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Improving economy

In recent years, the development in both the price of feed and that of pig meat has been very volatile. It now seems that feed prices are declining somewhat and the price of pig meat has settled at higher levels, which will, hopefully, contribute to improving the economy of Danish pig producers for the fourth year in succession.

It is still proving very difficult for Danish pig producers to finance new investments. In fact, many environmental approvals remain unused, in the absence of support the financial sector.

The export of weaners from Denmark continues to rise and now stands close to 10 million. A key factor behind this development has been improving productivity and the number of piglets produced per sow/year.

There are simply not enough places units to finish all the weaners being produced in Denmark. This situation is, of course, exacerbated by the failure to replace old, worn out facilities with new, modern pig housing. Construction of new finishing capacity is essential if the downward trend in the number of pigs being slaughtered in Denmark is to be reversed.

Confidence in the future

A comprehensive survey made among Danish pig producers shows that they are still willing to invest in the future, including new finishing capacity. However, the survey also revealed a growing concern that the business environment in Denmark, with its specific rules for environment and animal welfare, will undermine our competitive edge while, for example, pig producers in Germany are eligible for VAT advantages and those in Sweden enjoy the benefits of support from other financial schemes.

All Danish farmers now comply with the requirement for group-housing of gestating sows. The results of audits undertaken also confirm a general improvement in animal welfare standards.

Nevertheless, the Danish Minister of Food, Agriculture and Fisheries has now produced a new proposal that sows be kept in groups

in the service area – a statutory requirement that is set to apply from 2015 for new buildings. Even though the use of antibiotics is very low in Denmark's livestock industries, our government are also considering imposing new regulations in this area.

Biosecurity

Surveillance indicates that MRSA may be present on a larger number of Danish pig farms. Exposure to this strain of MRSA should be regarded as an occupational hazard and should be addressed by implementation of recommendations for good hygiene practice. All those working with pigs are potential carriers of MRSA and this information must be made available to doctors who may have to treat them for illness. It is vital that good hygiene routines and all biosecurity measures are fully implemented on all Danish pig farms.

Danish pig producers have made major investments to carry out cleaning and disinfection of lorries returning across Denmark's border. However, it remains the responsibility of each individual pig producer to keep his herd free of any new disease. Lately, we have seen a few cases of Salmonella Choleraesuis in Denmark. This strain is known to originate from Eastern Europe and may cause significant losses in the herd where it is present. However, an outbreak of, for example, swine fever may result in Danish pig meat losing access to key export markets, with major economic implications for all Danish pig producers.

DanAvl progress

The export of DanAvl pig genetics continues to increase, and today DanAvl is one of the largest global brands in its marketplace. As a result, export royalties are now making a larger contribution to the financing of all research and development activities undertaken by Pig Research Centre, and not just the breeding programmes themselves.

Competitiveness

Only a few years ago, the goal of 35 piglets per sow/year seemed impossible, yet all our departments have been working very hard on making it a reality. In this process, we have updated many of our recommendations across all areas of production - in particular, the feeding of sows, reproduc-

tion, split suckling, nursing sows, new farrowing pens and reducing piglet mortality. These recommendations have now been thoroughly tested, and form the basis of clear guidelines for managing the genetic potential of DanAvl sows with larger litters.

According to our latest records, the five best farms in Denmark reached the goal of 35 piglets per sow/year, and the average for all farms today is 29.6 piglets per sow/year.

This progress keeps Danish pig producers competitive and, despite high production costs, they remain among the most competitive in Europe. In fact, in recent years, the gap between Denmark and low cost competitors such as the US, Canada and Brazil has narrowed significantly, which is largely due to rising feed prices in these countries.

Thank you

The work of Pig Research Centre is based on close cooperation between pig producers, their advisors, vets and commercial suppliers as well as universities and government departments. Without this collaboration, the activities reported here and the many other initiatives described at www.vsp.lf.dk would not have been possible. It is a unique system, which has attracted envy the world over, and is good reason for us to offer our sincere thanks to all those parties who co-operate with us.

The Pig Levy Fund, the Promille Fund, the Danish National Advanced Technology Foundation and the European Agricultural Fund for Rural Development also contribute to the funding of our projects.

Best regards

Lindhart B. Nielsen/Nicolaj Nørgaard
Pig Research Centre



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AND BUDGET

Pig Research Centre (PRC)

Pig Research Centre is an integrated part of Danish Agriculture and Food Council (DAFC) and employs around 155 persons.

The role and activities of Pig Research Centre are laid down by the Sector Board "L&F Svineproduktion", under the direction of 12 elected pig producers:

- Three elected by the Primary Board, DAFC
- Three elected by Danske Svineslagterier, DAFC
- Three elected by the three regional pig production committees
- Three elected by the Danish Pig Producers' Association

Budget and sources of income

Pig Research Centre's activities are funded from a range of sources.

An essential source of income is provided by financial support of trials undertaken by Pig Research Centre. Many projects are financially supported by the Ministry of Food, Agriculture and Fisheries of Denmark and the European Agricultural Fund for Rural Development. Resources are also obtained from the Green Development and Demonstration Programme and the Danish National Advanced Technology Foundation.



Strategy

The new Pig Research Centre strategy for 2014-2018 includes the following main areas of activity:

- Competitiveness
- Environment
- Animal welfare
- Animal health and food safety
- Knowledge transfer
- Policy and reputation

The new strategy was developed from a comprehensive survey of our producers and a series of meetings with young pig producers with large production units.

A range of views and wishes were expressed during this process:

- Increased efforts are needed both on the political front to protect our "licence to produce" and to improve the image of modern pig production
- There is firm support for and satisfaction with the work of Pig Research Centre, and pig producers are still willing to make this investment. However, there should be more edge to the Pig Research Centre approach and it should develop even closer contact with Danish pig producers themselves.
- While Pig Research Centre serve its pig producers and international collaboration is desirable, there is no desire for support of a development centre representing pig producers in Central Europe.
- Pig Research Centre must maintain a high level of technical knowledge and keep developing new facilities which improve pig welfare. However, this development must also be market-driven rather than simply reflecting that Denmark is constantly at the forefront in legislation.
- Investment in new environmental technologies is still an area surrounded by uncertainty. Research activities under Pig Research Centre must improve the basis of assessing the durability, economy and impact of these technologies.

DanAvl success

Pig Research Centre organise and manage the DanAvl breeding programme and charges fees on sales of genetics.

Higher sales of genetic material has increased resources available to Pig Research Centre, which in turn has led to a reduction in the contribution paid Danish pig producers to the Pig Levy Fund in recent years.

To strengthen its sales and marketing programmes, DanAvl has implemented a new offensive strategy. The aim is to position DanAvl among the two or three major players in the global market for breeding stock.

New research activities in 2014

- Alternative protein sources for organic pigs
- Genetic progress – three new traits
- Gastro-intestinal diseases and FCR
- Feeding linked to performance
- Optimum use of acids in feed
- Gilts readiness for farrowing
- Sows readiness for a short farrowing period
- More fibre in sow feed
- New facilities and pens for finishers
- Water consumption
- Data online
- Cleaning of air via point extraction
- Optimum slurry treatment
- Air cleaning and production of algae
- Dimensioning of climate and ventilation systems
- High inclusion of phytase in feed
- Reduced use of zinc and copper
- Boar taint testing
- IUGR pigs – 'dolphin' pigs
- Farrowing facilities for large litters
- Electrical installations and their effect on tail biting and abnormal behaviour
- Detailed requirements of the farrowing pen
- Alternatives to straw
- Service check of the SPF system
- Universal monitoring of health
- The right choice of antibiotics
- Reduction of MRSA 398
- 'Minus 30' feed units per pig
- 'The Pig Academy' 2016
- Closer contact with pig producers

Member survey

Pig Research Centre conducted a comprehensive member survey, in which 600 pig producers were asked about their expectations for the future and their opinions of Pig Research Centre. The answers clearly showed a commitment to

AND BUDGET

and an expectation of setting up finisher production sites in the future. This was the response both from many finisher producers, wishing to expand their production, and specialised sow producers, planning to set up their own finisher production in the future.

Pig Research Centre would like to thank all the pig producers who participated in the survey.

Knowledge transfer

Part of the survey addressed how pig producers obtain new, specialist knowledge.

As shown in figure 1, the herd vet is regarded one of the most important sources of information, but the agricultural press is also described as an important source.

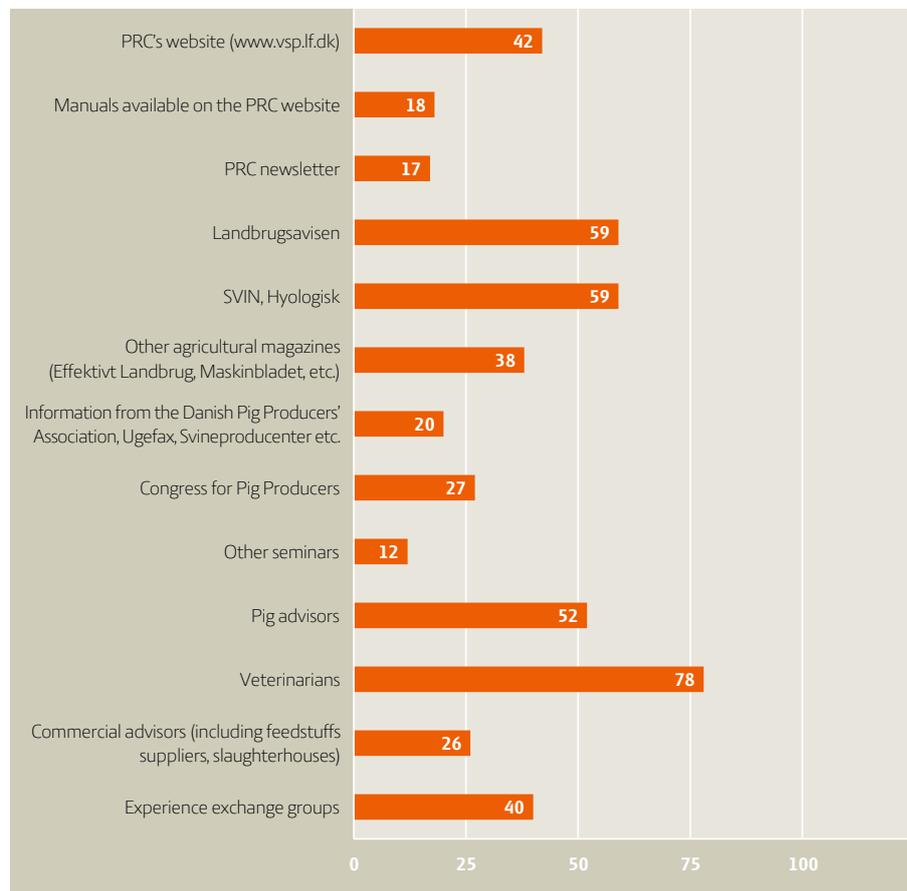
Implementation of new knowledge has always been a major goal of Pig Research Centre. The channels through which the information flows was of less importance, as long as new knowledge actually reaches pig producers. The survey clearly shows that this is the case.

Most pig producers said they are aware that they regularly receive new information and knowledge from Pig Research Centre.

However, there are still some pig producers and their staff who are not familiar with Pig Research Centre's website and its role as a library of pig industry information. This is regrettable, as the website holds much valuable information, guidelines and practical advice – much of which is also available in the English and Russian languages.

It was therefore decided to take steps to make this information even more accessible, and these will be carried out under the banner "Danish Pig Research Centre must be closer to pig producers".

Figure 1 - Vets are an important source of information, yet it is surprising that one fifth of all pig producers did not rate the vet among their top five sources of information.



Structural development

Information from Statistics Denmark, the central authority of Danish statistical records, show a total of 4,181 pig farms in Denmark in 2012, which is around 10% fewer than in 2011.

According to Pig Research Centre, the size of fully integrated farms averaged 436 sows/year. The average size of 'Farms with sows only' was 661 sows/year, and they accounted for around 43% of all sows kept in Denmark in 2012.

Approximately 47% of all pig farms operated exclusively in finisher production in 2012, delivering, on average, around 5,800 finished pigs for slaughter. 'Farms with fin-

isher production only' accounted for around 60% of all finishers produced in 2012.

Production

During 2012, the number of sows in Denmark averaged around 1.03 million, 2% below the level recorded in 2011.

This fall is attributed partly to poor production economy and partly to the requirement for group-housing of sows. The sow population in Denmark in 2012 was at the lowest level since 2001.

Figure 2 illustrates the trend in the production of pigs and the number of finished pigs slaughtered in Denmark. According to Statistics Denmark, 29 million pigs were produced

Table 1 - Weaner exports by destination 2011-2012, % share of total exports

| Country | 2012 | 2011 |
|----------------|------|------|
| Germany | 68.6 | 72.1 |
| Poland | 21.6 | 17.0 |
| Czech Republic | 3.7 | 3.9 |
| Italy | 3.3 | 3.9 |
| Netherlands | 1.3 | 0.9 |
| Others | 1.6 | 2.0 |

in Denmark in 2012, which is a small drop of around 1.2% compared with 2011.

The number of pigs slaughtered in Denmark fell by 6.7% to 19 million in 2012.

Export of weaners

The export of live pigs is increasing as the sow population remained largely stable. The number of pigs weaned per sow/year has increased by 0.5-0.8% annually, but the number of finished pigs slaughtered in Denmark continued to decline.

The export of weaners (below 50 kg live-weight) increased from 8.0 to 9.2 million in 2012, according to the Pig Levy Fund.

Germany remains the main destination for export of Danish weaners, accounting for a share of 68% in 2012.

The export of weaners to Poland rose dramatically in 2012, rising from 1.4 million to 2.1 million head.

Analysis by the Danish Agriculture & Food Council shows that the export of weaners to Poland increased its share from 17% to 22%.

- The sow population remained fairly stable with a small drop of around 2%, following the introduction of new welfare requirements in 2013
- Productivity per sow keeps increasing on the basis of number of weaners produced
- These developments led to the increasing export of weaners.

Figure 1 - Trends in sow numbers in Denmark, 1998-2013

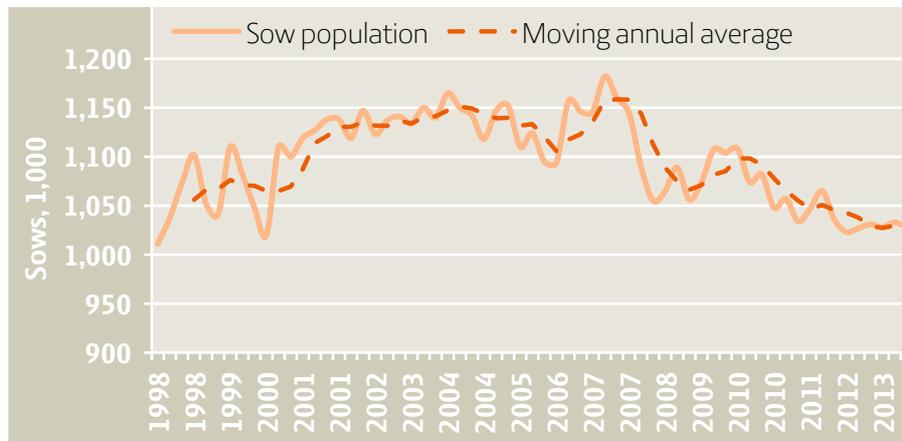


Figure 2 - Trends in pig production in Denmark, 1990-2012



New finisher facilities

In Denmark, there has been insufficient investment in new finisher facilities. There is an annual requirement for around 200,000 additional finisher places.

Figure 1 shows the correlation between the requirement for new investment and the actual investment made, according to financial accounts produced this year. This estimate is based on the number of pigs delivered for slaughter, as recorded in the accounts and applies to specialised finisher farms.

In 2012, this sample accounted for around 60% of all finishers delivered for slaughter in Denmark.

In 2012, investments reached 40% of the estimated requirement for this type of production.

Due to the low level of investment, the number of finisher places fell, with a corresponding drop in finisher production.

How to increase investment

Investment will automatically rise if pig prices remain higher than the break-even costs.

The last year in which the average finisher producer in Denmark experienced positive profitability was in 2006. As clearly illustrated in figure 1, this led to a heavy increase in investment in 2007.

Improving profitability

Several activities were initiated in the last year to improve profitability.

Support scheme from slaughterhouses

In 2012, the cooperative slaughterhouses introduced a financial support scheme through which DKK 0.15 more per kg is paid the first 5 years after the producer erected a new finisher facilities, up to a maximum of 8,000 pigs produced annually.

The scheme also pays DKK 0.75 per kg in support for a period of five years as a conversion premium for sow accommodation that is converted to finisher accommodation – also up to a maximum of 8,000 pigs produced annually.

New environmental support scheme

In an ‘environmental technology’ scheme introduced by the Danish Ministry of Food, Agriculture and Fisheries, DKK 150 million was set aside to support the establishment of environmentally friendly production facilities.

Pig producers may receive up to 40% support for investment in environmental components eligible for support in construction projects, including acidification plants, air cleaning, phase feeding, energy-friendly ventilation, LED lighting and water saving measures.

The financial support available may amount to 10-15% of the cost for a single production place.

