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<tr>
<td>Build-up of clotted feed</td>
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<td>Easy to clean</td>
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<tr>
<td>Working environment</td>
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<tr>
<td>Durability and wear</td>
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<td>Functionality index</td>
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</table>
the pigs stay in the section before a new batch is transferred, the greater the percentage of sorted pigs will need to be.

The strategy for handling of these pigs is based on model calculations based on data from more than 2,000 pigs weighed three times from weaning to finish. These weighings illustrate variations in weight and gain within a batch of pigs, and can be used for calculating the percentage of runts at different times of the production cycle.

Based on this data set, the greatest profit is obtained from sorting these pigs if they only stay in the facility for a short period.

With a stay of 13 weeks and a daily gain of 950 g, the best financial result is obtained by moving the 10% smallest pigs to a separate facility. The greatest improvement in result/place unit is obtained with 12 weeks, but this requires moving 25% of the pigs. There is no benefit in sorting the pigs with a stay of 14 weeks in the facility.

It is not always possible to predict a pig’s growth rate on the basis of weight at transfer. The smallest pigs are not always the ones growing slowest. Sometimes the growth rate changes during the growth period. Sorting the smallest pigs at the time of transfer will therefore not completely solve the problem with pigs that do not fit into the production.

Moving of pigs
In future production facilities, on-farm transport will take place over long distances and a large number of pigs will need to be moved weekly. It is therefore essential that a producer is able to move sows and pigs quickly and efficiently to limit the time spent on this task. It is also essential that the pigs are moved in a way that considers their natural behaviour.

To obtain more knowledge on how best to move pigs, video recordings were made on three commercial farms. Pigs in different age groups were moved to determine how to account for the pigs’ natural behaviour during moving. The video recordings are available at www.vsp.lf.dk.

Pigs react in predictable patterns and when we understand their patterns of behaviour, it becomes possible to predict their behaviour and use this in our handling of the pigs.

A few points must be taken into consideration:

- Flight zone; keep your distance to the pigs. If you are close enough to touch them, you are too close.
- Limited range of vision; pigs are unable to see what goes on behind them. Stay on the side of them and do not cross their point of balance.
- Bunching; pigs tend to bunch together if they feel pressured. Step back to disperse a group of bunching pigs.

Figure 1 - Marginal change in result/place unit compared with 13 weeks and 9% pigs sorted to a separate facility.
What makes a strong healthy sow
Focus on young females and gilts is crucial to keep sow mortality rates low. Young females must be kept free of injuries to legs and hooves, and gilts must be introduced gently to the gestation unit. Young sows are overrepresented among dead and culled sows proportional to their presence in their herd.

Socialisation of gilts
Socialisation is the process where animals acquire social skills through interaction with older animals. The aim of a recent investigation was to socialise gilts to manage in a large group of gestating sows.

Socialised gilts that as young females were housed with older sows in groups generally started using the lying areas faster than gilts that had not been socialised. This is an expression of faster integration in the group in the gestation unit.

Practical experience
Pig Research Centre investigated different principles of socialisation on 7 farms where gilts were housed in small pens (5-8 gilts per pen) in the quarantine facility. When the gilts were moved to the sow unit, gilts from several pens were mixed in a large pen where they were, for instance, trained in using electronic sow feeder stations (ESF). This type of mixing caused a great deal of confrontations between the gilts, which increases the risk of leg injuries in many gilts. Socialisation was intended to prepare the gilts for being part of a new, large group of gilts.

The gilts were given access to each other’s pens a few days before moving by opening the gates to the pens and thereby enabling the gilts to visit each other. This happened amicably, and gilts returned to their own pen, ie. socialisation took place in familiar surroundings.

Having implemented these routines, very few farm owners witnessed aggressive behaviour between gilts during the subsequent mixing.

It was also tried to house a few sows together with gilts in gilt pens before service. This seemed to work in large ESF training pens, and gilts clearly gave way to the sows after the first few days’ confrontations. It is essential that the pen is large and that the sows are suitable for the job — ie. young, strong gestating sows that can handle confrontations with the gilts.

Improve the gilt pens
Non-skid floors are essential in preventing leg injuries among gilts. It is particularly important that faeces does not accumulate on the floor in pens where gilts are mixed and ranking takes place. Research shows that changing the layout of existing pens keeps non-skid floors clean.

Straw boards in the lying areas and additional sprinkling were introduced in two pens accommodating 30-50 gilts each. Results showed that this made zones more clearly defined, ie. gilts used the lying areas as intended to a greater degree and tended to move away from the lying and feeding area when dunging.

For more information, see report 1208 at www.vsp.lf.dk.

Straw boards made lying areas more attractive.

Three gilt pens turned into one common pen by opening the gates towards the inspection alley. At their own rate, gilts were able to explore the new area and their new pen mates in the pens. The group was moved collectively to a larger pen after approx. 1 week.
Group-housed sows
Sows produced for the UK market must be housed in groups after weaning. In addition, it is our aim over time that group-housing is the generally rule from weaning.

Service unit
Once sows housed in groups in the service unit enter oestrus, they will display sexual behaviour. This is observed in the form of, for instance, mounting other sows in the group.

As the onset of standing oestrus varies, some sows are mounted while not in oestrus (old sows typically enter oestrus sooner than young sows). Mounting may lead to reduced reproductive performance or to culling due to leg problems. Mounting is estimated to have a negative impact on 10-20% of the sows in a group (in the form of reduced reproductive performance and/or culling due to leg problems).

Research has previously demonstrated that:
- Sorting sows according to size in the service unit may increase the number of pigs born in total per litter among young sows.
- Permanent access to an escape route (eg. feeding/resting stall) may increase farrowing rates and reduce weaning-oestrus interval compared with group-housed sows with no escape route.
- Farrowing rates increase in 2nd and 3rd parity sows that are given 2 hours of rest after insemination.
- If housed in stalls from day 3 after weaning until day 3 after service, the percentage of sows culled due to leg problems or lack of service drops by 4 percentage points compared with sows housed in groups from weaning until transfer to the gestation unit. Pig producers with a UK contract are not allowed to house sows in stalls.

There are several potential ways to reduce the impact of mounting, but future research will clarify which combination of the above is most appropriate to relieve the impact of group-housing in the service unit.

Conversion from stalls to groups
A pilot study made in connection with conversion from stalls to group-housing during gestation found that nesting boxes with low lying walls (5 cm wide) function as intended. The sows chose to rest against the walls, whereby the lying area largely remained dry. The sows were easily able to step across the lying walls.

Low lying walls approx. 45 cm high and 1.3 m long encourage the sows to use the lying area. It is likely an advantage if the walls are 2 m long corresponding to the length of a sow.

Liquid feeding in long troughs
When converting gestation facilities from stalls to group-housing, many producers choose liquid feeding in long troughs. It is essential to ensure that all sows in the pen get their feed as quickly as possible.

In the minutes leading up to the feed being released into the trough, all sows prefer to stand by the valve that releases the feed first (top picture) and do not disperse until the other valves start releasing feed. However, there will never be an even number of sows by both troughs (bottom picture).

Recommendations:
- Every sow must have min. 0.55 m room by the trough.
- If the feed ration is divided over two subsequent fillings, the trough must not be empty after the first allocation.
- Feed should not take more than 3 seconds to distribute in the trough.
- Head/shoulder partitions do not seem to be efficient in creating calm by the trough.
FARROWING PENS

Same pen – new design
The traditional farrowing pen where the sow is housed in a crate is the safe choice in terms of production. PRC is currently investigating how to improve the farrowing pen with the crate to optimise working environment as well as management.

Trial pens have been established with
- Improved access to the pen
- Straw rack above the sow’s trough
- Rear gate in the crate that staff does not bump into
- Trough divided into two: one for water and one for feed
- Drain below trough in pens with solid floor

The aim is technically simple solutions that can also be used in existing pens. Not all solutions are available for sale yet.

The project is financially supported by the EU and the Danish Ministry of Food, Agriculture & Fisheries. Journal no. 3663 U 11 00183. Vissing Agro, Ikadan and AgroElementer also participate in the trial activities.

A split trough reduces the risk of feed mixing with water.