- The environmental support scheme reduces the cost of investment and, therefore, production costs
- Advisory tools will help improve the economy of finisher production

Value over the entire life of a building

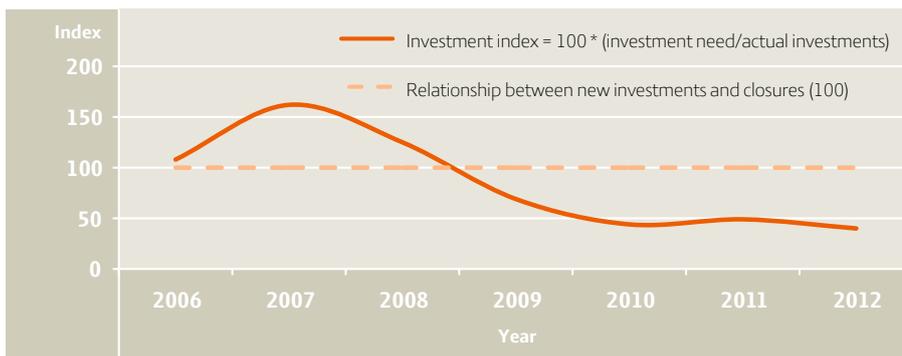
According to calculations made by Pig Research Centre, financial support from the cooperative slaughterhouses and the environmental support scheme potentially improves profitability by around DKK10-12 per finisher. This calculation relates to a 25-year-investment horizon, which is the expected life of a new pig production facility.

Other measures

The potential of Danish pig production is still not fully utilised.

Three different advisory tools were introduced to increase the efficiency of finisher production by a minimum of DKK 25 per pig. A new software programme that relates gross margin of an individual producer to national average efficiency measures, emphasized that many farms still have a huge underutilized production potential.

Figure 1 - Estimated requirement for investments vs actual investments made in the period 2006-2012 for Danish finisher farms * 100



Ten year trend

Over the last decade productivity gains have been greater for sow producers than for weaner and finisher producers.

Figure 1

The value of productivity increases in the last decade based on the break-even gross margin in July 2013 for sows, weaners and finishers. A marginal gross margin of DKK 263 per weaned pig is applied. For weaners and finishers, a marginal gross margin of DKK 59 and DKK 150, respectively, was applied for an improvement of 1 feed unit per kg gain; a value per 100 g daily gain of DKK 11 and DKK 13, respectively; and a value of DKK 3.5 and DKK 7.5 per percentage point dead pigs.

On the basis of these values, productivity gross margins were calculated for each year based on changes in the national averages for productivity. Gross margin per sow/year in July 2013 was DKK 3,225; DKK 50 per weaner; and DKK 126 per finisher, which corresponds to the break-even costs. In the period 2003-2012, the number of weaned pigs per sow/year increased from 24.6 to 29.6. This leads to a gross margin of DKK 1,910 when corrected for the additional five pigs reared. This difference corresponds to a 70% increase in gross margin per sow/year. However, measured per weaned pig, gross margin only increased by 40%, from DKK 78 to DKK 109 per pig. For weaners in the weight interval 7-30 kg, gross margin increased by approx. 40%, from DKK 35 to DKK 50. For finishers, the gross margin increased from DKK 110 to DKK 126, which is an increase of 13%.

Figure 2

The increase in productivity of the top 25% farms equates with productivity increases on average farms. Gross margin for the top 25% sow farms per sow/year was DKK 623 higher than that for the average farms and this corresponds to a 25% improvement. Gross margin per weaned pig was DKK 14 higher (15%). For finishers, the difference between the average farms and the top 25% is significantly higher: production value was DKK 46 (39%) higher among the top 25%. The productivity value includes the value of increased gain. This indicates that there is still significant potential for improving the average productivity levels in finisher production.

Figures 3 and 4

The productivity gains of the top 25% farms resemble that of the average farms. It is clear that the distance between the average and the best farms is smaller on breeding units than on finishing units. This reveals larger variations in gross margin in finisher farms than in sow farms, and shows a potential for improving gross margin.

Figure 1

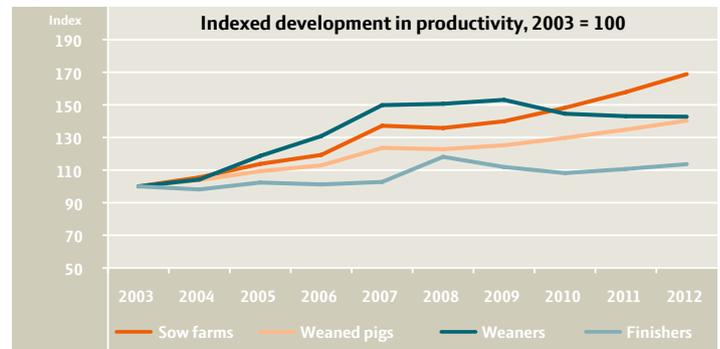


Figure 2

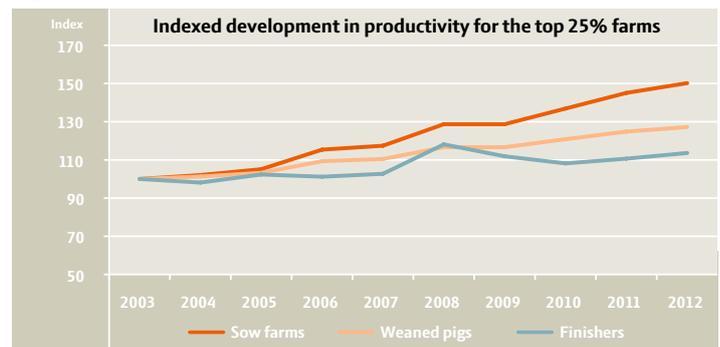


Figure 3

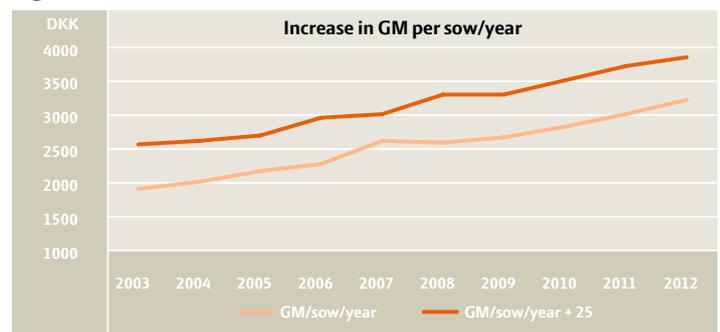


Figure 4



Financial results

Table 1 outlines the development in production economy on 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 the key financial figures for each production category.

The number of full-time pig farms has dropped by approximately 3,150 holdings (approx. 56%) in the last ten years, while the number of sows/year per farm has increased from 200 to 370 (85%).

The number of produced finishers per pig farm has increased from 2,929 to 5,314 (80%). The associated land area has increased from 104 to 164 ha (58%).

These figures represent an average of all pig producers; therefore, for instance, specialised finisher producers will have a significantly higher production than the one shown in Table 1.

As pig farms expand, overall gross margin increases. Records show an annual increase of 12% in gross margin, while

overhead expenses have increased by 10%. Costs of financing have increased by 9% in that same period.

Economy per production unit

In the last ten years, gross margin per sow/year averaged DKK 3,668, while gross margin on finisher farms averaged DKK 114 per finished pig.

Following an all-time low in 2007, gross margin of sow farms has increased to DKK 4,784 per sow/year, while for finishing pig

producers gross margin reached DKK 130 per finisher, which is almost level with that of 2011.

Trend in terms of trade

Terms of trade in 2012 were 6.42, which is an increase from 2011 (6.15) with an average of 7.05 over the last decade.

The rising pork prices are now reflecting in the terms of trade that were negatively affected by the soaring prices of grain and feed.

Figure 1 - Development in terms of trade, 2003-2013 June

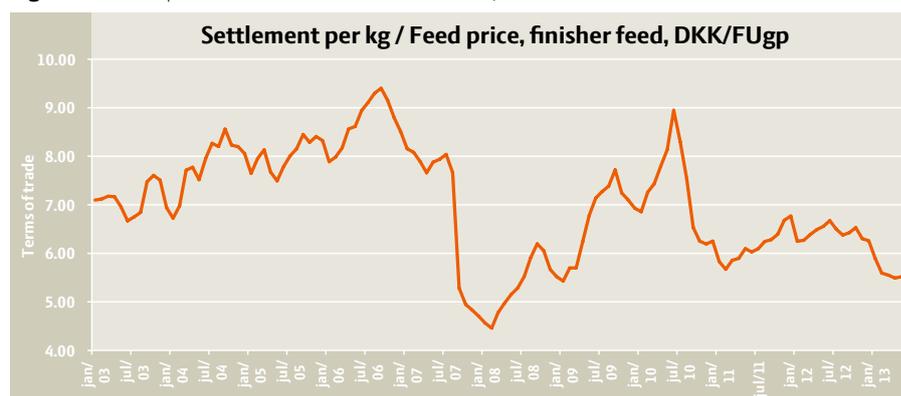


Table 1 - Ten-year development in Danish pig production

| | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011* | 2012* |
|--|--------------------------------|-------|-------|-------|-------|-------|--------|--------|--------|--------|
| No of. accounts | 2,053 | 1,935 | 1,852 | 1,776 | 1,694 | 1,508 | 1,660 | 1,667 | 1,744 | 1,317 |
| Farms | 5,655 | 4,870 | 4,401 | 4,176 | 4,210 | 3,447 | 3,154 | 3,529 | 3,404 | 2,492 |
| Sows/year | 200 | 199 | 223 | 255 | 241 | 267 | 300 | 311 | 309 | 370 |
| Produced finishers | 2,969 | 3,415 | 3,397 | 3,677 | 4,003 | 4,713 | 4,607 | 5,180 | 6,316 | 5,314 |
| Ha | 104 | 112 | 115 | 125 | 136 | 148 | 148 | 150 | 172 | 164 |
| Total economy | Per farm, DKK 1,000 | | | | | | | | | |
| Gross profit | 3,207 | 3,534 | 3,550 | 4,342 | 4,156 | 5,416 | 5,634 | 6,760 | 8,286 | 9,473 |
| Gross margin | 1,471 | 1,804 | 1,766 | 2,321 | 1,711 | 2,053 | 2,211 | 3,122 | 3,490 | 4,212 |
| Key financial figures | DKK per production unit | | | | | | | | | |
| GM/sow/year | 2,853 | 3,850 | 4,033 | 4,811 | 1,893 | 2,828 | 3,398 | 4,077 | 4,153 | 4,784 |
| Prod. pigs/sow/year | 23.6 | 22.6 | 23.7 | 24.9 | 26.1 | 26.3 | 26.2 | 26.6 | 28.3 | 28.5 |
| Price/prod. pig | 309 | 338 | 351 | 368 | 327 | 333 | 354 | 363 | 358 | 412 |
| GM/prod. weaner | 121 | 170 | 170 | 193 | 73 | 108 | 127 | 154 | 147 | 168 |
| Price per FU, sow feed and weaner feed | 1.38 | 1.38 | 1.35 | 1.31 | 1.63 | 1.95 | 1,72** | 1,75** | 2,04** | 2,26** |
| GM/finished pig | 79 | 111 | 138 | 149 | 97 | 86 | 83 | 135 | 132 | 130 |
| FU per kg gain | 2.90 | 2.91 | 2.82 | 2.96 | 2.96 | 2.88 | 2.86 | 2,87** | 2,87** | 2,86** |
| Price per kg, incl. bonus payment | 8.34 | 9.25 | 9.38 | 9.83 | 9.15 | 9.83 | 9.41 | 9.93 | 10.79 | 11.99 |
| Price per FU, finisher feed | 1.10 | 1.13 | 1.19 | 1.08 | 1.30 | 1.67 | 1.34 | 1,36** | 1,71** | 1,86** |

*) 2011 accounts figure are final; figures for 2012 are preliminary.

**) Feed units (FU) are based on production reports and account figures.

On-farm mixing – sow units

The financial advantages of on-farm mixing of feed are confirmed in the software program DB Tjek (“gross margin check”). Pig producers who practise on-farm mixing of feed for sows and weaners achieved a gross margin of DKK 417 per sow/year, which is higher than that of producers who buy ready-mixed feed.

The higher gross margin is primarily attributed to lower feed costs per sow/year of DKK 212 and, secondarily, to lower sow mortality rates for producers mixing feed on-farm. In addition, on-farm mixing has associated other small benefits.

Health status – sow units

Pig producers with a high health status also have a higher gross margin. Pig producers in the SPF system have a higher gross margin (DKK 572 per sow/year) than conventional pig producers.

The higher gross margin is primarily attributed to more live born piglets per litter and thereby more weaned pigs per sow/year. Records from SPF farms show 0.27 more live born piglets per litter. Furthermore, costs for vets and medication per sow/year amount to DKK 117 for SPF producers, which is lower than that of conventional producers.

A comparison of SPF pig producers who mix the feed on-farm with conventional pig producers who buy the feed shows a difference of DKK 1,060 per sow/year.

On-farm mixing – finishers

Finishing pig producers can also reap financial benefits from on-farm mixing of feed. On-farm mixing with minerals results in a higher gross margin of DKK 36 than with purchased feed.

In this case, too, lower feed costs are the main reason. For finisher producers practising on-farm mixing, feed costs are DKK

0.44 lower per kg gain. Compared with pig producers who buy the feed, mortality rates are also lower, lean meat percentage the same and daily gain lower.

Large finisher farms

The average gross margin for large finishing units is DKK 17 higher per pig than for small finishing units. Once more, feed costs explain part of this difference, as feed costs for large finisher farms are DKK 0.21 lower per kg gain than for small finisher farms.

Overall, a large finisher producer who practises on-farm mixing has a gross margin that is DKK 46 higher per finisher than the average small finisher producer who purchases ready-mixed feed.

- On-farm mixing leads to a higher gross margin of DKK 417 per sow/year and DKK 36 per finisher.
- SPF health status leads to a higher gross margin of DKK 572 per sow/year.
- Large finisher farms have a higher gross margin of DKK 17 per finisher.

The project was financially supported by the Pig Levy Fund and the Ministry of Food, Agriculture and Fisheries of Denmark, and The European Agricultural Fund for Rural Development. Journal no. 321010-D-12-00547.

Table 1 - Average difference with different types of sow units

| | Feeding strategy | | Produced pigs/year | |
|---|-------------------------|--------------------|----------------------------|------|
| | Minerals | Vitamin supplement | SPF | Myc. |
| | Compared with purchased | | Compared with conventional | |
| Weaned pigs per sow/year | -0.16 | -0.18 | 0.94 | 0.61 |
| Feed costs, breeding stock, DKK, sow/year | -212 | -210 | 64 | -22 |
| Veterinary costs, DKK, sow/year | 17 | 8 | -117 | -87 |
| Gross margin/ sow/year | 417 | 325 | 572 | 445 |

Table 2 - Average difference with different types of finisher production

| | Feeding strategy | | Produced pigs/year | |
|------------------------------|-------------------------|--------------------|----------------------------|-------------|
| | Minerals | Vitamin supplement | 0-4,999 | 5,000-7,999 |
| | Compared with purchased | | Compared with conventional | |
| FUgp/kg gain | 0.00 | 0.04 | 0.08 | 0.04 |
| Ref. daily gain 30-100 kg, g | -14 | -17 | -16 | -1 |
| Feed costs/kg gain, DKK | -0.44 | -0.30 | 0.21 | 0.09 |
| Gross margin/finisher | 36 | 24 | -17 | -9 |

Table 1 - Genetic progress (4 years) for each trait and breed and average of a D(LY) finisher.

| Breed averages | Year | Daily gain (0-30 kg), g/day | Daily gain (30-100 kg), g/day | FCR, FUp/kg gain | Lean meat % | LP 5, no. | Conformation, points | Killing out % | Longevity, % |
|----------------|---------|-----------------------------|-------------------------------|------------------|-------------|-----------|----------------------|---------------|--------------|
| Duroc | 4 years | 3.6 | 17.9 | -0.045 | 0.16 | - | 0.02 | 0.01 | - |
| Landrace | 4 years | -0.4 | 7.9 | -0.033 | 0.07 | 0.19 | 0.05 | -0.07 | -0.03 |
| Large White | 4 years | -0.4 | 7.7 | -0.028 | 0.02 | 0.29 | 0.05 | -0.03 | 0.03 |
| 3 breeds | 4 years | 1.6 | 12.9 | -0.038 | 0.10 | 0.24 | 0.04 | -0.02 | -0.001 |

Table 2 - Importance of genetic progress for gross margin, average of 4 years.

| | Genetic progress | Economic weighting | Value of genetic progress, DKK (assuming 100% dissemination) | Dissemination in production, % | GM improvement in production, DKK/finisher |
|------------------------------|------------------|--------------------|--|--------------------------------|--|
| Gain (30-100 kg) | 12.9 | 0.14 | 1.8 | 80 | 1.44 |
| FCR | -0.04 | -133 | 5 | 80 | 4 |
| Lean meat % | 0.1 | 8.6 | 0.88 | 150 | 1.31 |
| LP5* | 0.24 | 22 | 2.59 | 85 | 2.2 |
| Gain | 1.6 | 0.09 | 0.14 | 100 | 0.14 |
| Conformation | 0.04 | 12.5 | 0.45 | 100 | 0.45 |
| Longevity* | -0.001 | 85 | -0.05 | 100 | -0.05 |
| Killing out % | -0.02 | -4.9 | 0.1 | 100 | 0.1 |
| Av of 4 years and all breeds | | | 10.9 | | 9.59 |

* Large White and Landrace 50% contribution each.

Table 3 - Number of purebred and hybrid litters in 2012.

| | Purebred litters | | Hybrid litters | |
|-------------|------------------|------------|----------------|------------|
| | Code 100* | Code 200** | Code 100* | Code 200** |
| Duroc | 3,581 | 1,087 | 67 | 228 |
| Landrace | 4,764 | 11,825 | 5,385 | 51,207 |
| Large White | 4,881 | 10,516 | 9,484 | 81,111 |

* Code 100: Litters born in nucleus breeding herds. Litters can be used by all herds.

** Code 200: Litters born in either nucleus or multiplication herds, but cannot be used in future nucleus breeding.

Table 4 - Purebred females in nucleus breeding and multiplication herds, August 2013.

| Purebred females | Nucleus herds* | Multiplication herds |
|------------------|----------------|----------------------|
| Duroc | 1,786 | - |
| Landrace | 2,206 | 34,201 |
| Large White | 2,217 | 25,721 |
| Total | 6,209 | 59,922 |

* Sows on contract

Genetic progress

Table 1 shows the genetic progress in each trait for the three breeds in the breeding programme in the period 2009-2013 and the average progress in D(LY) finishers for that same period.

Progress in feed conversion per kg gain is 0.038 (vs 0.036 in 2012), which in particular has arisen as a result of progress in Landrace and Large White breeds. Daily gain, particularly in the period 0-30 kg, has improved compared with 2012; in 2013 the progress averages 1.6 g/day for all three breeds.

Table 2 shows the economic importance of genetic progress, which is based on the economic values used in the index calculations and on the dissemination of the traits in the production chain.

Herd structure

Currently, 26 nucleus breeders have a contract with Pig Research Centre, and in total they represent 40 herds with purebred animals comprising 13 Duroc, 14 Landrace and 13 Large White. As of August 2013, 144 Danish multiplication herds were approved and of these 27 were in some way affiliated with a nucleus breeding herd. In Tables 3 and 4, the number of nucleus and multiplication litters (codes 100 and 200, respectively) is shown.

Pig Research Centre also have contracts with 72 international multiplication herds, and this number is constantly increasing.

Production level

In the past year, 4,846 boars were performance tested at Bøgildgård of which 2,358 were Duroc boars.

GENETIC PROGRESS AND SALE OF GENETIC PRODUCTS

BREEDING

In nucleus breeding herds, 35,201 males and 47,136 females were performance tested. Tables 5 and 6 show the average production level in 2013 for males and females, respectively, in nucleus breeding herds.

Table 7 shows the performance test results from Bøgildgård.

Litter size and live pigs day 5

Table 8 shows the litter size of purebred nucleus litters in 2013 based on litters used for breeding: live pigs on day 5 after birth (LP5) average 13.4 for Large White, and 12.1 for Landrace.

AI boars

Average time in production of AI boars for all three breeds has increased drastically compared with last year: by 10.3% for Duroc; 4.7% for Landrace and 12.1% for Large White.

The average index level of active Duroc boars has increased by 0.8 index points, and index levels for Landrace and Large White boars have increased by 7.0 and 7.2 index points, respectively, compared with last year (Table 9). The increase is most likely the result of the inclusion of genomic information in the index calculation.

Nine distributors have between them 1,811 boars on 35 AI stations internationally. Table 10 shows the distribution on breed and index for AI boars nationally as well as internationally.

The number of AI boars internationally has increased since last year as has the index level. Nevertheless, the index of Danish AI boars is still significantly higher than the international index; in Denmark, the index level is 9.7 index points higher for Duroc, 15.7 for Landrace and 16.1 for Large White (Table 10).

Table 5 - Nucleus breeding herds – average production results for boars the past year.

| Breed | Number | Daily gain, g/day | | Lean meat % | Conformation, points | Scanning objective, mm | Scanning weight, kg |
|-------------|--------|-------------------|-----------|-------------|----------------------|------------------------|---------------------|
| | | 0-30 kg | 30-100 kg | | | | |
| Duroc | 7,215 | 393 | 1,135 | 61.1 | 2.91 | 7.5 | 95.8 |
| Landrace | 13,264 | 375 | 1,011 | 62.3 | 2.99 | 8.3 | 93.9 |
| Large White | 14,722 | 358 | 977 | 61.8 | 3.13 | 8.3 | 93.3 |
| Total | 35,201 | | | | | | |

Table 6 - Nucleus breeding herds - average production results for females the past year.

| Breed | Number | Daily gain, g/day | | Lean meat % | Conformation, points | Scanning objective, mm | Scanning weight, kg |
|-------------|--------|-------------------|-----------|-------------|----------------------|------------------------|---------------------|
| | | 0-30 kg | 30-100 kg | | | | |
| Duroc | 9,642 | 396 | 1,086 | 61.4 | 2.98 | 7.2 | 95.1 |
| Landrace | 19,104 | 380 | 952 | 62.7 | 3.08 | 7.8 | 93.3 |
| Large White | 18,390 | 360 | 944 | 61.6 | 3.20 | 8.6 | 92.8 |
| Total | 47,136 | | | | | | |

Table 7 - Average production results from performance-testing at test station Bøgildgård, 2012.

| Breed | Number | Gain (30-100 kg), g/day | FCR, FUp/ kg gain | Lean meat % | Killing out % | Scanning objective, mm |
|-------------|--------|-------------------------|-------------------|-------------|---------------|------------------------|
| Duroc | 2,358 | 1,111 | 2.30 | 60.0 | 24.9 | 7.6 |
| Landrace | 1,271 | 1,021 | 2.41 | 60.4 | 25.3 | 8.4 |
| Large White | 1,217 | 951 | 2.41 | 60.8 | 25.4 | 8.5 |
| Total | 4,846 | | | | | |

Table 8 - Nucleus breeding herds – litter size of purebred litters in the past year (litters with code 100)

| Breed | Litter size | LP5 | Per cent litters from first parity sows |
|-------------|-------------|------|---|
| Duroc | 9.8 | - | 68.4 |
| Landrace | 15.6 | 12.1 | 69.6 |
| Large White | 16.0 | 13.4 | 65.0 |

Sale of semen

4,678,582 doses of Duroc semen were sold in Denmark in 2012, which is a slight increase from the year before. Sale of Duroc semen outside Denmark continues to increase; in 2012, sales reached 777,711 doses, which is an 18.4% increase from the year before.

International sales of semen from the white breeds are not recorded in doses of semen; instead, the number of on-farm replacement production sows is recorded. This has increased drastically in recent years and continues to increase; in 2012, records showed on average 290,896 on-farm replacement production sows internationally (Table 11).

Sale of breeding stock

The sale of purebred animals in Denmark increased from 2011 to 2012 as did the export of purebred animals.

Sale of hybrid females continues to increase nationally as well as internationally. The sale of gilts in Denmark increased from 236,121 in 2011 to 241,223 in 2012, and the export of hybrid females increased by 28% from 271,144 to 347,575 in that same period (Table 11).

Figure 1 shows the distribution according to country (top 10) of fees on genetic material; approximately half of the fees originate from international sale of genetic products.

Table 9 - Index and time in production of AI boars.

| Breed | Boars entered, 2012 | Active boars, August 2013 | Index for active boars, August 2013 | Months in service of boars departed in 2012 |
|-------------|---------------------|---------------------------|-------------------------------------|---|
| Duroc | 2,357 | 2,340 | 111.8 | 11.8 |
| Landrace | 647 | 390 | 130.9 | 6.7 |
| Large White | 771 | 479 | 132.3 | 6.5 |

Table 10 - DanAvl AI boars sold nationally and internationally, August 2013.

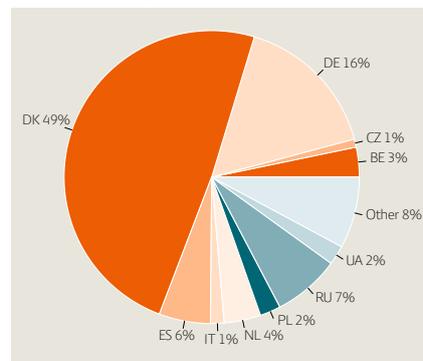
| | Internationally | | Nationally | |
|-------------|-----------------|-------|------------|-------|
| | Number | Index | Number | Index |
| Duroc | 1,203 | 102.1 | 2,304 | 111.8 |
| Landrace | 319 | 115.2 | 390 | 130.9 |
| Large White | 289 | 116.2 | 479 | 132.3 |
| Total | 1,811 | | 3,173 | |

Table 11 - Sale of genetic breeding stock from DanAvl in 2012, nationally and internationally.

| | 2011 | | 2012 | |
|--|-----------|-----------------|-----------|-----------------|
| | DK | Internationally | DK | Internationally |
| Purebred females | 4,640 | 22,007 | 6,551 | 23,465 |
| Hybrids | 236,121 | 271,144 | 241,223 | 347,575 |
| DD and XX boars | 1,093 | 1,780 | 685 | 2,090 |
| LL and YY boars | 5 | 997 | 26 | 995 |
| DD and XX semen, doses | 4,568,000 | 657,000 | 4,678,582 | 777,711 |
| LL and YY semen, doses | 242,817 | - | 234,662 | - |
| On-farm replacement production sows internationally* | - | 220,000 | - | 290,896 |

* Sale of LL and YY semen internationally is not recorded; instead the number of on-farm replacement production sows is shown.

Figure 1 - Fees on sale of genetic products in 2012 according to country (top 10)



Breeding objective

The latest revision of the breeding objective for Duroc, Landrace and Large White was carried out in March 2011. The revision included an evaluation of the traits and their weighting. The traits currently included in the breeding objective are shown in Figures 2 and 3.

Figure 2 - Breeding objective for DanAvl Landrace and Large White – economic contribution.

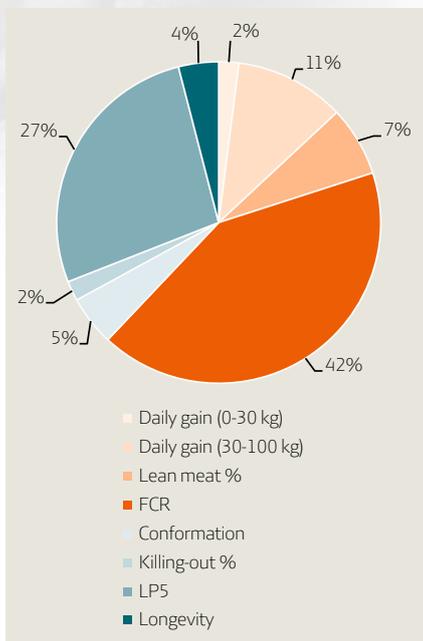
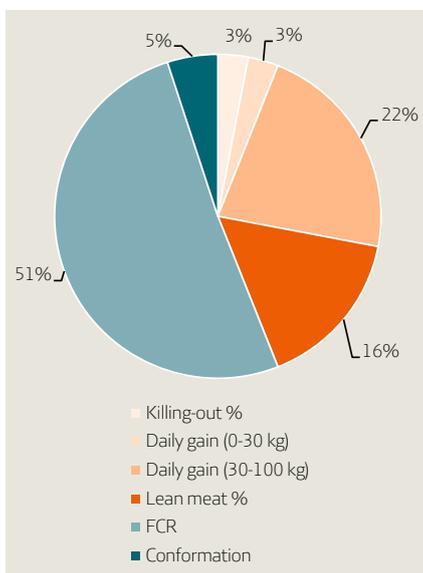


Figure 3 - Breeding objective for DanAvl Duroc – economic contribution.



Experiences with maternal traits

Maternal traits (14P, LP5) were studied using data from standard commercial herds with the aim of finding a new trait for use in the future breeding work to improve sows' ability to rear piglets in the farrowing unit.

Normally, data from nucleus breeding herds are used for genetic research, but in this project data from commercial herds with LY/YL-hybrid sows were used.

A large amount of data was collected in one of the herds, which was located in Germany and housed 9,000 Danish sows. The trait "number of piglets in the litter on day 21 after farrowing" was recorded after the sows were given 14 piglets to rear the first day after farrowing (14P). Between days 1 and 21, no piglets were moved to or from the sows. Live piglets on day 5 (LP5) was also recorded for first parity sows. The genetic makeup of all sows included in the trial was known.

Data collection was complete by the beginning of 2013. 14P and LP5 were recorded for 10,500 litters; 8,150 of these were used in the preliminary analyses.

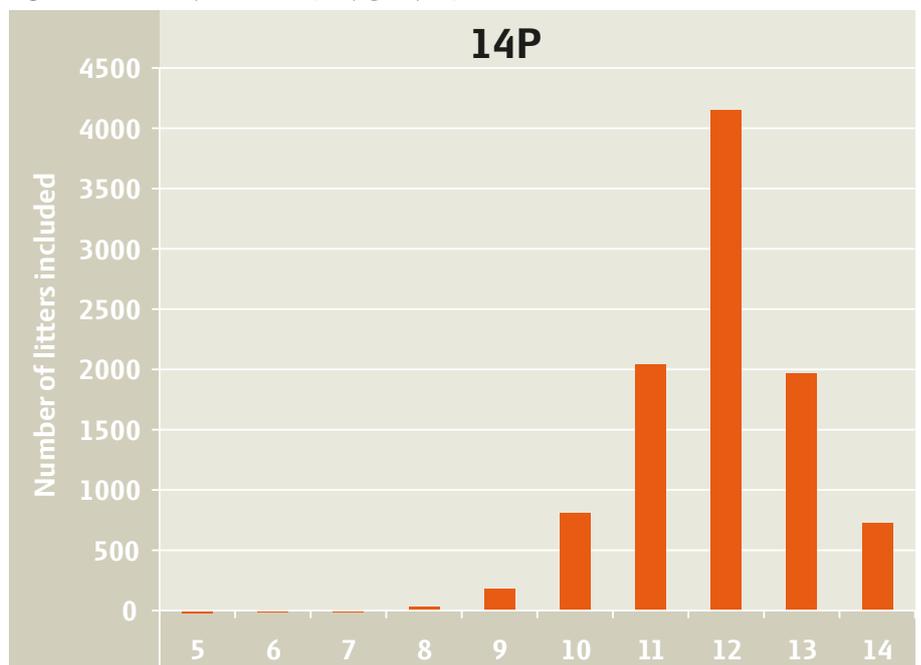
Data from the study and, in addition, data from purebred and related pigs were analysed to determine heritability and genetic correlations. Regarding 14P recorded in commercial herds, preliminary results show a heritability of 0.059 and for LP5 a heritability of 0.055.

This level of heritability is almost the same as when it is estimated on only purebred populations in this analysis. The phenotypic correlation between 14P and LP5 is low (<0.1), whereas the genetic correlation is slightly higher (0.15).

Figure 4 shows the preliminary result for 14P; the trait varies from 5 to 14 piglets with an average of 11.9 piglets on day 21.

The preliminary results show that it is in fact possible to collect data in commercial

Figure 4 - Preliminary results 14P (live pigs day 21)



herds for use in genetic research, but it is a time-consuming task. In addition, routine collection is required about the genetic makeup of purchased gilts. Genomic selection also requires DNA analysis of hybrid sows. Hair samples from 5,000 sows from the German herd were subject to DNA analysis. The final results from 14P are expected in autumn 2013, and it will subsequently be investigated if this trait can be incorporated into the breeding objective. Genomic selection requires further theoretical calculations with the new genetic and statistical models developed for the project "Genomic selection III".

Genomic selection

The purpose of genomic selection is to increase genetic progress through a more exact parentage than previously. Extensive theoretical evidence shows that genomic selection improves genetic progress, but there is only little practical evidence. DanAvl are currently evaluating the practical effect of this technique.

Over the last 7 years, genetic progress has been fairly stable for all three breeds; particularly for Landrace and Large White there are indications that progress has improved slightly since the introduction of genomic selection (Figures 5-7).

In continued monitoring of this development, Pig Research Centre are now working on optimising the benefits of genomic selection even further through more DNA testing and improved use of data.

Genomic selection:

- Used by DanAvl since 2011
- Based on DNA analyses
- Improves genetic progress by 10-25%.

Hybrids and DNA analyses

In cooperation with the Department of Molecular Biology and Genetics of Aarhus University (AU), Pig Research Centre are currently engaged in a two-year project on breeding for better hybrids through DNA

Figure 5 - Genetic progress, Landrace



Figure 6 - Genetic progress, Large White

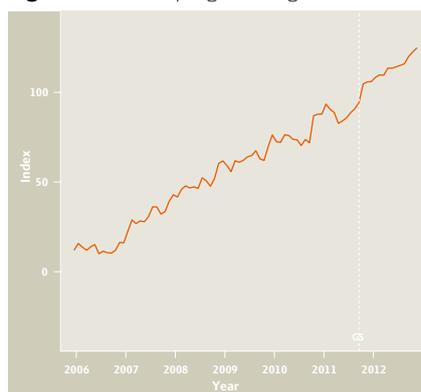
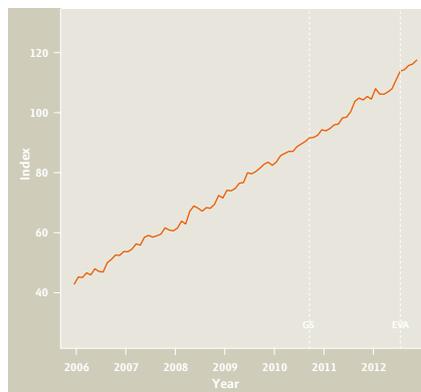


Figure 7 - Genetic progress, Duroc



populations. Based on preliminary results of a previous study, the primary aims of this project are:

Focus areas in the project:

- Development of methods for evaluation of pigs in purebred and hybrid populations, and methods for selection of pigs for genotyping
- Development of strategies for selecting pigs for breeding to be able to utilise heterosis (dominance) and epistasis in hybrids.