Improved rear gate in crate that does not extend into the pen area and that can be adjusted without the sow being able to back out of the gate.

Straw rack reduces the number of refills and increases the utility value of the straw.

Gate (top) or low step (bottom) may improve working environment.

Hygiene tends to be poorer in pens with solid floor due to feedwater wastage, but this can be solved by installing drain below the trough.

Compared with the traditional AP crate, the AP Welfare crate is characterised by improved space for the sow lying laterally and for the nursing piglets.

Room for lactation
Results of a trial comparing the AP Welfare farrowing crate (AP Company) with the traditional AP farrowing crate demonstrated no differences in neither litter weight at weaning nor piglet mortality. For more information, see www.vsp.ili.dk

Most farrowing crates available in Denmark are fairly identical, but vary in terms of space and adjustability. A sow lying laterally measures ≤ 71 cm from back to udder and the length of a 4 week old pig is ≤ 56 cm. A sow lying laterally measures ≤ 47 cm in “height” (shoulder width). These dimensions apply to 95% of Danish hybrids and piglets, and must be taken into consideration when designing a crate to ensure that the sow is able to utilize the extended lying area.

Heat behind the sow at farrowing
Preliminary results of a trial on the use of heat in the slatted floor behind the sow during farrowing did not show any positive effects on piglet survival. The surface temperature of the slatted floor was approx. 28 °C.

Loose sows in the farrowing unit
Two types of farrowing pens for loose sows are recommended by PRC:
- **FF-pens:** Free Farrowing where the sow is loose all the time.
**Housing**

- **SWAP pens:** Sow Welfare And Piglet Protection, which is a modified FF-pen where the sow’s movement can be restricted – for instance during the first couple of days after farrowing to increase piglet survival.

**Loose all the time (FF)**

For a few years, PRC recorded productivity on farms with both traditional farrowing pens with crates and pens for loose sows. Results demonstrated that a percentage of loose farrowing sows actually have a production level that is comparable with that of sows housed in traditional pens with crates. Results also showed that in many pens for loose sows solid floors are dry provided the pens are designed according to recommendations, i.e. dimensions and design as shown in Figures 1 and 2.

The dimensions of the FF-pen allow the sow to turn around freely, and the floor profile allows for maintenance of good floor hygiene.

**Loose – as much as possible**

The combi pen “Combi-flex farrowing pen 2011” from Vissing Agro was investigated on one farm to monitor the sows’ use of the pen. The sows were crated pre-farrowing and for the first few days post-farrowing.

Experience showed that when the crate was opened, the sows preferred to lie with their head towards the feeding area (55%) whereas when dunging they faced away from the feeding area (56%). For more information, see report 1204 at www.vsp.lf.dk.

Results are not sufficiently clear-cut for us to actually define the ideal place for, for instance, a solid floor area. However herd experiences with loose farrowing sows indicate the need to be able to restrict the sow’s movement for a few days post-farrowing to increase piglet survival.

The **SWAP pen** (Figure 3) is expected to meet this requirement. Together with the University of Copenhagen, PRC is investigating the effect of confinement for a few days on sow welfare and piglet survival rates. As sows are only housed in confinement for a few days, the pens must generally be designed as the FF-pens.

A large number of SWAP pens will be established on a commercial farm in 2012 where the pens will be compared with FF pens.

**Climate and immediate environment**

PRC is monitoring a farm with loose farrowing and lactating sows with two circuits for heating/cooling in the floor in the farrowing facility: one in the creep area and one in the pen. Preliminary figures reveal an overall consumption per sow/year of 269 kWh of which 211 kWh is for the creep area and 36 kWh pen for heating/cooling, respectively, in the pen, and 22 kWh for the heat lamp.

The project was financially supported by the EU and the Rural District Programme under the Danish Ministry of Food, Agriculture & Fisheries. Journal no. 3663-D-10-00458.

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**Figure 1. Key sketch of the FF pen for loose farrowing sows (FF = Free Farrowing).**

**Figure 2. Picture of the FF pen for loose farrowing sows (FF = Free Farrowing).**

**Figure 3. Key sketch of the SWAP pen where the sow’s movement is restricted for the first few days post-farrowing.**
Rooting and enrichment materials
As the transition period for rooting and enrichment materials ended in 2012, all pigs must now have permanent access to rooting and enrichment materials. This obviously also applies to sows in service/control facilities and farrowing facilities regardless of age and design of the facility.

Dispenser
Dispensers for finely chopped straw and straw pellets were developed in cooperation with Ikadan Systems A/S specifically for lactating sows, incl. piglets, and weaners, respectively.

The dispenser for lactating sows was set up in four farrowing pens and monitored in 8 batches. Consumption varied from 0.5 to 3.5 kg/sow with an average of 0.8 kg straw/sow. Dispensers were refilled twice during lactation, but this also varied.

The dispenser for weaners was set up in four weaner pens and monitored in 5 batches. In the period 7-30 kg, consumption averaged 2.1 kg straw pellets/weaner. The dispenser was typically refilled 1-2 times a week.

Gestation and service facilities
The requirement for bedding on the solid floor for group-housed gestating sows ensures that the requirement for rooting and enrichment material is met in this facility.

Automatic refilling of straw with the JH Mini-Strø dispenser was investigated in a service/control facility with crates and a gestation facility with nesting boxes and ESF.

Results demonstrated that:
- In the service/control facility, it is recommended to supply straw between feedings.
- In the gestation facility with group-housed sows and ESF, where the feed day starts at midnight, it may be an advantage to supply straw in the afternoon.
- When slurry pits had been emptied, high-pressure washing was necessary in the service/control facility as large amounts of straw had passed through the pits.

Straw racks for finishers and sows
Straw racks are currently being investigated on a finisher farm where pigs are fed in long troughs and straw racks are placed above the liquid feed trough. In a facility for group-housed gestating sows, a straw rack is placed in each nesting box. The aim is to investigate the function and use of the straw racks.
Castration
The majority of all male pigs in Denmark are castrated to prevent boar taint in meat from these pigs. In 2009, pain relief was introduced as a requirement during castration of all male pigs in Denmark. Initially, this was a requirement under the DANISH Product Standard concept that was later made statutory. Pain relief injected in the neck of the pig lasts approx. 24 hours.

European scientists are searching for suitable methods for anaesthetizing piglets during castration. However, so far they have not found any applicable methods, i.e. methods that are both practical, safe for humans and animals and have a documented positive effect on piglet welfare.

Politics
In Europe, it is agreed to stop castration by 2018, and this is the time frame we are working with.

For Danish pig producers to stop castrating male piglets, we need to have an online method to ensure that our customers are not offered pork with boar taint. It is also essential that the method and acceptance limits are accepted by the consumers.

Boar taint
Boar taint is primarily attributed to two substances: skatole, which is produced in the intestines, and androstenone, which is produced in the testicles. Both substances are metabolized and decomposed in the liver. The fractions that are not decomposed in the liver are deposited in fatty tissues. Boar taint is particular distinct when meat is prepared, but not all are able to smell it. In 1980s and 90s, Danish scientists developed online equipment for recording skatole. At the time, slaughter weight was lower than today, and skatole was then the documented predominant cause of boar taint. Consequently, in order to keep producing male pigs that are increasingly heavy, future analysis equipment must be able to detect skatole as well as androstenone.

Trials with male pigs
PRC is currently focusing on:
- Cost-benefit, male pig production
- Effect of feeding on boar taint
- Development of boar taint with age and weight
- Breeding against boar taint (see p 12)

Economy
When a pig producer delivers a male pig for slaughter, DKK 25 is deducted from the price to cover skatole analyses etc. A male pig is only approved when skatole levels in fat are below 0.25 ppm. If a male pig is rejected, DKK 2 is deducted per kg carcass weight. New cost-benefit analyses reveal that compared with production of castrates, profits range between DKK +7 and DKK +29 per male pig after male pig deduction (0% rejected) with liquid feeding and dry feeding ad lib, respectively. Profits drop by approx. DKK 1.5 per pig when rejections increase by 1 percentage point (August 2012).

The project was financially supported by the EU and the Rural District Programme under the Danish Ministry of Food, Agriculture and Fisheries.