Genomic information, which is only used in genomic selection, may possibly also be used to increase the effect of heterosis in hybrid populations. This will require strategies that increase the heterosis in a hybrid animal. This may be achieved by focusing on different genotypes in different breeds.

Approximately 4,000 three-way cross-breds will be produced for this project in which some of the essential recording parameters include finisher daily gain, feed conversion ratio (FCR) and lean meat percentage as well as slaughter traits such as pH and boar taint. All pigs will be genotyped, and the recorded data will be used for calculations and method development.

The project is financially supported by Green Development and Demonstration Programme. Journal no. 34009-12-0540.

EVA

In 2012, DanAvl implemented EVA, a new tool for reducing inbreeding in Duroc. With this tool it is now possible to achieve the same level of genetic progress, and at the same time reduce inbreeding. EVA therefore guarantees continued genetic progress for many years to come.

In 2013, EVA was updated to capture more litters from high-index boars, and

there are indications that the desired effect is at hand: fewer boars are now being selected with just an average higher index, but the best boars are being assigned more litters. Furthermore, there are indications that the update has slowed the degree of increase in inbreeding.

It is currently being attempted to extend EVA to include a limited inbreeding at DNA level. However, controlling inbreeding at DNA level requires research in and development of new methods and this is just one area of collaboration between Pig Research Centre and AU.

Pig Research Centre expect EVA to be implemented for the white breeds once the effect of the update on inbreeding for Duroc is known and when more knowledge is available on inbreeding at DNA level.

Breeding for reduced boar taint

In the EU, a voluntary agreement has been made to abandon castration as of 2018 in order to improve pig welfare. It is therefore currently being investigated how to reduce boar taint in Danish pig breeds through, for instance, breeding and genetics. Boar taint is primarily attributed to two chemical compounds: androstenone and skatole, while indole is less important. The first results of a three-year project, financially supported by the Danish National Advanced Technology Foundation, and of a two-year project financially supported by The European Agricultural Fund for Rural Development are now available. The results are based on analysis of existing data from the Landrace population that were compiled in connection with the EU project SABRE in which the Department of Breeding & Genetics participated.

Heritability of skatole and androstenone were estimated to be 0.33 and 0.59,

respectively, and the genetic correlation between the compounds is 0.37; consequently, to achieve the largest possible reduction in boar taint, it is necessary to select for both compounds. Results reveal slightly favourable genetic correlations between boar taint and production traits, which are also confirmed by international research findings. It is essential to focus on both sow as well as boar fertility, which is why the correlations between litter size, semen quality and semen quantity were determined. Genetic correlations between litter size, semen quality and semen quantity were low - in several cases close to zero.

One of the cornerstones of the project is the implementation of individual performance testing for boar taint.

The trait boar taint is based on a combination of chemical analyses and the release of boar taint from the carcass during heating, which is evaluated on a scale from 0 to 2. On live animals, boar taint is established with a biopsy where skatole and androstenone are determined, while slaughtered boars can also be tested for boar taint with an odour test. The advantage of using an odour test as a potential breeding objective is that the score will reflect the variation in human perception of boar taint.

Furthermore, the contribution of each compound to the intensity of boar taint is not known, and it is therefore not possible to determine the mutual weighting of the compounds. Preliminary results based on on-going data collection reveal rejection rates of 5%, 25% and 7% for Duroc, Landrace and Large White, respectively. This is good news as Duroc contributes with 50% of the genetics in finishers. Heritability of the odour test varies from 0.10 to 0.15, which means that the human nose is capable of detecting genetic variations between pigs.

In 2014, research will focus on mapping genetic correlations between boar taint, production and reproduction traits in Large White and Duroc, and on mapping the genes of boar taint in all breeds.

The project is financially supported by the Danish National Advanced Technology Foundation and the Ministry of Food, Agriculture and Fisheries of Denmark, and The European Agricultural Fund for Rural Development (journal no. 32101-U-13-00238) in cooperation with the Group for Quantitative and System Genetics at the Scientific Faculty of Health at the University of Copenhagen.

Social interactions

Selection that includes interactions between pigs is a method that includes the fact that the daily gain of a pig depends on not only the pig itself, but also on its pen mates.

Ideally, the method requires that all pigs in a batch in the commercial trial are of known genetic origin. Rules for e.g. recording of pigs in the individual performance test carried out in the nucleus breeding herds were therefore adjusted.

Starting on January 1, 2014, all pigs in the performance tests must therefore have their genetic makeup defined. Preliminary analyses of existing data for daily gain in Landrace indicate a significant social genetic effect. Results are still preliminary, but do point towards an unexploited potential for genetic progress in daily gain.

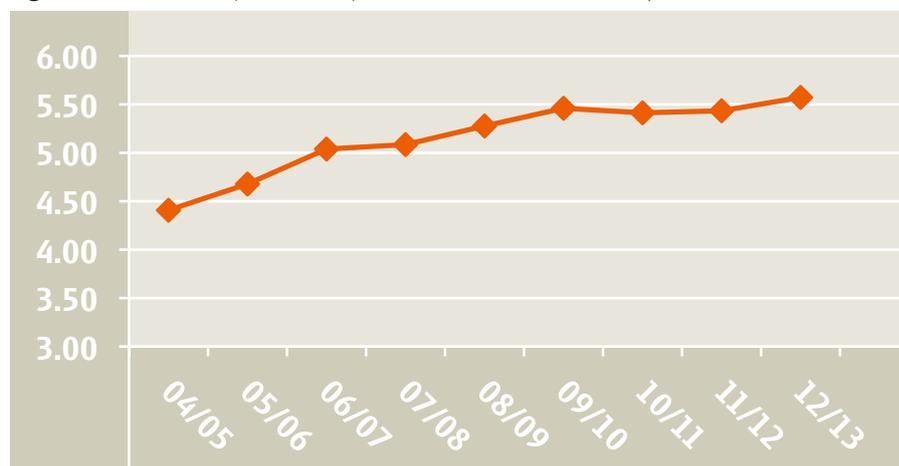
Research and development

Research and development within AI is managed by Pig Research Centre. Trials and projects are continuously prioritised by Pig Research Centre and Danish DanBred AI stations through a joint steering committee.

Sale of semen

Sale of semen from DanBred AI stations increased by 2.5% compared with 2011/12. Overall, 5.6 million sperm doses were sold from the AI stations, and it is assumed that approximately 90-95% of all inseminations are made with purchased semen. Figure 1 illustrates the sale of semen for the past nine years.

Figure 1 - Sale of semen (million doses) from DanBred AI stations in the period 04/05 to 12/13.



Effect of pooled semen

In Denmark as from 2013, commercial semen doses, i.e. not intended for breeding and multiplier herds, contain semen from a minimum of three and maximum of ten boars whereas previously doses contained semen from one to ten boars. This change was based on the outcome of an investigation made on five farms where sows were inseminated with semen from one, three or six boars. Compared with semen doses containing sperm from one boar only, litter size increased by 0.3 pigs when the doses contained sperm from more than one boar. For more information, see "Publikationer" at www.vsp.lf.dk (trial report no. 969). Consequently, pooled semen is considered a more efficient product.

Quality control

Quality control of semen from Danish DanBred AI stations includes analyses of sperm number per dose; monitoring of sperm quality; and routine control of materials used at the AI stations. This quality control is financed by Danish DanBred AI stations.

Number of sperm in semen doses

On a weekly basis, each AI station submits approximately ten semen doses for analysis of sperm number per semen dose. The result is used by the AI station to ensure that sperm number per semen dose is adequate and meets the guidelines for AI stations. The number of sperm per dose is also monitored through unannounced audits of the boar stations, and the results of these audits are made available to the public. Since the last Annual Report, unannounced audits have been made at six AI stations demonstrating that Boar Station Mors 2 had too many samples with too low sperm content.

Sperm motility

Sperm quality for Landrace and Large White is routinely monitored by recording sperm motility. This method may be used for assessing sperm fertility. With this method, approx. 5% of all Landrace and Large White boars are culled due to increased risk of reduced fertility.

The method is not applied on Duroc boars as semen doses from Duroc contain pooled semen, which will neutralise the effect of a boar with low fertility.

Sperm-toxic effects in materials

Pig Research Centre routinely check the quality of materials used in the production of semen. This procedure is used for approving new types of materials and to find alternatives to existing materials. As a result of this checking, changes have been introduced; e.g. now a new type of gloves are worn during semen collection and a different type of gauze is used for semen filtration.

Sperm morphology

Pig Research Centre have developed an instrument for recording sperm morphometry and morphology (for more information, see "Publikationer" at www.vsp.lf.dk, trial report no. 965). The instrument consists of a microscope fitted with a camera attached to a computer. The camera records a series of images of sperm cells that are automatically analysed for defects. Tests of the instrument demonstrated that the device may be an alternative to manual analysis of sperm morphology. The system is currently being phased in for permanent use at Danish AI stations.

Reduced 5 point plan

On four sow farms, the five point plan was investigated to determine whether it is necessary to apply all five exercises to all sows when the sows are checked for oestrus.

5 point plan

1. Push with a fist or knee to the flank
2. Grab and lift the groin
3. Push with a fist under the genital opening
4. Massage the corners of the sow's hips
5. Back pressure test (the inseminator sits on the sow)

Reduced 5 point plan

- 1-4 are optional with most sows
5. Back pressure test is obligatory

Oestrus detection was performed either according to the five point plan or to a reduced version of the plan where the first four exercises were left out if the sow clearly displayed standing oestrus. All sows had to "pass" the back pressure test before insemination. Results revealed no differences between farrowing rates and the subsequent litter size in the two groups. Consequently, farms with high production results and experienced staff may save time in the insemination unit by applying the reduced five point plan (with the exception of nurse sows, returners and gilts). For more information, see "Publikationer" at www.vsp.lf.dk (trial report no. 967).

Sperm quality index

Pig Research Centre have developed a boar sperm quality index, which may partially predict boar fertility. Today, the index



This analysis is applied for monitoring the semen quality of Danish boars. It is used to ascertain whether materials used in production are sperm toxic; and for testing sperm quality in trials.

consists of a summation of the percentage of motile sperm and their uniformity of movement.

The sperm quality index was implemented on DanBred AI stations more than two years ago; data are used for detailed analyses to improve the sperm quality index for Landrace and Large White boars. An improved index is expected by the end of 2013. In time, recording of sperm morphology will be included in the index when the method is introduced on all AI stations.

Returners

In spring 2013, some farms experienced problems with returners – often between

40 and 70% – in certain weekly batches. Thorough research failed to establish the cause of these returners, but Pig Research Centre believe that the switch from one type of antibiotic to another in the semen doses in January 2013 may be the cause. A new type of antibiotic was introduced because the type previously used was no longer available. When it was realised that this may be the cause, the boar stations immediately switched to another type of antibiotic deemed more secure. This seems to have solved the problems.

Feeding strategy after insemination

Restricted feeding of sows the first four weeks after insemination is recommended as this improves reproduction results. However, restricted feeding is only possible if sows are housed individually. Pig Research Centre are currently investigating the effect on reproduction of feeding individually housed gilts and sows either 2.3 FUsow, 3.6 FUsow or 4.6 FUsow a day the first four weeks after insemination.

The results will be used for recommending a strategy for feeding sows housed and fed in groups in this period. Changes in weight and back fat will also be recorded in this trial. As expected, preliminary results show that gain and back fat thickness of the sows increase when the feed dose is raised. In terms of the effect of feed dose on reproduction results, it is too early to draw a conclusion.

The project was financially supported by the Ministry of Food, Agriculture and Fisheries of Denmark, and The European Agricultural Fund for Rural Development. Journal no. 32101-U-12-00197.

Danish vs Dutch sow feed

Mortality rates and feed used per sow/year among sows in the Netherlands are much lower than in Denmark, and it was therefore decided to take a closer look at the Dutch feed recommendations. The Dutch recommendations are based on a different mineral composition and a higher content of fibre in gestation as well as lactation feed. The recommendations also list monitoring of back fat thickness as an essential management tool for using the correct feeding curves.

Pig Research Centre are investigating if sow productivity, feed consumption and longevity are affected when sows on two farms are fed according to Dutch or Danish recommendations, respectively.

The study is being undertaken in cooperation with Provimi and 3S, and results are expected in 2014.

Optimisation of feed consumption

On eight farms, a dedicated effort to optimise feed consumption was made; this was described in the annual report 2012. Results showed that the pig producers succeeded in reducing feed consumption by on average 65 FUsow per sow/year. In this period, productivity improved by 0.8 weaned pigs per sow/year. The improvements obtained on each farm are shown in Table 1.

It is crucial that sows' feed consumption is determined in each cycle to be able

to make appropriate changes if feed consumption is too high. The three main effort areas in this trial were:

- Consistent management of body condition during gestation
- More feed for lactating sows to reduce weight loss
- Push the sows to rear more piglets to reduce FCR per produced pig

For more information, see "Publikationer" at www.vsp.lf.dk (report no. 1315).

Large variations in weight loss

On each farm, approx. 100 litters were cross-fostered to study the maternal traits and weight loss of the sows. Results showed an average weight loss of 19.3

Table 1 - Development in sows' feed consumption and productivity on eight farms.

| Farm | Change in feed used/sow/year, FUsow | Change in FCR/sow/year, % | Change in number of weaned pigs/sow/year |
|------|-------------------------------------|---------------------------|--|
| 1 | -57 | -4 | +2.2 |
| 2 | -162 | -11 | +0.6 |
| 3 | -180 | -12 | -0.6 |
| 4 | -29 | -2 | +1.4 |
| 5 | +62 | +4 | +1.4 |
| 6 | -32 | -2 | -0.2 |
| 7 | -126 | -8 | +0.2 |
| 8 | +3 | 0 | +1.1 |

Table 2 - Average litter gain per lactation day corrected for weight of piglets that died during lactation.

| Farm | Litter gain, kg/lactation day | | |
|------|-------------------------------|-----------------------------|-----------------------------|
| | Average | 10% percentile ¹ | 90% percentile ² |
| 1 | 2.65 | 2.08 | 3.28 |
| 2 | 2.99 | 2.51 | 3.51 |
| 3 | 2.30 | 1.79 | 2.79 |
| 4 | 2.38 | 1.82 | 2.98 |
| 5 | 2.82 | 2.35 | 3.32 |
| 6 | 2.31 | 1.81 | 2.78 |
| 7 | 2.68 | 2.09 | 3.21 |
| 8 | 2.88 | 2.29 | 3.48 |

¹ 10% percentile indicates that 10% of the litters had a litter gain lower than the value shown.

² 90% percentile indicates that 10% of the litters had a litter gain higher than the value shown.

The sections on Pig Research Centre's website concerning feeding of gestating sows, lactating sows and gilts, which are in Danish, are updated in accordance with these research results.

kg during lactation when correction was made for the weight of the piglets born, but excluding weight of amniotic fluid and foetal membranes. Weight loss varied greatly between sows as shown in Figure 1.

Research indicates that some weight loss in sows may make milk producing capacity more efficient. In Figure 2, sows' weight loss and litter gain are compared indicating a slight effect despite great variations between sows.

For more information, see "Publikationer" at www.vsp.lf.dk (report no. 1316).

Variation in daily litter gain

Many pig producers pay little attention to average daily litter gain, but this parameter actually reveals sows' ability to convert feed and possibly weight loss into litter gain. Table 2 shows the average daily litter gain of the sows. On average the sows produced 2.62 kg litter gain/lactation day, and the top 10% sows produced more than 3.24 kg litter gain/lactation day.

Results varied substantially between farms, and, as indicated in Figure 3, litter size at weaning was a decisive factor in how much litter gain a sow is able to produce.

For more information, see "Publikationer" at www.vsp.lf.dk (report no. 1316).

The project was financially supported by the Ministry of Food, Agriculture and Fisheries of Denmark, and The European Agricultural Fund for Rural Development. Journal no. 3663-U-11-00183.

Figure 1 - Corrected sow weight loss during lactation on eight farms.

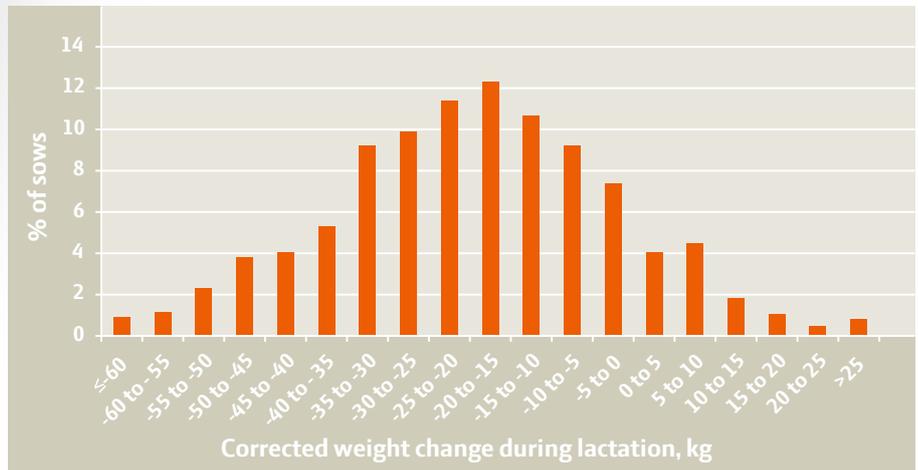


Figure 2 - Correlation between sows' weight loss during lactation and average daily litter gain/lactation day.

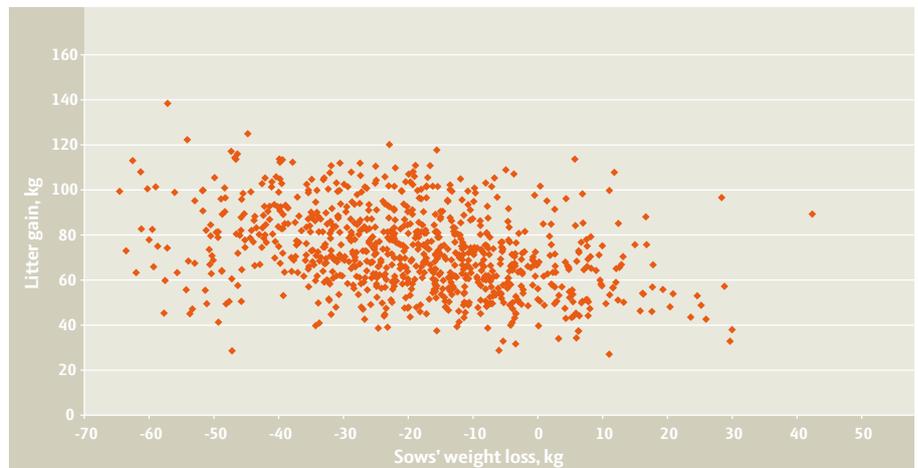
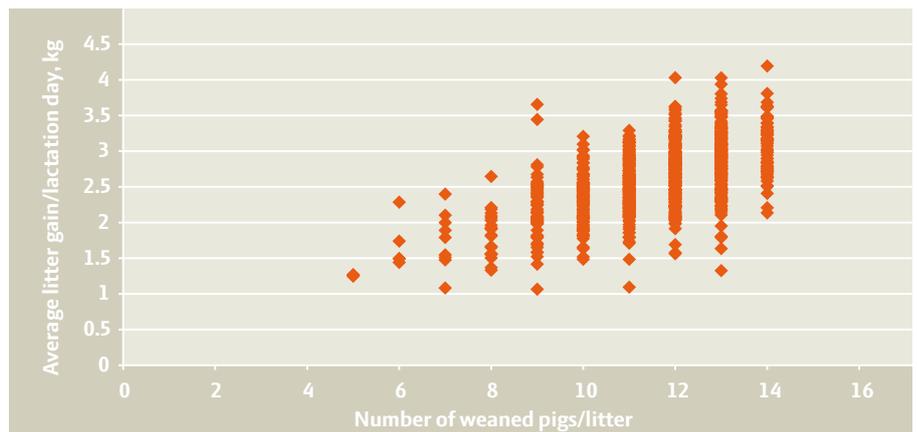


Figure 3 - Correlation between number of weaned pigs of the sow and average daily litter gain/lactation day.



Agreement

Along with other interested organisations in the EU, Danish Agriculture and Food Council have signed a voluntary agreement to terminate castration as of 2018 to improve animal welfare. However, this requires agreement on methods and equipment for analysis of boar taint as well as rejection limits in the EU. The Danish pig industry must also demonstrate to its international customers that Danish pig producers are capable of producing high-quality pork from entire males.

In Denmark, scientists are therefore working on developing appropriate analytical methods. Furthermore, investigations are underway to determine whether boar taint can be reduced through breeding or management routines whereby also rejection rates would be reduced.

Production of entire male instead of castrates will only be profitable if rejection rates are low. With the current pig prices, the economic advantage in producing entire males versus castrates amounts to DKK10-20 per male pig. This amount will vary depending on feeding strategy and rejection rates. For more information, see “Publikationer” at www.vsp.lf.dk (trial report no. 974).

The project was financially supported by the Ministry of Food, Agriculture and Fisheries of Denmark, and The European Agricultural Fund for Rural Development. Journal no. 3663-U-11-00182.

Determination of boar taint

At one slaughterhouse in Denmark, boar taint is still determined with online measurement of skatole but already this method is technologically outdated. It is also possible to apply the human nose method (hot water method), i.e. a sample of fat from each pig is poured into a flask with boiling water and stands for 2 minutes after which a sensory panel scores the odour on a scale from 0 to 2, where 2

equals heavy taint = rejection. Boar taint can also be determined with a laboratory method whereby both skatole and androstenone, the two main boar taint compounds are determined. However, this method is far too slow and too expensive to be used in practice.

Skatole and androstenone

The two substances that primarily cause boar taint are:

- Skatole produced by bacteria in the large intestine
- Androstenone produced in the testicles

Both are metabolised in the liver, and the surplus is subsequently deposited in the fatty tissue.

Research demonstrated that changes in feeding strategy may affect skatole, but not androstenone levels in fat. To impact on androstenone, age/slaughter weight or breeding must be affected.

Feeding and boar taint

Previous research demonstrated that skatole, but not androstenone, is affected when 15% chicory is added to pig feed beginning the last two weeks before slaughter, i.e. the slower growing pigs delivered last for slaughter were fed the chicory diet for up to six weeks. However, the cost is approx. DKK 50 per male pig, and chicory is therefore not profitable in such inclusion rates for this period of time. Future research activities will establish whether a lower inclusion rate for a shorter period of time may have the same effect.

Grain and boar taint

Research shows that feeding with grain the last four days before slaughter has the same effect on skatole as chicory, but did not affect the human nose score. This feeding strategy costs approx. DKK 10-15 per pig in lost gain as the pigs that were slaughtered last in the pen delivered last for slaughter were fed grain for eight days in a 14-day period.

The project was financially supported by the Ministry of Food, Agriculture and Fisheries of Denmark, and The European Agricultural Fund for Rural Development. Journal no. 3663-U-11-00182.

It is currently being investigated if it is possible to cut this period down to two days before slaughter, but still have same impact on skatole reduction.

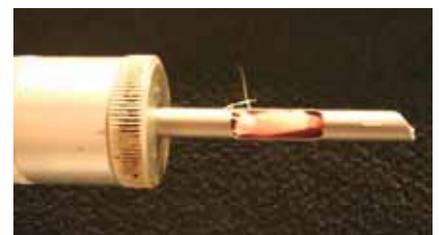
The project was financially supported by the Green Development and Demonstration Programme. Journal no. 3405-10-op-00134.

Age and slaughter weight

Research demonstrated that when slaughter weight increased from 75 kg to 95 kg, androstenone in fat increased, which led to an increase in rejection rates of approx. 20% when the rejection limit used was > 1.00 ppm androstenone.

The project was financially supported by the Green Development and Demonstration Programme. Journal no. 3405-10-op-00134.

In a new project, scientists are collecting fat biopsies and blood samples from live entire male pigs in intervals of 10 kg from 60 kg to slaughter at 120 kg to investigate whether age or slaughter weight has the greatest impact on the development of boar taint compounds.



Biopsy of neck fat

Standards for lactating sows

In spring 2013, the amino acid standards for lactating sows were revised following research on the amino acid requirements of sows for milk production. The research findings showed that with an average daily feed intake of 6-7 FUsow per sow throughout lactation, sows must mobilise a considerable amount of protein from body reserves for milk production when suckling a litter of 12-14 pigs.

The new standards, shown in Table 1, are based on an overall analysis of the previous standards, results from international research, model calculations and the latest recommendations from the American National Research Council (NRC).

According to the revised standards, the average lactating sow will have an extra intake of approx. 110 extra standardised digestible lysine in a 28-day lactation period, which according to the NRC corresponds to the sow being able to produce approximately 6 kg extra litter gain without having to mobilise more protein and energy from body reserves.

During this process, it was realised that the optimum lysine:valine ratio recommendation was actually based on a very uncertain foundation. Consequently, a comprehensive trial was initiated on the optimum ratio for high-prolific Danish sows; until results are available, the valine standard remains unchanged.

A minimum requirement for 110 g digestible crude protein per FUsow will lead to an increase in the price of lactation feed by approx. DKK 2 per 100 FUsow.

For more information, see "Publikationer" at www.vsp.lf.dk (reports no. 1308 and 1312).



With new amino acid standards for lactation feed, litter gain may increase even more

The project was financially supported by the Pig Levy Fund and the Ministry of Food, Agriculture and Fisheries of Denmark, and The European Agricultural Fund for Rural Development. Journal no. 32101-U-13-00239 and 32101-U-12-00228.

Standards for finishers

Standards for finishers were revised on the basis of the financial optimum found in recent trials with amino acids and protein for finishers. As the price ratio between free amino acids and crude protein has changed drastically in recent years, it was decided to increase all amino acid standards by 4%. As the requirement for tryptophan in per cent of lysine is at the same time raised from 19 to 20% based on new French meta analyses, the tryptophan standard increases by approx. 10% expressed in gram per feed unit (FUgp).

Furthermore, the requirement for digestible crude protein was decreased by approx. 10 g per FUgp since there is no justification for maintaining the old requirement in an era of soaring protein prices.

It is expected that the new standards for finishers will increase gross margin by approx. DKK 2 per finisher compared with the old standards with the current price ratios.

For more information, see "Publikationer" at www.vsp.lf.dk (reports no. 1308 and 1317).

Table 1 - Revised amino acid standards for lactating sows and finishers.

| | Lactating sows | | Finishers, 30-105 kg | |
|--|--|-------------|---------------------------------------|-------------|
| | Gram standardised digestible per FUsow | % of lysine | Gram standardised digestible per FUgp | % of lysine |
| Lysine | 6.6 | 100 | 7.7 | 100 |
| Methionine | 2.1 | 32 | 2.4 | 31 |
| Methionine + cystine | 4 | 60 | 4.5 | 58 |
| Threonine | 4.3 | 65 | 5.1 | 66 |
| Tryptophan | 1.3 | 20 | 1.54 | 20 |
| Isoleucine | 3.7 | 56 | 4.5 | 58 |
| Leucine | 7.6 | 115 | 7.9 | 102 |
| Histidine | 2.6 | 39 | 2.8 | 61 |
| Phenylalanine | 3.6 | 55 | 4.7 | 61 |
| Phenylalanine + tyrosine | 7.5 | 113 | 8.9 | 116 |
| Valine | 5 | 76 | 5.4 | 70 |
| Min. standardised digestible crude protein | 110 | | 120 | |

Grinding

Research has led to the belief that it is possible to grind liquid feed more coarsely than dry feed without jeopardising the feed conversion due to fine grinding taking place during the fermentation process. This was investigated on a finisher farm with liquid feed mixed on-farm. The trial comprised two groups; one group with finely ground grain (72% particles below 1 mm) and one with coarsely ground grain (40% particles below 1 mm).

Results revealed that fine grinding improved the production value per place unit/year compared with coarse grinding. The improvement was primarily attributed to increased daily gain and improved feed conversion observed with fine grinding.



Recommendations for grinding do not differ between liquid feed and dry feed.

The overall occurrence of gastric changes was low on this farm, but increased incidences were observed for pigs fed finely ground grain.

Based on this outcome, it is recommended that grain used in liquid feed

– as with dry feed – be finely ground to achieve the best possible feed conversion ratio. However, the grain must not be so finely ground that the gastro-intestinal is adversely affected.

For more information, see “Publikationer” at www.vsp.lf.dk (trial report no. 981).

The project was financially supported by the Pig Levy Fund and the Ministry of Food, Agriculture and Fisheries of Denmark, and The European Agricultural Fund for Rural Development. Journal no. 3663-U-11-00181.

Enzymes

When added to dry feed, xylanase, which is a carbohydrate-splitting enzyme, activates enzymes when pigs eat the feed whereby NSP (fibre) are decomposed. In liquid feed, enzymes may be activated in the feed before the pigs eat it thereby overall increasing the effect on feed conversion ratio.

The outcome of a lab trial where feed was fermented for 4 or 8 hours, respectively – with or without the addition of xylanase – showed that:

- Enzyme activity of xylanase was sustained
- The addition of xylanase to liquid feed did not affect the decomposition of total NSP content

Though no effect of xylanase was recorded in liquid feed, the enzyme activity in the pig should remain due to full enzyme survival. Consequently, the effect of xylanase is expected to be identical in liquid feed and in dry feed.

The project was financially supported by Green Development and Demonstration Programme. Journal no. 3405-10-0098.

Regulation of eating time

When finishers are fed liquid feed restrictively, it is crucial in terms of production results that the feeding curves match the production level of the farm to ensure that the pigs are fed neither too much nor too little feed.

On many farms, it is a challenge to determine the optimum feeding curve and manage the daily regulation of feed. A system that automatically regulates feeding based on the eating time of the pigs may be a helpful tool in overcoming this challenge.

The use in practice of such a system from Big Dutchman was investigated on one farm. The system records how long it takes for the pigs to eat the feed in each trough; by comparing this with the actual period of time planned for eating, the amount of feed required at the next feeding is calculated.

Experiences showed that the system worked satisfactorily. With this system, the time normally spent on checking if the amount fed in each pen is adequate is saved. Furthermore, all pigs are assured of the right amount of feed throughout the entire growth period.

The system is currently being used in a trial aimed at determining the optimum feed ration at the beginning of the finisher period.

The project was financially supported by the Pig Levy Fund and the Ministry of Food, Agriculture and Fisheries of Denmark, and The European Agricultural Fund for Rural Development. Journal no. 32101-U-12-00195.

Rye for weaners and finishers

As feed prices continue to rise, the search intensifies for alternative ingredients to improve feed conversion ratio at the lowest possible costs. Rye is a high-yielding crop on sandy soil with low cultivation costs, and may therefore be such an alternative.

Pig Research Centre therefore investigated the effect of rye in feed for weaners and finishers. The effect of 20%, 40% and 60% rye in weaner feed was investigated whereas in finisher feed, the effect of 40% rye was investigated. Productivity levels of weaners as well as finishing pigs were compared with rations without rye.

| Difference compared with control | | | |
|----------------------------------|-------|----------|---------|
| Rye, % | g/day | FUgp/day | FUgp/kg |
| Weaners | | | |
| 20 | - 20 | - 0.05 | - 0.01 |
| 40 | - 69 | - 0.11 | + 0.03 |
| 60 | - 87 | - 0.12 | + 0.08 |
| Finishers | | | |
| 40 | - 60 | - 0.13 | +0.04 |

Productivity of both weaners and finishers dropped when the feed contained rye; this was primarily attributed to lower feed intake and daily gain. However, finishers had a higher lean meat percentage. The content of ergots of rye in the batches used was so low that the total content of the diet containing 60% rye was far below the maximum ergot level of 500 ppm.

How much cheaper than wheat must rye be per 100 kg to be profitable for use in pig feed?

- DKK 20 with an inclusion rate of 20% rye in feed for weaners
- DKK 10 with an inclusion rate of 40% rye in feed for finishers

For more information, see "Publikationer" at www.vsp.lf.dk (trial report no. 964).

The project was financially supported by the Pig Levy Fund and the Ministry of Food, Agriculture and Fisheries of Denmark, and The European Agricultural Fund for Rural Development. Journal no. 32101-U-12-00227.

Cleaning of grain

Cleaning of grain in connection with grinding of grain for livestock feed has become increasingly common in recent years. Pig Research Centre therefore tested three grain cleaners from Big Dutchman, Skiold and Øgendahl Maskinfabrik, respectively.

Results showed that:

- Cleaning ability did not differ between the three brands
- At medium speed, averagely 61% of the impurities was removed
- At high speed, averagely 48% of the impurities was removed
- Cleaning the grain did not reduce the content of toxins and harmful microorganisms
- As variations are great, it is required to make multiple microbiological analyses. Thus, this is not an appropriate method for this purpose.
- Energy content in the cleaned product averaged 71 FUgp per 100 kg.

Although cleaning does not eliminate all impurities and although neither the toxin content nor the microbiological quality were affected, using a grain cleaner will reduce the wear and tear of the grinding equipment and is thereby still expected to be a good investment.

For more information, see "Publikationer" at www.vsp.lf.dk (report no. 1317).

The project was financially supported by the Pig Levy Fund and the Ministry of Food, Agriculture and Fisheries of Denmark, and The European Agricultural Fund for Rural Development. Journal no. 3663-U-11-00181.



Pig Research Centre tested three different grain cleaners: results showed that cleaning ability did not differ. The above screen cleaner from Øgendahl Maskinfabrik was one of the three tested cleaners.

Variations in home-grown grain

Many pig producers ask themselves if routine analyses of home-grown grain are in fact necessary.