Age/slaughter weight
Preliminary research demonstrates that when slaughter weight increases from 75 to 95 kg, androstenone increased, but skatole remained unaffected.

Improvac
In cooperation with Pfizer, the effect of immuno-castration was investigated. Results demonstrated that immuno-castrated male pigs grew faster and had better FCR and lean meat percentage than castrates, and were actually performing at the same level as female pigs. No male pigs were rejected due to skatole, but a taste panel found that vaccinated male pigs excreted more boar taint than castrates (IPVS 2012). Though approved for use, Improvac is not used in Denmark as Danish slaughterhouses refuse to receive vaccinated male pigs.

The future
PRC will continue to research for ways to reduce boar taint in cooperation with research institutes and universities. In addition, several of our external collaborators are working on detection and development of online analysis methods.
Quality control programme:
DANISH

DANISH, the Danish pig producers’ own quality control programme with independent audits of all Danish pig farms, was introduced five years ago. All farms will soon have been through two rounds.

DANISH has increased the audits of hospital pens in terms of number, layout and use. In 2011, it was decided that as of July 1, 2011, non compliances found during a DANISH audit must be reported in terms of number or extent to make it possible to monitor the development in these objectives. For instance, all auditors must record the number of pigs that ought to have been moved to a hospital pen or destroyed.

Hospital pens
Animal welfare improves and mortality drops when hospital pens are used correctly. The industry therefore decided that DANISH audits must now also include inspection of layout and use of hospital pens. Objectives are to:
- Reduce the number of herds where auditors find pigs that ought to have been destroyed to max 5%.
- Reduce the number of herds where auditors find pigs that ought to have been moved to a hospital pen to max 10%.
- Reduce the number of farms with no hospital pens or with incorrectly designed hospital pens from 10% to less than 1%.

Destruction

In 2011, pigs that should have been killed were reported in 7% of all audits. The goal that the objective should be reached in 2011 is thereby not fulfilled, but we are moving in the right direction.

In the period July 1, 2011-September 30, 2012, a total of 7,330,363 pigs were audited. Pigs that ought to have been destroyed accounted for 0.03 per mille of all audited pigs in that period, which corresponds to three pigs in 100,000 pigs.

Use of hospital pens

Figures from DANISH audits in 2011 reveal that in 18.2% of the audits sick or injured pigs were found that should be undergoing treatment or placed in a hospital pen, but were not. That is above the objective, but when farms with just one pig are excluded from the analyses, the figure drops to 81%. All pigs must be taken of but we do not expect ever to reach 0% as we are dealing with live animals.

In the majority of the herds, non compliance concerned just one pig that has not been moved to a hospital pen. In 4.6% of the audits, auditors found two pigs that ought to have been moved to a hospital pen. In that period sick and injured pigs that ought to have been moved to a hospital pen accounted for 0.18 per mille, corresponding to 18 pigs for each 100,000.

Layout of hospital pens

Sick or injured pigs must be treated immediately and if necessary be moved to a hospital pen. In Denmark certain requirements apply to the layout of hospital pens to ensure that sick or injured pigs are housed under optimum conditions. All hospital pens must be equipped with a soft lying area and sources of heating/cooling.

Preliminary DANISH figures for 2012 reveal that 9% of the audits found non compliance with one or more requirements for layout of hospital pens.

These figures show that more information and advice on correct layout of hospital pens is required.

Routine inspection is essential

The outcome of the DANISH inspections demonstrates that on farms where regular inspection of all sections is an incorporated routine and where clear procedures for good animal welfare are agreed with the staff the audits with really good results.

It is in particular important that clear procedures are agreed with the staff on correct handling of and tending to the pigs on the farm.

It is also essential that the herd is registered correctly in the CHR register in terms of production, sales agreements and in particular transport of pigs to and from the site.

Figure 1 - % audits reporting failure to move pigs to a hospital pen of a total of 3,640 audits in the period July 1, 2011-September 30, 2012.
(Source: Data from DANISH)
Welfare policy – objectives
In 2011, the industry launched a new animal welfare policy that concerns, among other things, reducing mortality rates by 20%.

Reducing mortality rates
Sows
In 2008, it was decided that sow mortality must be reduced by 25%, i.e., from 15.2% in 2008 to 11.5% by 2013. In 2011, mortality had dropped to 13.7%. This shows that trend is right, but a dedicated effort is still required.

Piglets
Piglet survival rates must improve. The objective is a 20% reduction in mortality by 2020, when mortality rates among stillborn and dead during nursing must also be reduced. By 2011, mortality had dropped to 23% from 24.2% in 2009, and the number of liveborn increased in that same period.

Table 1 – Trend in mortality for piglets, weaners and finishers.
(Source: National average of productivity in Danish pig production, 2011. Pig Research Centre)

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<tr>
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<th>2009</th>
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<tr>
<td>Mortality during nursing, %</td>
<td>14.0</td>
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<tr>
<td>Mortality, finishers, %</td>
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<td>3.7</td>
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Weaners
Objectives state that mortality rates among weaner must be reduced from 3% to 2.5%. In 2009, mortality averaged 2.9%, i.e., no reductions were seen in 2009.

Finishers
The objective is to reduce finisher mortality from 4% to 3%. In 2011, mortality dropped to 3.7%. This is a positive development, and work will continue to reach the objective by 2020.

Cross-compliance
In cooperation with 9 pig advisors and one lawyer, PRF set up a cross-compliance (CC) network in 2012. The purpose is to assist pig producers as much as possible during CC cases and pool experience and current cases to share this knowledge professionally as well as politically.

The group will be able to provide even better advice and a large number of anonymous cases will be compiled in a database from which the group can gather experience from others who have completed a successful case.

With legal assistance, the advisors are able to inform pig producers of their rights and options in the case handling process. Pig producers are offered to have one of these nine advisors by their side through the entire process.

The main experience of the group is that CC cases often concern handling of one animal, and that the greatest success in non-compliance cases is seen when actions are made in time.

For more information on the group’s work, see wwwvsplf.dk (in Danish).
A hidden disease
Gastric ulcers occur in growing pigs, sows and gilts, but it is often highly difficult to tell that a pig is suffering from poor gastric health.

Among pigs of all ages, symptoms of severe bleeding gastric ulcers may be pale skin and dark faeces. Sudden death may be the outcome of bleeding gastric ulcers, and post-mortem examinations will reveal lesions in the stomach. Research has shown that severe gastric ulcers reduce daily gain in finishers by up to 100 g a day.

Examination of stomachs
A finisher producer may request examination of stomachs at the slaughterhouse, which costs DKK 42 per stomach. In 2010 and 2011, 100-150 producers chose gastric health examinations. This indicates a big awareness of gastric health. A gastric ulcer diagnosis always requires examination of min. 20 stomachs.

Straw
Research has not confirmed that straw improves gastric health. Together with scientists at Aarhus University, PRC is investigating the effect of increasing amounts of straw in the pen. Results are expected in 2013.

Gastric health in sows
Many sow producers left the industry in the autumn 2012 due to the considerable investments required for converting the housing facilities by 2013. This made it possible to examine gastric health in sows of all parities, which is currently being analysed.

Feeding strategies
Using finishers as a model for sows, it is currently being studied whether it is possible to influence gastric health in gestating sows through feeding. At experimental station Granhøj, three strategies with meal feed as well as pelleted feed are being studied:

- 1 daily feeding
- 2 daily feedings
- Ad lib feeding

Preliminary figures reveal that with one daily feeding pelleted feed results in the fewest gastric changes. The effect of meal feed is currently being analysed.

Ulcers develop and heal quickly
Research shows that if growing pigs switch from meal to very fine pelleted feed, almost all pigs develop gastric changes within few weeks. One study revealed gastric ulcers or scars from ulcers in 95% of all pigs three weeks after changing diets. After four weeks on pelleted feed, the pigs switched to coarsely ground meal feed. This improved gastric health significantly in only a few weeks. After two weeks with coarsely ground meal feed, only half of the slaughtered pigs suffered from gastric changes. These changes were mainly scars after ulcers that had likely developed when the pigs were fed fine, pelleted feed.