To answer this question, samples were collected routinely during emptying of four silos: three oxygen-free silos (two with wheat, one with rye), and one silo fitted with a stirrer contained wheat and rye. Samples were analysed for water, crude protein and phosphorus contents. It was subsequently concluded that the content of water, crude protein and phosphorus in home-grown wheat and rye varies so little that there is no need for routine analyses.

For more information, see "Publikationer" at www.vsp.lf.dk (report no 1318).

The project was financially supported by the Pig Levy Fund and the Ministry of Food, Agriculture and Fisheries of Denmark, and The European Agricultural Fund for Rural Development. Journal no. 3663-D-11-00509.

Corn in dry feed

Corn cultivated in Denmark is typically used in liquid feed diets as corn is fairly wet when harvested, i.e. the water content is higher than the optimum level of 38-40%. Advisors and pig producers

are therefore asking for information on whether corn silage can be used in dry feed. Thereby it might be possible for pig producers using dry feed and owning land in warm areas to benefit from the high yield of corn. This was further investigated on a farm where wet, corn silage was included in dry feed in increasing amounts for a short period in the winter. The corn used was very wet; it had a water content of 50%. The texture of the corn made it impossible to convey it by auger.

An inclusion of 20% silage corn in dry feed led to a water content of 20.4% in the finished diet and this led to clogging of the feed in the silo storing the finished feed. This, however, may be prevented if the silo is equipped with a stirrer. Feeders with stirrers were seen to function well, while in feeders without a stirrer additional adjustments were necessary when the feed contained 20%+ corn silage.

Small clots may form in the feed as the high content of water may lead to dust and feed remnants absorbing some of this water. Mould fungus may develop from this clogging, and pig producers must therefore pay close attention to the feed hygiene and realise that the need for cleaning may increase.

The experience obtained in this pilot trial may provide inspiration to others; however, at this early stage, no actual recommendations were made as this was only a pilot study.

For more information, see "Publikationer" at www.vsp.lf.dk (report no. 1319).

The project was financially supported by the Pig Levy Fund and the Ministry of Food, Agriculture and Fisheries of Denmark, and The European Agricultural Fund for Rural Development. Journal no. 32101-U-12-00227.

Feed-Field system

Feed-Field system is a new tool developed by the Knowledge Centre for Agriculture and Pig Research Centre for analysis of feed and field economy.

With this program, it is possible to analyse the outcome of different scenarios; compare alternative feed plans; and simulate how these will affect the potential field plan. For each scenario, the economy in both field operations and the pig facility is calculated.

The program is based on a range of feed formulations according to which the overall amount of feed required is determined and an appropriate field plan is automatically prepared.

The program is fitted with a range of standards for feeding, yields and machinery costs that can all be adapted to each farm. This includes the module "Mark & Maskiner". The program is capable of making detailed calculations, which take account of the different machinery costs of each farm.

This tool may be a good starting point when evaluating alternative feeding strategies, since with just a few clicks, a potential profit may be revealed. Pig Research Centre recommend that the tool be used in cooperation with the local pig and crop production advisor. The program is available at www.landbrugsinfo.dk where more information is also available.

Management of on-farm mixing
This tool will help improve the quality and optimise on-farm mixing routines.

In cooperation with local pig advisors and select pig producers mixing their own feed, guidelines and checklists have been made.

The project demonstrated that 'Management of on-farm mixing':

- Is easy to use
- Helps create overview and security
- Optimises ingredients and diets and the use of them
- Uncovers hidden errors
- Facilitates stable, high production
- Ensures correct feed calculations

For more information, see "Viden" at www.vsp.lf.dk (only available in Danish).



The new Bygholm 2 sieve was developed and tested during the demonstration project 'Management of on-farm mixing'. For more information, see "Publikationer" at www.vsp.lf.dk (report no. 1304).

The project was financially supported by the Pig Levy Fund and the Ministry of Food, Agriculture and Fisheries of Denmark, and The European Agricultural Fund for Rural Development. Journal no. 3663-D-11-00509.

Analysis of finished feed

In 2013, Pig Research Centre made an analysis of the declared content of energy and select nutrients in pig diets from six compound feed suppliers

- ATR
- DLG
- Danish Agro (DA)
- HEDEGAARD Agro (HED)
- Hornshyld Købmandsgaard (HK)
- Vestjyllands Andel (VA)

Overall, the diets contained the content of feed units (FU) as declared with the exception of the feed from Danish Agro that contained on average one feed unit less than declared.

| Compound feed producer | Feed units, declared/ 100 kg | Feed units, analysed/ 100 kg |
|------------------------|------------------------------|------------------------------|
| ATR | 105.3 | 105.1 |
| DLG | 101.7 | 101.3 |
| DA | 103.1 | 102.1 |
| HED | 106.7 | 107.5 |
| HK | 105.3 | 105.0 |
| VA | 103.7 | 104.1 |

The guaranteed content of lysine, methionine and threonine (threonine was only declared in diets from HEDEGAARD) were on average met in all samples.

Ninety samples were analysed; a phytase deficiency of more than 30% was only found in two samples – both from Vestjyllands Andel. All other samples contained more phytase than declared.

For more information, see “Publikationer” at www.vsp.lf.dk (report no. 1313).

The project was financially supported by the Ministry of Food, Agriculture and Fisheries of Denmark, and The European Agricultural Fund for Rural Development. Journal no. 3663-D-12-00227.

Analysis of mineral diets

In 2013, Pig Research Centre also made an analysis of the declared content of calcium, phosphorus, phytase, free lysine and free methionine in mineral diets from four feedstuff producers:

- Vilomix
- Vestjyllands Andel
- Nutrimin
- Vitfoss

Sixteen different mineral diets from each company were analysed in the study.

Results demonstrated that all diets contained the levels of calcium, phosphorus, phytase, lysine and methionine shown on the declaration.

The content of phytase was significantly higher than guaranteed in all the diets.

For more information, see “Publikationer” at www.vsp.lf.dk (trial report no. 976).

Analysis of amino acids

In 2010, laboratory trials in which mineral diets were weighed and mixed correctly demonstrated 100% recovery of free lysine, methionine and threonine, while a 10-20% deficiency of free tryptophan and valine was found.

In a recent laboratory trial, it was investigated if deficiency was affected by the composition of the mineral diet or by the analysis method used. Free valine and tryptophan were analysed in diets with and without calcium carbonate and benzoic acid. Free tryptophan was subject to four different analysis methods.

Regardless of the composition of the mineral mix and analysis method, results showed deficiencies of 0-5% in free valine and of 10-15% in free tryptophan. Free tryptophan and free valine are thereby lost in the analysis process. The new analysis method did not improve analysis accuracy.

The project was financially supported by the Ministry of Food, Agriculture and Fisheries of Denmark, and the European Agricultural Fund for Rural Development. Journal no. 32101-U-12-00195.

Butirex VFA C4

Trial results revealed improvements in productivity when 0.3% Butirex VFA C4 (butyric acid) was added to weaner feed. The cost of adding Butirex VFA C4 to the feed amounted to approx. DKK 6 per 100 kg feed, and this was more than covered by the increase in productivity. Daily gain increased by approx. 30 g (7%) and FCR improved by 0.04 FUgp/kg (2%).

Similar effect was found in other Danish trials with different organic acids. Butirex VFA C4 is therefore a profitable alternative when the price is competitive compared with other organic acids.

For more information, see “Publikationer” at www.vsp.lf.dk (trial report no. 971).

The project was financially supported by the Ministry of Food, Agriculture and Fisheries of Denmark, and the European Agricultural Fund for Rural Development. Journal no. 3663-D-12-00227.



Butirex VFA C4 (butyric acid) improved weaner productivity.

Feedstuff database

When EU commission regulation no. 68/2013 on the Catalogue of feed materials was introduced on August 19, 2013, several common protein feed materials changed names; for instance, soybean meal is now called "soy (bean) meal feed" and sunflower meal is now "sunflower seed meal".

Pig Research Centre's feedstuff database is updated in accordance with this, and the nutrient content of the ingredients in the database is updated in collaboration with the feedstuff industry.

For more information, see "Publikationer" at www.vsp.lf.dk (brief no. 1322).

The project was financially supported by the Ministry of Food, Agriculture and Fisheries of Denmark, and The European Agricultural Fund for Rural Development. Journal no. 32101-U-12-00195.

Digestibility trial

In cooperation with the Department of Animal Sciences, University of Illinois, Pig Research Centre determined the standardised ileal digestibility of protein and amino acids fed to the weight interval 9-20 kg. The products comprised:

- HP 300
- Vilosoy
- AlphaSoy PIG 530
- Imcosoy
- Dehulled soy bean meal
- EP 100 (dehulled rapeseed protein)
- Scanola rapeseed cake

When results are available, the feedstuff database will be updated accordingly. The results will make the evaluation of each protein feedstuff more accurate during feed formulation.



A pig fitted with a fistula at the end of ileum for determination of standardised ileal digestibility of protein and amino acids in different soybean and rapeseed products. The outcome will improve the evaluation of feedstuffs.

The project was financially supported by Hamlet Protein A/S, Dansk Vilomix A/S and the Ministry of Food, Agriculture and Fisheries of Denmark, and the European Agricultural Fund for Rural Development. Journal no. 32101-U-12-00195.

Fusarium toxins

Pig Research Centre contribute to screening of select Fusarium toxins in wheat - a screening that also includes a small number of other varieties of grain. Overall, Fusarium toxins were found in a large number of samples, but only few samples had levels so high that - according to the EU limit values - the grain could not be used in pig feed.

Several factors may increase the risk of Fusarium toxins developing in grain:

- Rain when wheat is flowering
- Corn as precrop
- Reduced tillage combined with grain as precrop

Selecting a resistant variety may reduce the risk of toxins developing.

The project was financially supported by the Ministry of Food, Agriculture and Fisheries of Denmark, and the European Agricultural Fund for Rural Development. Journal no. 32101-U-12-00195.

Iodine value in feed and fat

Pig Research Centre, Danish Meat Research Institute and Danish Crown are currently investigating the maximum iodine value in fat when taking quality and the corresponding maximum iodine value in feed into consideration. Research made by Pig Research Centre has established a direct correlation between the iodine value contribution in feed and the iodine number in fat. It is essential in this investigation that analyses of fatty acids and iodine value are accurate and do not vary considerably – measured in dietary fat and in back fat.

Analyses made by six different laboratories demonstrated satisfactory accuracy for fatty acid profiles and iodine value based on the fatty acid profile. Only a slight analytical inaccuracy in variations between feedstuffs and pigs were found. Consequently, an accurate iodine value can be established with just a few analyses of a batch of feed.

A model will soon be available for determining the iodine value contribution of a diet, and Pig Research Centre expect that the maximum iodine value in fat in terms of consumer demands will soon be determined.

General recommendation

The Commission recommends that new environmental regulation of livestock production should be introduced to benefit the farming as well as the aquatic environment, nature and the climate.

In this process, society and green interest groups must accept that farming – like all other industries – must be allowed to develop and grow. Correspondingly, farming must acknowledge that society argues for a diversified nature and a clean environment.

Future regulation must, to a greater extent, pursue meeting the objectives set for the environment and nature rather than imposing restrictions on food production. Greater transparency and flexibility are also necessary to allow farmers to organise the spreading of fertiliser, cultivation practices and livestock production whilst still complying with all environmental requirements.

New regulations for livestock production

Today, livestock production is environmentally regulated via general rules and specific conditions laid down in the associated environmental approval. In the approval, production scope is stifled, i.e. even small changes must be reported and permission or approval obtained from the authorities.

The Commission propose a new regulation where approval of a livestock facility no longer restricts the number of animals produced, but is rather written as an emis-

sion permit (emission limit) for significant impacts on nature and environment. It is also proposed that the use of fertiliser on these areas be regulated separately from the livestock approval unlike present common practice.

Emission-based regulation will lead to more flexibility within the framework of an environmental approval. It must be possible for livestock farmers to benefit from new technologies and through genetic progress provided the emission limits stipulated are met.

Proposals for actions

- Regulation of livestock farming must be based on actual emissions
- Areas for spreading of livestock manure must be regulated through an independent, separate regulation system
- In relevant legislation in environment and farming, animal welfare evaluation must be put on the same footing as evaluation of other conditions related to nature and environment
- New dedicated and differentiated regulation of all nitrogen application on the areas
- New dedicated and differentiated regulation of all phosphorus application similar to nitrogen

National ammonia regulation

In spring 2011, new ammonia regulations were adopted that were even stricter than the basis in the Directive on the conservation of natural habitats and of wild fauna and flora.

Particularly in terms of category 3 nature, it must today be specifically assessed whether a certain requirement needs to be imposed. In accordance with legislation, the requirement must not be more restrictive than 1 kg N/ha/year in excess deposition. However, for category 3 nature, in local administration practices it is rather the rule than the exception to demand max 1 kg N/ha/year in excess deposition in relation to nearby nature. In addition, regulation of category 2 nature is alarmingly restrictive seen in the light of the failure to follow up with actual action plans or funds dedicated to improving the virgin areas. For instance, it is not possible to ease the requirements made for targeted tending of areas such as heaths and open grazing land. There is, furthermore, no scientific reason for a restrictive practice that fails to take into account the overall drop in nitrogen deposition. As shown in Table 1, it will be highly difficult to find investment-proof locations for extending or setting up livestock production units. The Commission elected not to take a position on this.

In future political negotiations, this will be a central issue for the agricultural industry in the discussions on how to ensure a better – and more – nature with a high level of biodiversity. Future regulation must be based on an overall assessment, which also takes into consideration areas where not all nature necessarily requires the same high level of protection as that needed on a particularly environmentally sensitive livestock site.

Table 1 - Calculated distance requirement to ammonia sensitive nature based on a new finisher site with 6,000 place units (24,000 produced annually).

| Nature vulnerable to ammonia, estimated distance requirement | Specific ammonia requirement | General BAT requirement 0.22 kg NH ₃ -N/pig 5,280 kg NH ₃ -N/year | Possible with slurry acidification 0.15 kg NH ₃ -N/pig 3,600 kg NH ₃ -N/year |
|--|--------------------------------|---|--|
| Category 1: Natura2000 | 0.7 N/ha/year (1 farm) | 595 m | 490 m |
| | 0.4 N/ha/year (2 farms) | 790 m | 660 m |
| | 0.2 N/ha/year (> 2 farms) | 1,170 m | 945 m |
| Category 2: Large heaths/open grazing land | 1 kg N/ha/year (total impact) | 495 m | 410 m |
| Category 3: §3 nature, vulnerable forest | 1 kg N/ha/year (excess impact) | 495 m | 410 m |

Outdoor and ten-year weather data

Today, calculations of nuisance limits for odour are based on one-year weather data from Copenhagen airport.

However, modern computers today make it possible to calculate ten-year weather data hour by hour. This method is very accurate, which makes it possible to interpret the nuisance limit for odour much more sharply than in the current conservative interpretation (see Figure 1).

Particularly in northerly and southerly directions, the nuisance limit may be reduced by up to 50%, whereas in easterly and to a certain degree westerly directions the limit typically remains unchanged in as far as the current calculation in the IT application system is concerned.

The Danish Environmental Protection Agency ruled that the IT application system will be based on one-year weather data. However, in situations where it is estimated that a sharp interpretation of the nuisance limit would lead to changes in approval conditions it, became possible in autumn 2013 to substitute the one-year calculation for a new one based on a decade of weather data.

Standard values used for reporting changes

The scheme for reporting changes in livestock type and “full pig houses 2”, which concern environmental approvals granted after January 1, 2007, is based on calculating the environmental impact using the latest standard values for content of nitrogen and phosphorus in pig manure.

In terms of reporting changes in livestock type, there are only few implications. On October 1 every year standard values used in environmental calculations are updated on the website husdyrgodkedelse.dk when the environmental impact before and after is calculated using the same new standard values.

However, in terms of reporting extensions under “full pig houses 2”, the options may vary considerably from year to year depending on the development in the national average as the extension is based on utilising the environmental progress compared with standard values from 2008/09.

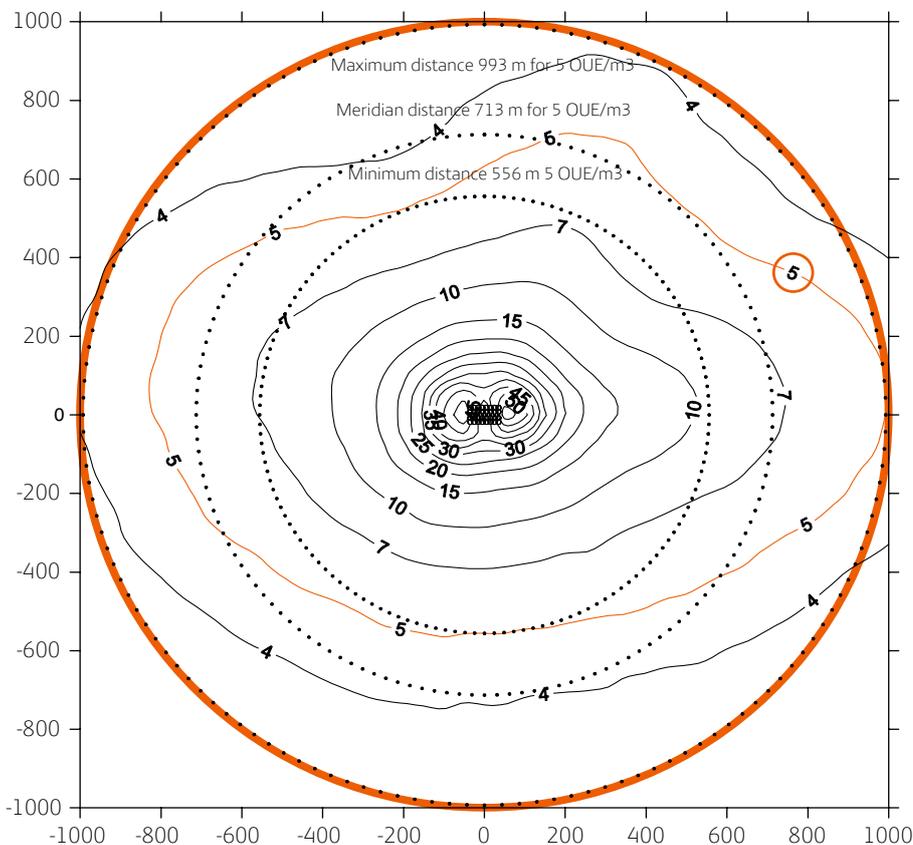
According to the latest standard values, N and P content have increased slightly in pig manure and as from October 1, 2013, this actually halves the possibilities for extensions compared with the year before for weaners and finishers, whereas for sows it is not possible at all to make any extensions under this scheme (see figure 2).