Impact of other diseases
Veterinarians and pig producers often find that gastric health is stronger if the pigs do not suffer from eg PCV2 virus infection. In order to investigate the impact of other diseases, stomach and lungs from finishers on 50 farms are being examined for disease. The materials are analysed for PCV2 virus in lymph nodes, and results are expected in 2013.

The activities were conducted in cooperation with Danish Crown, and were financially supported by the EU and the Rural District Programme under the Danish Ministry of Food, Agriculture and Fisheries. Journal no. 3663-U-11-00181.
**Laboratory for Pig Diseases**

The Laboratory in Kjellerup conducts a multitude of diagnostic examinations for a wide range of pig diseases.

The examinations can be divided into three main groups:

- Routine samples from SPF Health Inspection
- Diagnostic submissions from veterinarians
- Research and development activities

SPF Health Inspection primarily submits monthly blood samples for pleuropneumonia (Ap), pneumonia (Myc), PRRS and Salmonella. Examinations for rhinitis and pig dysentery are also performed.

Since July 2012, the Lab is responsible for Salmonella serology on serum and meat juice.

Diagnostic examinations of submitted material typically start with a post-mortem examination of entire pigs or organs from which samples are analysed for relevant pathogen bacteria, viruses, parasites or subjected to microscopy.

**Estimated number of analysed samples**

- Serological examinations SPF 250,000
- Salmonella meat juice 250,000
- Post-mortem examinations 4,000
- Nose swabs for rhinitis 4,000
- Bacteriological samples 1,500

The Lab also participates in a wide range of research activities on subjects such as piglet diarrhoea and gastric ulcers.

Another significant activity is assisting practising vets contacting the Lab in connection with sampling, interpretation of lab results and analyses of health problems on pig farms.

One of the great forces is that analysis of submitted material is fast and response time short. This enables vets as well as pig producers to initiate correct treatment fast and avoid unnecessary losses in the production.

**SPF Health Inspection**

SPF Health Inspection is performed in all breeding and multiplication herds with red SPF status, and this involves monthly inspections where herds are clinically inspected and blood samples analysed for antibodies against SPF diseases.

On August 1, 2012, approx. 260 CHR numbers were classified as red SPF status.

On these farms, inspection also includes animal welfare, including shoulder lesions, tail biting, stocking density and hospital pens.

Export of breeding stock increased drastically in 2012, and was at times a time-consuming task for the Department. The department also functions as practising veterinarian for approx. 25% of all Danish farms.

The Department has offices in Vejen, Kjellerup and Copenhagen.

**SPF Health Status**

SPF Health Status is in charge of maintaining the SPF database and manages all status statements and changes. SPF Health Status also declares Danish pigs farms for the following diseases:

- Pleuropneumonia (Ap)
- Pneumonia (Myc)
- Pig dysentery
- Rhinitis
- PRRS
- Lice
- Mange

As of August 2012, the SPF system had:

- 260 red farms
- 2,838 blue farms

SPF Health Status also maintains SPF Health Regulations and SPF Transport regulations.

SPF Health Status is located in Vejen in the same office building as SPF Health Inspection.

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International recognition
In December 2010, the Yellow Card Scheme was introduced in Denmark. Since, the consumption of antibiotics has dropped by 20% nationally. Internationally, this has increased the interest in how the Danish pig production has industry has managed to reduce the use of antibiotics. PRC staff have therefore spoken widely on the subject at congresses, to foreign delegations visiting Denmark and at the conference “Combating Antimicrobial Resistance – Time for Joint Action” during the Danish EU presidency.

Stop of use of Cephalosporins
Cephalosporins are a group of antibiotics critical to the treatment of infections in humans. In July 2010, PRC introduced a voluntary stop of the use of cephalosporins out of regard for consumers. Since, consumption has been almost 0 as very few exemptions were required to maintain health and animal welfare among pigs.

The voluntary stop was a huge success: reports in 2011 showed no findings of resistant bacteria against this type of antibiotics on Danish pig farms. In 2010, ESBL producing bacteria was detected in 10% of all Danish herds – this has now dropped to 0. This impressive result is documented in the DANMAP report 2011, which is an annual report issued by the Danish authorities documenting the development resistant bacteria. Veterinarians as well as herd owners have all contributed positively to this.

EU project
PRC is participating in the EU project MINIAPIG. The purpose is to evaluate strategies for reducing antibiotic use and to identify the factors influencing farmers and veterinarians when deciding which strategies to use. Six countries participate in the project that is scheduled to end in 2014.

Effective resistance / less resistance
PRC is also part of a project on resistance at the University of Copenhagen called MINIRESIST financially supported by the Danish Council for Strategic Research. In this project, IT-based models will be developed for testing the development in resistance under different treatment strategies. The project also includes analyses of the effect of these strategies on treatment of diseases in pigs.

Interview with farmers
22 owners of weaner farms were interviewed on handling and use of antibiotic in feed and water on their farm. The views underlined areas where improvements was possible and that pig advisors should take note of.

Water - quality and distribution
- Cleaning of water pipes
- Production and administration of stock solution
- Homogenious mixing of antibiotic administered in dry feed

MRSA
MRSA is staphylococcus that has grown resistant to the antibiotic normally used. MRSA is found in many variants in humans, including MRSA 398 that is particularly connected to pig farms. The prevalence of MRSA has generally increased, and in 2011, MRSA 398 accounted for 5% of all MRSA types found in humans. The Danish health authorities released a new set of MRSA guidelines in October 2012.

Figures from the 2011 DANMAP report shows that the number of farms infected with MRSA have been fairly constant the last few years. Approx every 8th farm is infected with MRSA.

PRC does not believe that testing of all farms is the solution as this may provide a false feeling of safety – farms tested negative may be positive shortly after. Instead, we should focus on information.

MRSA should be considered a potential working environment problem. It should be expected that many people working on infected farms have MRSA either in their nose or on their skin. The advice today is that everyone who has a regular visitor to pig farms should say this upon contact with the hygiene care system to ensure correct treatment. PRC is actively engaged in talks with trade unions, health authorities and the Danish Veterinary and Food Administration to ensure an open dialogue and correct information on MRSA.

Visitors to pig farms should not worry about the infection. Dutch research shows

Figure 1 - Drug use (ADD/animal) 9 months before and after action plan.
that almost all visitors no longer had MRSA 24 hours after the visit.

Reduction is possible
Sixteen farms participating in a trial successfully reduced antibiotic use by focusing on health, feeding and management. PRC monitored their efforts to reduce antibiotic use on weaner farms with a high level of treatments. An action plan was tailor-made for each farm based on the conditions of that particular farm. The manual “Good antibiotic practice” was used as a tool for ensuring optimum conditions for the weaners.

29% drop
These 16 farms reduced consumption from 23 ADD/month to 18.6 ADD/month when the Yellow Card Scheme was introduced (figure 2). Nine months after the implementation of the action plan, antibiotic use had dropped to averagely 13.2 ADD corresponding to a drop of 29%. In that same period, antibiotic use dropped approx. 20% nationally. Owners and staff proved that with a dedicated effort it is in fact possible to reduce antibiotic use. However, experience also shows that the need for treatment may increase if new pathogen bacteria are introduced into the herd.

Medliq
Medliq is a product used for pen-wise administration of antibiotic on farms using liquid feed. Medliq is currently being studied on two farms. Preliminary results show that Medliq is fairly easy to use.

The activities were financially supported by the EU and the Rural District Programme under the Danish Ministry of Food, Agriculture and Fisheries. Journal no. 3663-D-10-00459.

How to handle MRSA: Before leaving a pig section – also if taking a break – clean and disinfect boots and take off work clothes. Wash your hands thoroughly with soap and water – or even better, take a shower. Dry your hands in a clean towel, preferably a paper towel, and use a hand disinfectant with spirits to which glycerol is added.
Vaccination against oedema
Preliminary trial results indicate that one vaccination during the first week of life is enough to reduce mortality from oedema from 8% to 1% corresponding to a 90% drop. In the weaner period, vaccinated pigs grew 15 g faster a day compared with those that were not vaccinated, though the difference is not significant.