To benefit fully from the scheme “full pig houses 2”, it is essential that the national average for crude protein and phosphorus in pig feed be kept as low as possible.

For finishers, phosphorus is the most limiting factor.

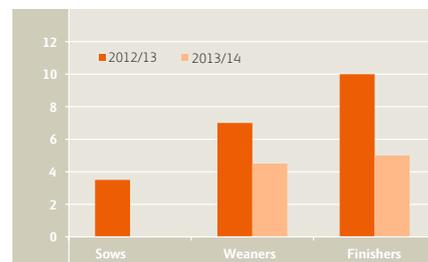
Since the possibilities for extensions have slimmed since October 1, 2013, farm owners may consider waiting one year before reporting extensions of their production, but there are no guarantees that conditions will have changed for the better next year.

Figure 1



Calculations of nuisance limits for odour are based on typical wind directions over a year. The bold orange circle illustrates the conservative interpretation of nuisance limits for odour in urban zones (5 OUE/m³). The thin orange line illustrates the consequence of a sharp interpretation of the nuisance limit for odour.

Figure 2 - Extension possibilities for “full pig houses 2” before and after October 1, 2013.



Ventilation principle

With “point extraction” the main source of odour and ammonia emissions from a pig building is collected in a very small amount of air that is subsequently cleaned. Combined with air cleaning, point extraction permits cost-efficient reductions of odour and ammonia from pig housing.

Research activities at Grønhøj Experimental Station demonstrated that approximately 70% of ammonia emissions and approximately 50% of odour emissions from the pig house were collected in an amount of air that corresponded to 10% of the ventilation capacity. The remaining part of the air from the pig house was extracted through suction units placed in the ceiling.

Emission of ammonia and odorants primarily comes from slurry in the slurry pits. Extraction of part of the air from this area reduced the concentrations in the room, which improved the working environment for the staff. In addition, point extraction of air improves the ventilation efficiency in the pens.

Point extraction

In pig facilities, the highest concentrations of ammonia and odour are found in the slurry pit or close to the lying area, which is why the suction point in point extraction systems is placed there.

At the Agromek fair in 2012, this ventilation principle was awarded three-star EU novelty status. Pig Research Centre have conducted full-scale testing in different types of pig accommodation for a year to document the effect of point extraction with the aim of the technology being accepted on The Technology List in combination with air cleaning.

Finisher facilities

Full-scale point extraction was tested in three finisher facilities. Results showed

that in a finisher unit with drained floor in the lying area 65% of ammonia emissions and 47% of odour emissions were removed through the point extraction system.

Results of full-scale testing of the point extraction system thus correspond with the outcome of finisher trials made at Grønhøj Experimental Station.

Partial cleaning

Ventilation requirements vary with the changing seasons. Consequently, by cleaning the first 20% of the ventilation capacity (corresponds to cleaning of all ventilation air from the pig house for 40% of the time), the total ammonia emissions from the pig house drop by 65%.

With point extraction, it is sufficient to direct 10% of the ventilation capacity through the air cleaner, which reduces ammonia emissions by 60%. Point extraction makes it possible to reduce costs for air cleaning by 30-40% and thereby ensure a more cost-efficient reduction of odour and ammonia emissions from the pig house.

Gestation facilities

Results of testing of point extraction in a gestation unit with electronic sow feeding

(ESF) showed that 58% of ammonia emissions and 53% of odour emissions were removed through the point extraction system.

In this type of pig house, 14% of the maximum ventilation capacity was extracted through the point extraction system.

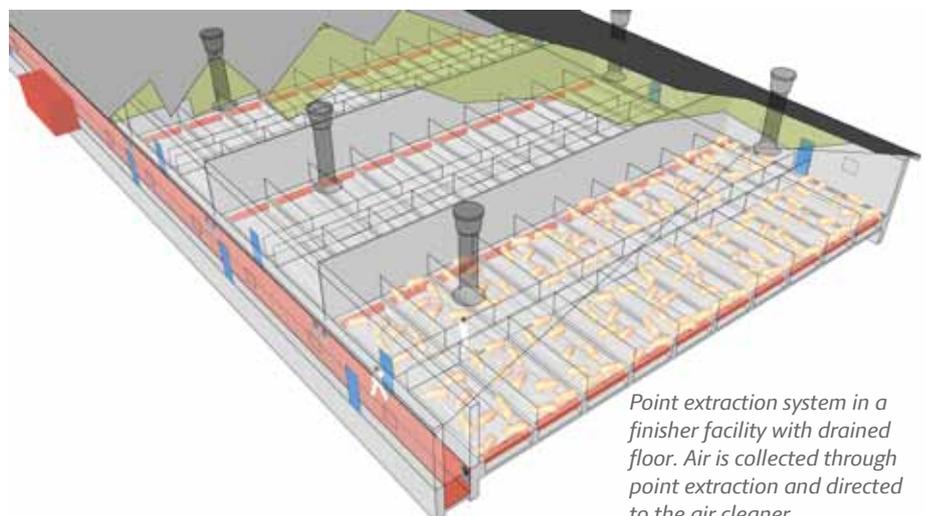
Farrowing facilities

Pig Research Centre are currently testing the effect of point extraction in a farrowing facility that consists of traditional farrowing pens and partly solid floor. Ten per cent of the maximum ventilation capacity is extracted through the point extraction system. Preliminary results of recordings made during the summer show an effect similar to that found in finisher facilities.

Existing facilities

When environmental approvals are re-evaluated, implementation of environmental technologies may be one of the requirements made.

Pig Research Centre are currently studying the effect of point extraction that is installed in an existing finisher unit with a solid floor covering two thirds of the overall floor area. One of the aims is to analyse the percentage of ammonia and odour that can be removed through the point extraction system when installed in an existing pig facility.



Point extraction system in a finisher facility with drained floor. Air is collected through point extraction and directed to the air cleaner.



Installation of nozzles and cross-over flue in a gestation house with electronic sow feeding. The channel for point extraction is placed just below the solid floor by the transition to the slurry pit.



Dimensioning

Getting the specification correct is essential to create an efficient ventilation system, and for this purpose the software program “Staldvent” is often used.

Pig Research Centre are currently measuring the elements included in point extraction systems with the aim of validating and, if necessary, revising the current specification guidelines. The guidelines will also include recommendations for pipe dimensions, where to place suction units etc. in a given type of pig house. Furthermore, an update of Staldvent will make it possible to specify dimensions for the ventilation system in the program based on values obtained by Pig Research Centre.

Additional air intake

The effect of the point extraction system depends on the location of ceiling inlets installed as additional air intake in pig houses with diffuse ventilation. At Grønhøj Experimental Station, Pig Research Centre are currently investigating the effect of point extraction when ceiling inlets are placed by the back wall combined with 90% opening of the valve flap, i.e. the air current is led directly into the lying areas. However, this strategy requires that the pigs use the drained area by the back wall as lying area.

The project was financially supported by the Green Development and Demonstration Programme. Journal no. 3405-10-0172.

The project was financially supported by the Pig Levy Fund and the Ministry of Food, Agriculture and Fisheries of Denmark, and The European Agricultural Fund for Rural Development. Journal no. 32101-U-13-00235.

Environmental technology for pig housing

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 manufacturers of environmental technologies and pig producers and at Grønhøj Experimental Station where modern trial facilities are available for research and development purposes.

Below, outlines of various research activities relating to mature technologies are presented followed by research and development activities on products not yet ready for sale. Table 1 presents the environmental technologies for pig housing currently on The Technology List of the Danish Environmental Protection Agency and lists the technologies available for reducing odour and ammonia (NH₃) emissions from farming.

Cooling of slurry

Cooling of slurry in the slurry pits is accepted on The Technology List since it reduces ammonia emissions by up to 30%. As a general rule, ammonia emissions drop by approximately 10 percentage points for each 10 W/m² slurry pit that is cooled. During cooling, heat is generated that can be used in other sections or for other purposes on the farm.

At Grønhøj Experimental Station, ammonia emissions dropped by 51% when

slurry was cooled with 55 W/m² slurry pit thereby confirming the theoretical correlation between cooling effect and ammonia reduction.

Acidification of slurry

A large part of ammonia emissions from pig housing originate from slurry. Research shows that ammonia emissions drop by approximately 70% when slurry is acidified with sulphuric acid at pH 5.5. This is infused once a day in a tank outside the facility and subsequently returned to the slurry pits.

An acidification system from Jørgen Hyldgaard Staldservice was tested on two farms; results showed that ammonia emissions dropped annually by 71% from the finisher facility.

The acidification system NH₄⁺ from Infarm A/S is temporarily accepted on The Technology List with 70%. Pig Research Centre are currently testing the system to document environmental effects and operational costs.

Chemical air cleaning

Chemical air cleaning can be used for reducing ammonia emissions from pig housing; the outlet air from the facility is cleaned with water acidified with sulphuric acid to a pH level between 2 and 2.5.

Based on tests on two farms, a vertical air cleaner from Munters A/S is temporarily accepted on The Technology List with

an ammonia reduction of 90%. The air cleaner has a capacity of 25,000 m³/hour.

On one farm, the test was performed at 60% partial cleaning, i.e. cleaning of the first 60% of the maximum ventilation capacity corresponding to cleaning of around 85% of all outlet air annually. On the other farm, all ventilation air from 240 place units was cleaned in the air cleaner.

Costs for electricity, water and acid at full cleaning where 90% of all ammonia was removed amounted to DKK 19.8 per finished pig. In comparison, at 60% partial cleaning where approximately 80% of all ammonia was removed costs amounted to DKK 9.4 per finished pig produced.

A horizontal air cleaner from Munters A/S that functions along the same principles as the vertical air cleaner is currently being tested.

MHJ Agroteknik A/S are marketing a chemical air cleaner originally developed by ScanAirClean A/S. This air cleaner is temporarily accepted on The Technology List. For the air cleaner to remain on the list, additional documentation is required according to the VERA protocol. Pig Research Centre are currently testing the air cleaner.

Biological air cleaning

In biological air cleaning, outlet air is washed whereby ammonia and odorants are metabolised by bacteria in the air cleaner.

Rotor A/S are marketing a Dutch air cleaner from Dorset Millieutechniek B.V. Analyses at a German laboratory demonstrated a reduction in odour of 74%. The air cleaner is currently accepted on The Technology List with 40% odour reduction and minimum 70% reduction in ammonia emissions.

SKOV A/S have 2 two-step biological air cleaners: Farm AirClean BIO module and Farm AirClean BIO Flex. Both are temporarily accepted on The Technology List with a reduction in odour of 73% and at least a 70% reduction in ammonia emissions.

Table 1 - Environmental technologies for pig housing accepted on The Technology List of the Danish Environmental Protection Agency as of August 24, 2013.

| Technology | Brand | Ammonia % | Odour % |
|-------------------------|---|--|---------|
| Cooling of slurry pit | | < 30 | - |
| Acidification of slurry | NH ₄ ⁺ (Infarm A/S) | 70 | - |
| | JH Forsuring NH ₄ ⁺ | 71 | - |
| Chemical air cleaning | Munters TLV-A (Munters) | 90 | - |
| | ScanAirClean (MHJ Agroteknik A/S) | 90 | - |
| Biological air cleaning | Farm AirClean BIO Flex 2-step (SKOV A/S) | >70 % (NH ₃ out: 1 - 2 ppm) | 73 |
| | Dorset Biological Combi Air cleaner (Rotor A/S) | >70 | 40 |



Horizontal air cleaner from Munters A/S

The project was financially supported by the Pig Levy Fund and the Ministry of Food, Agriculture and Fisheries of Denmark, and The European Agricultural Fund for Rural Development. Journal no. 3663-U-11-0184.

VERA

VERA is a joint Danish, Dutch and German scheme for certification of environmental technologies for farming. The aim is for the same documentation to be applicable for approval of environmental technologies in all three countries. The environmental authorities in these countries collaborated on trial protocols for testing of environmental technologies. These protocols stipulate

- How to perform testing
- How many recordings are required
- Which methods are acceptable

The protocols are being evaluated by Pig Research Centre since researchers there

apply the VERA protocols for testing environmental technologies for both livestock housing and air cleaning systems.

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.

Air cleaning with alkaline water

Together with Munters A/S, Pig Research Centre studied the effect on ammonia and odour emissions of combining alkaline water and acid in a chemical air cleaner.

A two-step prototype was tested at Grønhøj Experimental Station; results revealed that odour emissions decreased by 39% and ammonia emissions decreased by 67% when the outlet air was washed in alkaline water (pH 10) followed by acidified water (pH 2).

The project was financially supported by the Innovation Act and Munters A/S and Bioscent I/S. Journal no. 3412-10-02822.

More frequent emptying of slurry

Studies investigating the frequency of emptying of slurry indicate that odour emissions from a finisher facility may be reduced by more than one third if slurry is emptied once a week rather than once every six weeks. An increased frequency of emptying may thereby be a cheap and efficient solution for reduction of odour emissions. Frequent slurry emptying was studied on three farms, and results showed no effect on ammonia emissions.

Separation of acidified slurry

At Grønhøj Experimental Station in cooperation with Infarm A/S acidified slurry was separated daily before pH was regulated with sulphuric acid. The aim was to reduce odour as well as ammonia emissions.

The project is financially supported by Erhvervsudviklingsordningen and Infarm A/S. Journal no. 3663-U-10-00150.

Other slurry treatment

Slurry sticks (Power Packs) from Biotech Innovation ApS were tested in the climate chambers at Grønhøj Experimental Station. No effect was found on odour and ammonia.

Sow well-being

Gilts and sows are housed in groups for the main part of the production cycle and Pig Research Centre have therefore analysed a number of factors important to group-housed gilts and management of group-housing.

Longevity

The percentage of sows that only manage to deliver one litter varies greatly between Danish farms.

Young sows are overrepresented among culled sows, and it is therefore crucial to pay attention to low-ranking sows which tend to be the younger sows

Socialisation

Research showed that sows, which as gilts, had been housed with older, bigger sows did not deliver more litters than sows that had not been socialised with more dominant pen mates.

However, having learnt to cope among older sows, the young sows within a mixed group spent less time during their first gestation on the slatted floor than the young inexperienced sows. The gilts already accustomed to older sows spent 20% of their time on the slats whereas those without previous experience were on the slats for 27% of the time.

Lying behaviour was unaffected by socialisation if the young sows were housed in a gilt pen in the first gestation.

For more information, see "Publikationer" at www.vsp.lf.dk (trial report no. 961).

The project was financially supported by the Pig Levy Fund and the Ministry of Food, Agriculture and Fisheries of Denmark, and The European Agricultural Fund for Rural Development. Journal no. 3663-D-09-00368.



It is recommended that insemination pens should be designed with drained, bedded straw mats; this improves the non-skid ability of the floor. Straw consumption averages 150 kg/place unit/year.

Insemination pens with group-housing

Behavioural studies were carried out on three farms with sows housed in groups in the insemination unit. The knowledge generated by these studies will form the basis of future trial activities. The pens on these farms had drained flooring, bedded straw mats in the activity area and free access to feeding/insemination stalls.

Results demonstrated that 27% of the sows did not engage in any mounting of pen mates on the two days of observation (days 3 and 5 post-weaning); 42% engaged in mounting on one of the days and 31% engaged on both days.



During oestrus, primarily the old sows mounted the young sows.

Mounting activity was more than twice as high on day 5 post-weaning than on day 3 post-weaning. The percentage of rejected mounts was highest on day 3 post-weaning.

In reaction to mounting attempts, most sows preferred to remain in the lying area

(90%), whereas only 10% retreated to the stalls. Approximately 10% developed leg problems 3-7 days post-weaning.

Future research will focus on management and design of insemination pens for group-housed sows and gilts.

For more information, see "Publikationer" at www.vsp.lf.dk (trial report no. 961).

The project was financially supported by the Pig Levy Fund and the Ministry of Food, Agriculture and Fisheries of Denmark, and The European Agricultural Fund for Rural Development. Journal no. 32101-U-12-00197.