On behalf of a medical company, the effect on mortality of vaccinating against oedema was investigated by PRC on one Danish farm with a long history of oedema disease.

The trial comprised 255 vaccinated pigs and 257 not vaccinated pigs. Vaccination was administered when the majority of the pigs in the pen were 4 days old. All pigs were weighed individually at vaccination, at weaning and at departure from the weaner unit.

The pigs were examined for side effects immediately after vaccination and 24 hours later. None of the examined pigs displayed any side effects from the vaccination.

One might ask, then, if it is profitable to vaccinate the pigs. From an economic point of view, vaccination is only profitable if mortality from oedema is generally high.

Vaccination is always profitable in cases of severe outbreaks. If the intention is for oedema vaccination to be routine — as a kind of insurance — vaccination costs must be analysed in proportion to the following facts:
- A 1% reduction in mortality in the weaner period increases gross margin by approx. DKK 350 per produced weaner.
- On some farms, vaccination has reduced the consumption of zinc.
- Less time is expected to be spent on supervision and treatment of sick pigs.
- Fewer concerns on oedema outbreaks and the economic losses connected to this.

This investigation was only conducted on one farm, and the effect will not necessarily be repeated on other farms.

**Diagnostic diseases**
Traditionally, a definite herd diagnosis requires analysis of many samples. However, this is expensive, and therefore too few samples are often analysed.

In cooperation with the Faculty of Health and Medical Sciences (University of Copenhagen) and the National Veterinary Institute (DTU), PRC has drafted proposal for a diagnostic manual to able—fairly cheaply—to establish whether treatment for diarrhoea is required.

The concept is that faecal samples are pooled so that instead of analysing 20 individual samples, these samples are instead pooled to one.

The possibility of using sock swabs, as is common in broiler production, is also being investigated. The diagnostic manual will be tried on 50 farms in cooperation with practising veterinarians.

Besides Lawsonia, the population of pathogen coli bacteria and Brachyspira pilosicoli will be analysed.

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**The project was financially supported by the Innovation Act. Journal no. 3412 08 02226 03.**
Eradication of PRRS?
In several countries, such as the US, the Netherlands, and Canada, authorities are trying to eradicate certain areas of PRRS (Porcine Reproductive and Respiratory Syndrome), often encouraged by the fact that diseases attributed to PRRS are extremely expensive. In the US alone, annual losses attributed to PRRS are estimated at $664 million.

It is therefore natural to investigate whether in Denmark it should be tried to eradicate PRRS, too. PRC is therefore currently analysing the economic losses incurred by PRRS in Danish pig production. Analyses include both acute PRRS outbreaks and chronically infected herds.

Loss – acute PRRS outbreak
Production data from farms with acute PRRS outbreaks was analysed. Data was compiled from a period before the outbreak and a period after the outbreak. Efficiency key figures before and after were converted to GM per place units/sows for a given time period.

At the time of writing, the analysis comprises six sow farms. Losses caused by a PRRS outbreak last from 12 to 60 weeks after infection with an average of 33 weeks. Figure 1 provides an example of how liveborn, stillborn and weaned/litter are affected during a PRRS outbreak in a herd. Overall piglet mortality was the parameter that was most affected – piglet mortality increased by 4.6 percentage points during an acute outbreak. The economic loss was analysed as loss per sow/year and varied from a profit of DKK 43 to a loss of DKK 734, the average being a loss of DKK 235. Among the six farms in the study, infection with the American type of PRRS seemed to cause more problems than infection with the Danish PRRS.

Loss – chronic infection
National averages from 2010 and 2011 were correlated with SPF health status. Farms were classified either PRRS positive, PRRS negative or PRRS status unknown for the entire 2010 or 2011, respectively.

When PRRS positive and PRRS negative farms are compared (Table 1), there seem to be no significant differences in productivity in 2010 and 2011.

Conclusion
Acute PRRS disease outbreaks are expensive and reduce productivity for a short period of time. However, analyses demonstrate that farms manage fairly quickly to return to the same productivity level as before the outbreak.

Comparisons of productivity figures for the entire year reveal no differences regardless of whether the herd is infected with PRRS. Provided the frequency of acute PRRS disease outbreaks is low, economic losses attributed to PRRS must be considered minimal.

In 2012, it will be further investigated whether PRRS affects welfare and drug use.

Table 1 - Effect on productivity in herds chronically infected with PRRS.

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<thead>
<tr>
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<th>2010</th>
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<tbody>
<tr>
<td></td>
<td>PRRS negative</td>
<td>PRRS positive</td>
<td>PRRS negative</td>
<td>PRRS positive</td>
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<td>Sows</td>
<td></td>
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<td>Farms</td>
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<td>1454</td>
<td>1484</td>
<td>1482</td>
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<tr>
<td>Total piglet mortality, %</td>
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<td>23.48</td>
<td>23.19</td>
</tr>
<tr>
<td>Weaners</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Mortality, %</td>
<td>2.65</td>
<td>2.88</td>
<td>2.73</td>
<td>3.29</td>
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<tr>
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<td></td>
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<tr>
<td>Mortality, %</td>
<td>2.73</td>
<td>3.29</td>
<td>3.50</td>
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</tbody>
</table>
DLBR Pig Facilities

The expert group “DLBR Pig Facilities” consists of five construction advisors and seven pig advisors. The aim is to:

• Exchange know-how on consultancy assistance in the construction of pig facilities
• Contribute to mutual development of skills
• Inform PRC and Knowledge Centre for Agriculture of Danish pig producers’ wishes and desires for new knowledge, tools and advice.

The group meets twice a year to discuss different subjects, such as environmental technologies, which included discussion of:

• Local extraction through fixed ducts under the solid floor in lying areas
• Layout of facility and pens
• Construction of carcass
• Materials
• Ventilation
• Prices of environmental technologies
• Possibility of fundraising for environmental technologies

In-depth discussions ensure that a particular subject is analysed from as many angles as possible, and at the same time update and calibrate the participants’ skills. This qualifies pig advisors as well as construction advisors to deliver qualified and dedicated advice.

Combating PRRS in Denmark

When herd veterinarians and advisors cooperate on combating PRRS, it becomes easier to include all aspects in the process.

Lately, focus has increased on combating PRRS on Danish pig farms as PRRS outbreaks cause losses and negatively affect the joy of work.

Normally, the herd vet plans how to control PRRS, but often a much better solution would be to also consult an advisor when changes are required in the layout of the facility, in the dimensioning of the batches or in ventilation etc. The advisor will also help estimate whether a certain effort is actually profitable.

PRC held a PRRS workshop where Danish vets discussed how to examine herds for PRRS and how to combat or eradicate the disease.

To improve the synergy in the corporation between vets and advisors, another PRRS workshop was arranged where both vets and advisors were invited.

The workshop emphasised the advisors’ focus on PRRS and underlined the benefits of cooperating for vets as well as advisors.

Approx. 40 vets and 20 advisors participated with presentations and group discussions in the workshop.

The presentations covered a wide range of areas – from an initiative to eradicate PRRS from the island of Bornholm to a presentation on how other countries are trying to eradicate PPRS. In between these presentations, vets and advisors discussed different problems in small groups. The day ended with a presentation from a cattle vet who explained how vets, farmers and advisors had successfully joined forces to eradicate different cattle diseases in Denmark.

However, it is clear that the greatest obstacle remains how to motivate farmers to combat or eradicate PRRS. PRC has therefore initiated a series of research activities to clarify the effect of PRRS on Danish pig production.
Farrowing surveillance
An efficient strategy for farrowing supervision and obstetric assistance may help reduce the percentage of stillborn piglets. Piglets can be saved simply by optimising routines within normal working hours. The percentage of stillborn piglets can be further reduced with the use of staggered working hours where one staff member is present in the farrowing facility at most farrowings.

This is the preliminary conclusion of a study made by PRC in spring 2012.

All sow farms in the study were visited by an advisor from the Farrowing Management Expert Group who analysed all routines before and during farrowing. Routines were optimised according to the recommendations of the farrowing guidelines. This was followed by a period of implementation when owner and staff incorporated the new routines.

Target areas varied from farm to farm - those with the greatest effect were:
- Systematic supervision of farrowing sows once an hour. During supervision, it was recorded which sows were receiving obstetric aid and how many live and dead piglets each sow had at the time of supervision.
- On some farms, recordings were made of all farrowings regardless of whether obstetric aid was administered. At each round of supervision, the following were recorded: time, live and stillborn piglets, obstetric aid, and how many live and dead piglets were pulled out during obstetric aid. This provided a good outline of the farrowing course and made it easier to pinpoint sows that could experience problems.
- Obstetric aid to sows that had not delivered a piglet since the last round of supervision.
- Upon transfer to the farrowing facility, sows known to have problems during a previous farrowing were marked with a coloured sow card or a peg when entering the facility. Each individual farmer defined what characterised a problem sow. It might be a sow with previous complicated farrowings, sows above a certain age, fat sows or sows that for some reason were not completely fit for farrowing. Obstetric aid was administered to these sows after 30 minutes if they had not delivered more piglets.

These were the most important measures implemented in all herds.

Other measures:
- Management of body condition during gestation to ensure correct constitution before transfer to the farrowing facility. Fat as well as thin sows have an increased risk of delivering stillborn piglets.
- Banning the use of oxytocin during farrowing. Besides the fact that it is illegal to use oxytocin during farrowing, it also increases the risk of piglets suffocating from lack of oxygen in the birth canal.
- Correct feed close from transfer to the farrowing facility and until farrowing. It is essential that the sow has the energy to farrow, but it should not be overfed.
- Correct timing of transfer to the farrowing facility. Sows transferred too late will have high stress levels during farrowing which increases the percentage of stillborn piglets. If, on the other hand, they are transferred too soon, they will lack the exercise they would normally get in the gestation facility, which may also increase the percentage of stillborn piglets.
- Peace and quiet. If the general level of unrest in the farrowing facility is high, sows will move their farrowing to night time when things are quieter in the facility.

All measures were adapted to the individual farm.

Figure 1: Trend in percentages of stillborn piglets born. The bold black line indicates the average of all farms.
HEALTHY GROUP-HOUSED SOWS

Team Soliv
- trivsel i fokus

2013
“Healthy group housed sows” was selected by FRC as a strategic effort area covering several trial activities all aimed at creating as much success as possible for humans and pigs. The purpose was to show how the activities can contribute to increases in sow welfare and thereby reduce mortality among Danish group housed sows.

The activities were financially supported by the EU and the Rural District Programme under the Danish Ministry of Food Agriculture and Fisheries. Journal no. 3663 D 09 00368.

Staff well-being is the basis
Six farms participated in the project called Team Soliv (“Sow life”). The outcome demonstrated that when staff is thriving, the possibilities of a dedicated effort increase whereby sow mortality drops.

In Team Soliv, the regular advisory process was combined with HR counselling. The more a farm owner includes the staff—professionally and personally—the easier it becomes to solve problems on the farm.

Results of Team Soliv
The aim of Team Soliv was to create wellbeing among sows through well functioning staff. The project ran for 18 months and six large sow farms participated. All farm owners wished to reduce sow mortality and all were prepared to work on staff wellbeing. Through an intensive advisory process in terms of production as well as HR, sow mortality dropped by an average of 2.9 percentage points over 13½ years calculated as dead and destroyed of sow/s/year.

The project comprised six sow farms and a total of 6,766 sows/year. Every time mortality rates drop by 1 percentage point, approx. DKK 46 is earned per sow/year. Added up, the owners of these six farms increased earnings by approx. DKK 1.5 million through dedicated focus on wellbeing among staff and sows for 18 months.

How did they do it
On all six farms, Team Soliv advisors analysed production routines as well as staff. Effort areas and goals were adjusted to the needs of each farm. Together with the HR advisor, farm owners conducted a survey of the wellbeing among the staff, and, combined with an organisation chart and staff profiles, this formed the basis of annual, confidential staff interviews.

Staff interviews clarified whether tasks and responsibility were assigned to the right staff members, and whether cooperation in its current form worked to everybody’s satisfaction. Subsequently, an action plan was tailor made to each farm.

Farmer Field Schools
Farmer Field Schools formed an important part of Team Soliv. Herd managers from the six farms took turns to visit each other and ahead of each visit, the herd manager decided which two effort areas to focus on that day. The Farmer Field School concept differs from, for instance, workshops being more focused and by providing concrete pieces of advice to the participants and following up on decisions made at previous meetings. The benefit is that you get the points of view of five other herd managers on two subjects that you as the host have picked for that day. Hosting the day, you will be asked questions, and you will be presented with suggestions from people who are aiming for a similar goal personally. At each meeting the participants get to see each other’s herds, and this opens your eyes and provides a joint frame of reference for the participants.

Production routines
In terms of production routines, some subjects were recurring on all farms.

Careful and consistent selection of gilts increases the chances of a long life as a sow, and correct socialisation routines make a stronger gilt.

On many farms, assessment of body condition was already a routine task, but not everybody had the same understanding of what makes good body condition. With some teaching and a bit of calibration, most farms improved on this area.

It takes patience
Changing areas of responsibility for an individual employee may be easy to do and may provide immediate relief for the employee in question. Likewise, getting its hooves groomed may improve the wellbeing of a sow immediately. However, making improvements at herd level, such as increasing longevity among sows and keeping employees, takes a year or more before an effect can be measured. Working with wellbeing among staff and sows therefore takes a lot of patience and requires a dedicated effort for a long period of time.

In this context, “HR” means management counselling. HR is an abbreviation of Human Resource, and HR counselling is a discipline in modern management integrating the needs and personal resources of each individual employee into the everyday work.
HEALTHY GROUP-HOUSSED SOWS

The steps taken did not necessarily involve new know-how; the difference was the way it was presented and the fact that agreements were closely followed up. Even though reductions in sow mortality are hard core productivity improvements, farm owners and herd managers agreed by the end of the project that the most essential factor in reducing sow mortality was the HR element and the consistent follow-up.

**High-proliﬁc sows**
Team Soliv also improved our understanding of the metabolism of lactating sows and the risk of sows developing secondary ketosis. This understanding has been passed on to the advisors. The project also pinpointed other tricky areas, which subsequently spawned a range of new research activities such as optimisation of feed formulation and correct feeding of lactating sows.

**Management of gilts**
Experience from ten farms demonstrated that systematic recording of age and ﬁrst oestrus of gilts makes possible to mate gilts at a uniform age thereby reducing variations in litter size. Staff on these farms found that this type of systematics made the daily work with the gilts easier as at stimulation and insemination in the service facility they only needed to focus on gilts that were actually ready for mating.

Overall, gilts' age at ﬁrst service from 280 to 262 and variations in age at service dropped from 29 to 20 on the farms in the trial. One extra feeding day for each gilt costs approx. DKK 7, ie. the reduction in age at service yielded a direct saving of averagely DKK 126 per gilt.

**Shoulder lesions – new scale**
Research activities aimed at deﬁning the best description of a shoulder lesion on live pigs produced a description based on three categories of shoulder lesions: No shoulder lesion, mild or severe lesion. The scale is solidly based on scientiﬁc research and is easily applicable by laymen. A calibration method was also developed that ensures that shoulder lesions are assessed fairly similarly in all herds at a given time. Guidelines in using the scale are being prepared in cooperation with Danish authorities.

**Bedding in sow pens**
Soft mats for prevention of shoulder lesions in farrowing pens were investigated. However, results showed that rubber mats do not have a general effect among sows in good body condition. Pig producers are therefore encouraged to focus on body condition and only place rubber mats in pens accommodating either sows in poor body condition or sows that have previously suffered from shoulder lesions.

Cooling of the ﬂoor in farrowing pens did not inﬂuence the frequency of shoulder lesions.

Seven different types of bedding in hospital pens for sows were investigated. Results revealed that besides straw, two types of rubber mats met the requirement for soft bedding in hospital pens.

**Hospital pens with drained, bedded (straw) lying area remained soft and dry throughout the trial. In this trial, 2 kg straw/pen/week was administered.**

**Layout of gilt pens**
Research demonstrated that it is possible to improve the immediate environment (hygiene, non-skid ﬂooring etc.) in existing pens for large groups of gilts. Layout of pens for minor groups of gilts was not included as herd visits demonstrated that pens with a layout similar to ﬁnisher pens were well-functioning pens.

**2013 conversion**
By 2013, the last facilities with stalls for gestating sows must convert to group-housing. Some sow producers have renovated existing facilities, while others have extended their farm and established group-housing in new facilities.

Regardless of which solution is selected, employees are crucial in making this conversion a success.

Hospital pen with rubber mat. The lying area will appear dry provided the bedding has a slope of approx. 5%. 
The devil is in the detail
The saying “the devil is in the detail” is confirmed in the project “Speeding up finisher production—the daily routines”. For 18 months, 40 large finisher producers participated in an advisory course, and 90% said that they witnessed an effect.

Farmers went from feeling chronically behind to feeling good and feeling ahead of things.

Numerous routines and habits were turned upside down:
- Washing and drying of a facility and pen before pigs are transferred
- Checking of quality and pressure of water
- Sorting of pigs at transfer
- Systematic treatment procedures and correct use of hospital pens
- Management of ventilation and climate
- Feed formulation
- Routine check of feed curves and feeders
- Sieving samples
- Focus on strategies for pick up for slaughter

None of the above increased the time spent on the tasks—time was just spent differently and far more efficiently.

The advisory process took place in the herds and was therefore extremely concrete and easy to implement. Farmers agreed that changing habits and routines is hard, but it can actually be done when they believe it makes sense either because of an economic gain or a relief in labour.

Gross margin and economy
Gross margin is the margin that covers overhead and capital costs, including the profit to the herd owner. Gross margin must cover costs for, for instance, production facilities (interest and depreciation), energy, maintenance and wages.

The project clearly underlined that there are huge differences per produced pig (Table 1) and that costs are distributed highly differently between farms. The bottom line therefore depends on much more than just production details.

All in all out
For 18 months, development in health and productivity was monitored on three large finisher farms. Unfortunately, one of them stopped production, and the investigation therefore only comprises two farms. Data collection ends in 2012.

On these farms, all in all out at site level is compared with traditional sectioned management at section level. Sites with all in all out at site level are completely emptied of pigs before a new batch of finishers is transferred. Facilities are cleaned and dried before a new batch is transferred regardless of whether management is all in all out at site level or sectioned management. Pigs are delivered to these farms from a sow batch infected with pleuropneumonia, pneumonia and PRPS.

The aim of the investigation is to examine whether all in all out at site level has a positive effect on diseases and productivity. The frequency of respiratory disorders is expected to be lower on sites with all in all out than on sites with sectioned management as there is only one batch on the site at a time. This eliminates the risk of old batches transmitting disease to newly transferred batches.

Preliminary results indicate a smaller frequency of pneumonia on the sites with all in all out (Table 2) whereas no differences are seen in the frequency of pleuropneumonia.

Table 2 - Preliminary results from 16 finisher batches. The table shows the number of batches with clear indications of pneumonia at slaughter (changes in lungs in > 20% of the pigs).

<table>
<thead>
<tr>
<th></th>
<th>Infected batches</th>
<th>Examined batches</th>
</tr>
</thead>
<tbody>
<tr>
<td>All in all out</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>Sectioned</td>
<td>6</td>
<td>7</td>
</tr>
</tbody>
</table>

Production results have not been analysed, but they are expected to be better on the sites with all in all out.

The programme is financially supported by the EU and the Rural Development Programme under the Danish Ministry of Food, Agriculture and Fisheries, Journal no. 3663 D 09 00366.

Table 1 - Table 1. Gross margin, overhead and capital costs, and result per produced finisher (4 farms).

<table>
<thead>
<tr>
<th>Per produced finisher</th>
<th>Second half, 2011</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Farm 1</td>
</tr>
<tr>
<td>GM</td>
<td>123</td>
</tr>
<tr>
<td>Overhead</td>
<td>14</td>
</tr>
<tr>
<td>Capital</td>
<td>77</td>
</tr>
<tr>
<td>Result</td>
<td>32</td>
</tr>
</tbody>
</table>
New possibilities
The technological development presents new possibilities for easy, maybe fully automated, transfer of data to the pig producer. With an increasing data basis, a pig producer will be even better capable of monitoring the development of his production. PRC is investigating several different technologies for supporting this need.

Electronic ear tags
New electronic ear tags are now available for sale and are already being used by a few breeding and multiplication farmers. The ear tags are currently compatible with DLBRIT’s pig programme and will soon be integrated with AgroSoft as well. Electronic ear tagging saves time in the selection of breeding stock and reduces the risk of reading errors when making the contract note. It also increases security and saves labour in all other routines where recordings of individual animals are made.

Electronic weighing
In cooperation with Bjerringbro Vægte A/S, PRC developed a scale with which it is possible automatically to record the pig’s weight and electronic number on a hand held ear tag scanner like the one shown in Figure 1. Via Bluetooth, the weighing unit transmits data to the hand held reader and data is stored in a file on the reader, and can subsequently be directly transferred to use. This method for weighing pigs saves time as manual recordings are no longer required of weight and individual identification.

Monitoring gain
Pig producers require new, more accurate and current figures for pig growth.

Today, large pens with sorting scales are used on several farms, and this system makes it possible for the farmer to monitor the average gain in a batch. With an electronic ear tag in each pig and a reader installed on the weighing unit, it is possible to form an accurate outline of the growth curve of each individual pig. This expands the possibilities for optimizing production routines, and PRC is currently cooperating with Domino to implement these possibilities.

Traditional systems require other solutions, and PRC is therefore currently testing fixed weighing units in a pen where pigs are weighed when they pass through the scale. The outcome of this system will be an average daily gain for a pen. For this system to function satisfactorily, it must be ensured that the result from just one pen can be transferred to the entire section.

Monitoring production
The digital development is also a reality in specialized productions where an essential objective in the coming years is to improve the data basis for managing the production. PRC contributes, for instance, by testing electronic ear tags in the field (Figure 2). This saves time and money as it becomes possible to make recordings of each individual sow without actually handling the animal.

Concluding remarks
For many years, the production report formed the basis for monitoring production. However, monitoring pig production is much more than just recordings related to the pigs.

The development within mobility makes it possible easily and often at no costs to make other types of recordings that may be relevant to a pig producer. These may be, for instance, recording of work processes, staff recordings, recordings of drugs with a bar code scanner, electronic tagging of farrowing huts with GPS tracking of location etc.

These brand new possibilities will give pig producers a far better overview of the entire production, and PRC will work on exploiting these options in pig production.
Welfare seminar
In January 2012, a welfare seminar was held for organic pig producers. The industry wishes to improve productivity and reduce the environmental impact, and five goals were therefore agreed at the seminar:
• Compilation of production data
• Improved survival rates
• Well-functioning outdoor areas for finishers
• Improved nutrition benefiting well-being, economy and environment
• Correct handling of sick pigs

Poca fibreglass hut
The first prototypes of a new farrowing hut made of fibreglass have now been tested, and reactions were positive. The hut has full standing height, two entries and automatic ventilation hatch. Two entries make it easy to drive the sow out, and, having finished castration, the employee then exits the hut fully erect opposite the sow’s entry. The hut has a covered creep area where piglets are able to create an excess temperature in cold weather. Using video recordings, it will now be studied how the piglets actually use the creep area.

Large hut for 4 sows with piglets
In January 2012, work began on development of a large hut accommodating four sows and their piglets. The project is a joint venture with Development Centre for Outdoor Livestock and Preben Hald Maskinfabrik, and the first huts are expected to be ready for testing in autumn 2012.

Prevention of diarrhoea
On two organic farms with weaners, production conditions were optimised to reduce the prevalence of post-weaning diarrhoea by implementing action plans tailored specifically to these two farms. Results showed that the action plans increased the percentage of pigs with normal faeces from 64% to 82% on farm 1 and from 52% to 81% on farm 2. However, on farm 1, Lawsonia was still estimated to be the main cause of diarrhoea, and the effect of vaccinating the piglets in the farrowing field (days 14-21) against Lawsonia and PCV2 was therefore investigated on farm 1. Vaccination improved FCR by 4.62 FUgp/pig and reduced mortality by 1.3%. This increased income by DKK 20.50 per pig including vaccination. Vaccination procedures did not increase labour as the extra time spent in the field was saved in the weaner period.

The project was conducted together with Organic Denmark.

Male pigs
Screening of boar taint on six organic farms demonstrated that if 0.25 ppm skatole is used as sorting limit – as is the case today – 18% of all male pigs would be rejected. If a 1.0 ppm limit for androstenone is added to this, rejection rates would reach 68%. Rejection rates varied greatly between the six farms. Lean meat percentage averaged 58.8% and slaughter weight averaged 82 kg.

Such high rejection rates will make it even more difficult to produce organic male pigs unless feeding concepts and management routines are capable of reducing boar taint in organic male pigs.

To investigate the possibilities, PRC has initiated a joint venture where preliminary studies have analysed the effect of feeding chicory and lupine in the last part of the growth period and variations in slaughter weight. Results demonstrated reductions in skatole, but no effect on androstenone of feeding chicory, and no effect at all of feeding lupine. When slaughter weight was increased from 75 to 95 kg, androstenone increased significantly. One way of lowering the rejection rates may be to reduce the slaughter weight.

The activities were financially supported by the EU and the Rural District Programme under the Danish Ministry of Food, Agriculture and Fisheries, and by GUDP funds. Journal no.: 3663-U-11-00182, 3663-U-09-00388, and 3405-10-0174.
Duroc in Danish pork
2012 saw PRC and DAFC use Duroc pigs as ambassadors for a new campaign on pigs in Denmark.

The campaign focused on the Duroc breed and the gastronomic qualities of this breed.

Duroc has fathered the largest export success in Denmark and is represented by 50% in Danish finishers that are exported worldwide. The campaign thereby underlines the premium quality of Danish pork.

Duroc does something really special for a dish. The breed is renowned for its rich flavoured meat and finely marbled fat.

Duroc history
The breed originates from New England, US, where it was bred around 1800. The name Duroc comes from one of the first breeders who owned a trotting stallion named Duroc, and this was the beginning of the only pig breed named after a horse.

The breed was first tested in Denmark in 1975 and made significant progress. Actual breeding began in 1980 with import of Duroc from Canada. Today, export of Duroc has expanded.

Duroc on display
The Danish population met Duroc in the summer 2012: Duroc pigs showed up in a field next to public roads or bicycle lanes where one could pull over and watch the pigs, and read the story of Duroc.

The pigs were seen by many who do not normally go to pig farms. They were presented
- In pens accommodating 20 pigs each in Aalborg, Odense, Roskilde and Farum
- At cattle shows in Herning, Horsens, Odense and Roskilde
- At Aarhus Food Festival

Regional as well as national media, radio, newspapers etc., ran the story of the Duroc pig.

Focus on meat quality presents an opportunity to actually discuss the Danish pig production industry, and engage consumers, who otherwise care very little for facts on income and antibiotic, in the dialogue.

Today, Duroc meat is primarily served at gourmet restaurants such as Kong Hans and Saison, but if demand increases, as a result of the campaign, the production will adapt.

Journals and newspapers, such as financial journal Børsen above, happily ran the story of pigs and multiple breeds.

Share the story of Duroc with your next dinner partner, and tell him/her that your pigs all have a gastronomic pig as father.
VSP.lf.dk
Pig Research Centre’s Danish website, VSP.lf.dk, contains a vast amount of the know how available on Danish pig production. This is the place to stay up-to-date with the latest research results from PRC and in general find information on pig production.

The homepage presents the latest news, the most recent publications, and short cuts to other current topics on the site.

Our website has three main areas:
- Viden ("Knowledge")
- Publikationer ("Publications")
- Aktuelt ("Current news")

Under "Aktuelt", you will find information on, for instance, weaner prices. This is also where users can find programmes for a summary of current or previous pig prices or calculate GM of various pig groups. News and current topics are also located here.

- "Viden" is divided into topics structured as a handbook. This is where users will go to find all available know how on a certain subject. This is also where manuals and practical instructions can be downloaded and used on the farm ("Til staldgangen").

- "Publikationer" comprises all research results and economic analyses issued by PRC. It is a comprehensive knowledge base containing both new and old publications and analyses.

Manuals
Pig Research Centre’s manuals collect all available know how on production of pigs. The manuals are a management tool made in cooperation between PRC and the local pig advisory offices. This combination between advisory services and practical tools will help prevent mistakes and misunderstandings in the daily work on Danish pig farms. The manuals describe how work routines should be performed to benefit animals, employees and owners alike.

Videos
"Viden" also includes a section with a wide range of professional videos. The videos are a supplement to the management tools offered by PRC and focus on subjects where live images improve the understanding of the subject in question. This includes how to perform obstetric aid and how your body language affects pig behaviour during moving of pigs. Several of the videos also have speak in English and Russian.

Fact sheets in English and Russian
Most of PRC’s fact sheets are available in English and Russian. These fact sheets provide an immediate outline of essential work routines on a pig farm. Topics described in the new fact sheets in 2012 are obstetric aid and daily routines in a finisher unit. They are one page long and are therefore highly suitable for printing and for use on the farm or in the lunchroom. Fact sheets are found under "Viden" on our website.

Newsletter
PRC’s newsletter is released via e-mail every Thursday when pig prices are available. The newsletter is in Danish and readers can subscribe on our website.

The newsletter also provides a summary of the headlines of the week, various features and it informs on meetings and seminars organised by PRC.

Subscribe to the newsletter to get all news and new publications from PRC.
Reports:
No. 1110: Nutrient content in grain harvested in 2011
No. 1111: Ideas for conversion from stalls to group-housed gestating sows
No. 1112: Maize cultivated in Denmark: Methods for storage and handling, nutritional value and feed quality of high-moisture maize
No. 1201: Project + DKK 25: Improved management routines improve health and productivity of finishers
No. 1203: Energy value of finisher feed
No. 1205: Piglet mortality on commercial farms with farrowing pens for loose sows
No. 1206: Demonstration of climate control to improve pen function in finisher units with partially solid floor
No. 1207: Oestrus management in gilts
No. 1208: Layout of gilt pens

Trial reports:
No. 902: Effect of Lawsonia and PCV2 virus on daily gain in finishers
No. 903: Effect on Lawsonia and faeces score on daily gain in finishers
No. 911: Effect of rubber mats in farrowing pens for prevention of shoulder lesions
No. 914: Dust reduction in weaner facility with electrostatic particle ionization equipment
No. 921: Importance of breeding to LP5 on commercial farms
No. 922: Multi-phase feeding does not affect ammonia emissions from finishers
No. 923: Correlation between calcium levels in blood before farrowing and percentage of stillborn piglets
No. 924: Importance of gilt birth weight to litter size of first litter
No. 926: Farm AirClean 3-step BIO Flex from SKOV A/S tested in a finisher facility
No. 927: CLA improves lean meat percentage
No. 928: Analysis of PCV2 status in two Danish herds – two-year follow-up
No. 929: Fermented liquid feed with inoculation culture does not improve productivity
No. 931: Breeding improves FCR
No. 932: Benzoic acid improved finisher productivity
No. 933: Benzoic acid reduced ammonia and odour emissions from finishers
No. 934: Rapeseed cake for weaners – different treatment and variety
No. 935: Dust reduction in weaner facility with electrostatic particle ionization equipment
No. 936: Correlation between leg assessment at 3-4 months and after service and gilt longevity

Fact sheets in English and Russian:
• Obstetric aid
• Daily routines
• Preventive steps against diarrhoea
• Adjusting sow feed dose after farrowing
• Good weaning procedures
• Cleaning of liquid feed systems
• Ten-point plan for job satisfaction
• Annual report 2011

Other information material
• Gestation management 1.3
• Management of on-farm mixing 1.1
• Danish biosecurity standards
• DANISH Product Standard
• DANISH Transport Standard
• How to measure shoulder lesions
• Team SoLiv – focus on wellbeing
• World class pig producers
• Animal welfare report 2011 – pig production
• Welfare and growth in organic pig production
• Production economy PIGS 2012