Flooring in gestation pens

Two different types of flooring were studied in sow pens with Electronic Sow Feeding and static groups with the aim of reducing the frequency of leg injuries.

Concrete slatted floors were compared with rubber mats or DUO slats in parts of the activity area. Results demonstrated that these materials did not reduce leg injuries; 15-20% of the sows were treated for leg and hoof injuries, and 10% had to be moved to a hospital pen.

Young sows constituted the majority of the sows treated for leg and hoof injuries, which underlines the need for continued research within this area.

Analyses showed that disease treatments and transfers to hospital pens mostly took place during the first two weeks after mixing it is therefore important that grouping takes place on non-skid flooring.

For more information, see "Publikationer" at www.vsp.lf.dk (trial report no. 959).

Feeding stations

The function of four types of feeding stations for ESF was evaluated on visits to herds where each manufacturer was represented.

Feeding stations included in the evaluation:

- Agrisys A/S
Nedap Velos; software: Nedap Velos version 2.3
- Big Dutchman A/S
CallMatic NT; software: P665
- Bopil A/S
ESF 7; software: Farmcontrol
- Skiold A/S
Skiold Datamix ESF; software: Version 2011aD981002800

The feeding stations were evaluated in terms of access for sows, security, provision of feed, hygiene level in the trough, feed wastage, setting options and the information included on the leftover list.

All brands scored “very good” or “good” on all points with the exception of “information included on the leftover list”.

For more information, see “Publikationer” at www.vsp.lf.dk (report no. 1310).

Design of lying area

A study is currently focusing on ways to reduce the amount of fouling in the sows’ lying area in ESF pens. Knowledge generated in this study will subsequently be used for other types of pens.

In pens with only small amounts of fouling, the need for daily cleaning drops; the quality of the air improves; and fewer sows are likely to develop leg injuries from skidding on slippery floors.

The effect of baffle plates installed above the lying area in ESF pens was also investigated: the baffle plates deflected the inlet air down into the lying area/bedded area once the temperature in the room increased to 18°C. However, this did not affect the degree of fouling in the designated lying area.

Currently, three alternative layouts of the lying area are being compared with the layout traditionally used in ESF pens. The sows’

Table 1 - Comparison of four feeding stations (ESF)

| | Agrisys | Big Dutchman | Bopil | Skiold |
|----------------------------|---------|--------------|-------|--------|
| Entry to station | **** | **** | **** | **** |
| Space | **** | *** | **** | **** |
| Access to trough | **** | *** | **** | **** |
| Caking in the trough | **** | *** | **** | **** |
| Feed wastage on floor | *** | *** | **** | **** |
| Collection of feed samples | **** | **** | **** | **** |
| Bridging | **** | **** | **** | **** |
| Time setting | **** | **** | *** | **** |
| Exit from the station | **** | **** | **** | **** |

use of the lying area and the amount of fouling will be recorded throughout 2014.

Straw racks for gestating sows

Five different straw racks were evaluated on a farm with group-housed gestating sows. The straw racks, placed above the lying area, provided bedding on the solid/draind floor and assured the sows of permanent access to rooting and enrichment material. Results show that the further development is required before the racks function appropriately.

The outcome of this study lead to the following recommendations for straw rack design:

- The lower edge of the rack should be placed approximately 1 m above the floor
- The rack should be approx. 40 cm deep
- The rack must be able to hold straw for several days’ use
- The straw should drop down easily and not block the rack
- Width of grating slats should be approx. 4 cm

For more information, see “Publikationer” at www.vsp.lf.dk (report no. 1302).



Examples of layout of lying area in pens with group-housed gestating sows that will reduce fouling in the lying area. Low lying walls will encourage the sows to lie in the bedded area.



Straw rack dispensed approximately 1 m above the floor assuring the sow easy access to straw.

FARROWING PENS – DESIGN AND TECHNOLOGY

HOUSING

Heat in the slatted floor at the time of farrowing

Piglet energy loss is known to drop when heat is installed in the floor at the place of birth. Research showed that piglet survival rates improved when a heat source is embedded in the slatted floor in traditional farrowing pens (Nooyen). Heat behind the sow during farrowing is currently available in the form of flexible radiant heat sources.

The project was financially supported by the Pig Levy Fund and the Ministry of Food, Agriculture and Fisheries of Denmark, and The European Agricultural Fund for Rural Development. Journal no. 3663-U-11-00183.

New heat sources in the creep area

Heat is more evenly distributed with a new type of oblong heating element when compared to traditional heat lamps. Preliminary results of an ongoing trial do not show any effect on behavior among the pigs. Energy use is currently being logged to document whether the energy used per produced litter is lower as expected. The new lamps also take a shorter time to warm-up the creep area than the traditional lamps.

Radiant heat sources integrated in the roof of the creep area currently being tested:

Heat lamps:

- E-heat (Animal care)
- Aniheater with and without light (FutureFarming)

Heat panel:

- Little Flat (Opend)

Techniques for providing additional milk

The vision is that in the future sows will be able to rear more of their own piglets than today and consequently fewer nursing sows will be required. Pig Research Centre are therefore currently testing milk cups

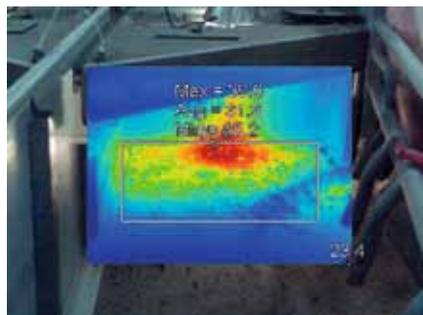
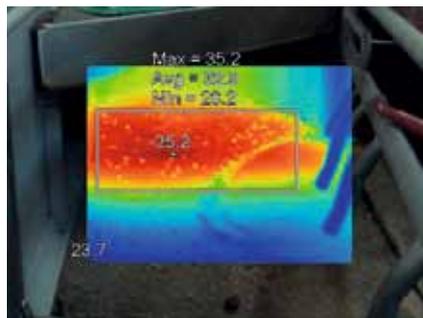
from Dutch producer Provimi. Milk cups are placed on the slatted floor in the farrowing pens and litters are cross-fostered to 18-19 piglets per litter.



Milk cups in farrowing pen. Milk is mixed manually in a tank and warm milk circulates in a central pipeline. A one-way valve in each cup prevents return of milk to the main line.

Farrowing

It is expected that farrowing will conclude faster if sows are loose-housed, which will reduce the risk of piglets suffering from lack of oxygen during birth. This, in turn, will improve piglet survival. At the same time, pig producers wish to crate the sows in the first couple of days after farrowing when piglet mortality rates are known to peak.



Heat is more evenly distributed with a new type of radiant heat source (top) compared with traditional heat lamps (bottom).

Table 1 - Farrowing course for crated sows vs loose-housed sows. Shown as median and 25 and 75% confidence interval (in parenthesis).

| | Crated | Loose |
|-------------------------------|---------------|---------------|
| Farrowings | 63 | 60 |
| Sow: farrowing duration, min. | 390 (264;646) | 417 (234;583) |
| Piglets: birth duration, min. | 188 (94; 318) | 168 (86; 307) |
| Piglets: birth interval, min. | 11 (5; 25) | 11 (5; 26) |

In a trial with 123 hybrid sows, duration of farrowing and of birth and birth intervals were documented through video recordings (Table 1).

Litter size averaged 18.4 total-born piglets and sow parity averaged 3.4.

At transfer to the farrowing pen, all the sows were loose-housed initially; approximately half were subsequently crated the day before the anticipated farrowing, while the other half remained loose-housed during farrowing. Contrary to the hypothesis, results showed no differences between the two groups in terms on duration of neither farrowing nor birth or in birth intervals.

- Farrowing duration: The time from the SOW delivers the first piglet in a litter until the last piglet is delivered.
- Birth duration: The time it takes for each PIGLET to be born, ie. from the birth of the first piglet to the birth of the next.
- Birth interval: The time between birth of two successive PIGLETS.

Farrowing pens for loose-housed sows

Piglets must be checked every day, and this must be an easy, safe and practical task to conduct. Creep areas should therefore be placed by the entry of the pen. The sow will often lie near the piglets, and therefore the lying area should also be placed by the creep and thereby by the entry. A loose-housed sow will defecate



SWAP pen: the sow is loose-housed, but its movement may be restricted in the period when crushing of piglets normally peaks.

away from the lying area and the feed, and the slatted floor should therefore be placed opposite the hallway. Other factors that need consideration when designing farrowing pens for loose-housed sows include open/close open sides, dimensions of sow and piglets, height of equipment, feed and water supply for sow and piglets.

Types of farrowing pens

Based on recent research and development, Pig Research Centre recommend two types of farrowing pens for loose-housed sows:

- FF: Free Farrowing where the sow is loose-housed all the time
- SWAP: Sow Welfare And Piglet Protection

In principle, a SWAP pen is an FF pen with optional restriction on the sow's freedom of movement.

In cooperation with the University of Copenhagen, Pig Research Centre are analysing productivity and welfare in FF pens and SWAP pens. The trial is being conducted in a new facility where farrowing pens are designed as FF pens and as SWAP pens. Two strategies for using the "crate" in the SWAP pen are being investigated:

- The sow is crated before farrowing until day 4 after farrowing

- The sow is crated once farrowing is complete and until day 4 after farrowing.

Titled lying wall

The risk of sows crushing the piglets diminishes if sows are supported when they lie down. Piglet mortality in pens with a tilted lying wall that supports the sow when it lies down was compared with piglet mortality in a pen with a farrowing rail that provides no support for sow when it lies down. Results showed significantly lower piglet mortality in pens with a tilted lying wall. Nurse sows were excluded from the data analysis.

The project was financially supported by the Pig Levy Fund and the Ministry of Food, Agriculture and Fisheries of Denmark, and The European Agricultural Fund for Rural Development. Journal no. 3663-U-10-00458.

Heat and ventilation

For a period of one year, Pig Research Centre monitored ventilation and heat supply in a newly built farrowing facility for loose-housed lactating sows with the aim of making a set of recommendations for a climate strategy.

The farrowing facility had solid floor in approximately two thirds of the pen, which was equipped with two sets of heat circuits: one in the creep area and one in the anticipated place of farrowing. As the floor behind the sow was heated, it was possible to lower housing temperature to approximately 16°C from day 3 after farrowing.

Energy consumption was 271 kWh per sow/year, which is approx. 50% more than what is used in traditional farrowing pens. This increase in energy use was attributed to bigger creep areas; creep areas that were not insulated and consequent heat loss to hallways etc.

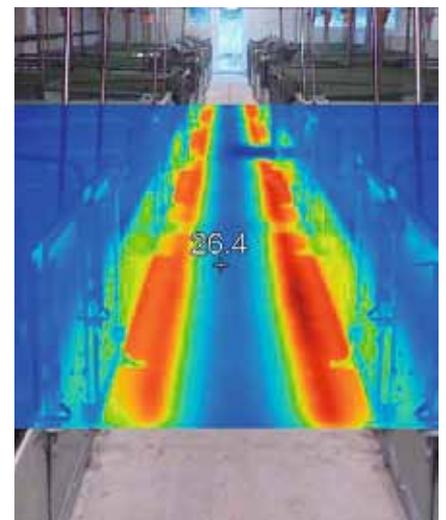
In an attempt to eliminate heat loss and thermal bridge to the hallway, a heat

source installed in the hallway is being investigated on another farm. An additional benefit of heat is that it improves drying of the facility in connection with disinfection and preparation for a new batch of sows.

Preliminary experiences with loose-housed sows in the farrowing facility have resulted in the following recommendations:

Design

- Generally, ventilation design as in traditional farrowing pens
- Install local ventilation or floor ventilation
- Heat source in the creep area, the solid floor under the sow and in the hallway
- Heat circuits dimensioned to max. 130 m per pipe
- Temperature difference between inlet temperature/return temperature of 3-5°C
- Circulation output
 - a) Creep area 150-180 W
 - b) Pen 50-70 W
 - c) Hallway approx. 100 W per pen



Floor heat in the hallway is recommended in facilities with loose-housed sows if the creep faces the hallway. This will reduce the heat loss from the creep area to the hallway. It is furthermore an advantage as gross area per sow is larger than in traditional pens, which increases the need for additional heat.

All in-all out

Research showed that with all in-all out (AIAO) management at site level, daily gain was 48 g higher than with AIAO at section level. Furthermore, there was a tendency to generate a higher gross margin of DKK53 per pig place per year. Furthermore, the occurrence of pneumonia was lower in AIAO at site level than AIAO at section level.

The trial comprised three production systems; each system consisted of a site with sows; a weaner facility; and two finisher sites. One finisher site was managed with AIAO at site level and the other at section level. The sows on the three farms that delivered the weaners were infected with pleuropneumonia, pneumonia and PRRS.

Results showed no differences between AIAO at site level compared to section level in the number of batches infected with pleuropneumonia or PRRS. Analyses showed that most batches were infected with both pathogens before transfer to the finisher facility. It is therefore not possible to decide whether AIAO at site level affects the transmission of pleuropneumonia or PRRS.

Overall, it was a challenge to maintain focus on good management, such as correct grinding of grain, power-washing and climate control. It cannot be ruled out that this may have adversely affected the overall production results.

Elimination of weight dispersion

It is difficult to practice consistent AIAO management as there will always be pigs that do not grow at the same speed as the rest of the batch. For a batch of pigs to produce a high gross margin, the percentage of underweight pigs must be kept to a minimum in order to reduce turn-round time. This requires separate handling of the smallest pigs. Elimination of all weight dispersion will never be possible, but the financial results may improve by applying different transfer strategies that reduce variations in weight through sorting and keeping the pigs in the pen for varying periods of time.

Using data from previous trials, Pig Research Centre simulated four different transfer strategies:

1. 'Waiting section' where the smallest weaners (15%) are housed for two weeks post-weaning.
2. The largest weaners (15%) are moved to the finisher facility one week before the weaner facility is due to be emptied.
3. The smallest weaners (15%) are moved to a collection facility when the weaner facility is emptied.
4. The smallest finishers (15%) are moved to a buffer section when the section is due to be emptied.

Results revealed only minimum effect on the financial results of each strategy. Evaluated individually, strategy 3 came out best and the pigs on that regime

achieved an extra profit of DKK3-4 per pig. The reference facility was consistent AIAO at section level without separate handling of the smallest pigs. The modest financial profit was attributed to the fact that only 15% of the pigs were handled separately and that only a slight correlation was found between daily gain as a weaner and daily gain as a finisher. Consequently, the effect of sorting the pigs according to weight was reduced as a pig growing slowly during the weaner period may compensate for this by having a higher daily gain in the finisher period.

The later the pigs are sorted, the better the chance of reducing variations at slaughter and maintaining a high utilisation of the facility until slaughter. The profit in using a separate strategy for just 5% of the finishers was therefore fairly large (strategy 4) compared to applying a separate strategy for 15% of the pigs earlier in life. The explanation is that one of most important issues in finisher production is minimising deductions at slaughter due to a low slaughter weight.

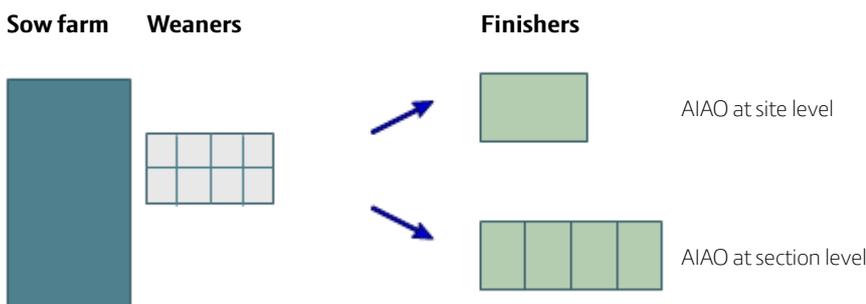
Pigs with long tails

If tail docking is banned, it is crucial to keep the prevalence of tail bites low in order to avoid compromising animal welfare.

On two farms, trials are underway investigating whether pigs with long tails can be housed under such conditions that no more than 2-4% of the pigs suffer from tail biting. The effect of therapeutic measures in pens with tail bites will also be analysed. For a farm to participate in the trial, high production results are a key requirement. Slaughter data must indicate that tail biting has not exceeded 0.5% on average over the previous two years.

Though the trial was conducted on highly well-run farms, the prevalence of tail biting increased on both farms. Pigs with long tails were housed under the same production conditions as pigs with docked tails. Preliminary results show that:

Figure 1



Sketch of the production systems investigated. Each breeding unit delivered pigs for both types of farms.



Handling of pigs with undocked tails presents quite a challenge to pig producers.

- Slaughterhouse data recording incidences of tail biting increased.
- Daily provision of straw on the floor is not enough to prevent tail biting.
- Tail biting behaviour may to some degree be stopped by providing rope or Bite Rite in the pen.
- The biter must be located and isolated as quickly as possible and additional rooting material be provided immediately.

Straw racks for finishers

Straw in racks fulfills the requirement for rooting and enrichment material. Pig Research Centre studied the function of five different brands of straw racks placed above the liquid feed trough.

It was generally concluded that:

- Straw racks placed above the liquid feed trough may work, but it ought to be possible to adjust the mesh size to help regulate the consumption of straw and minimise the loss of straw that drops into the slurry pits.
- Straw consumption varied from approximately 10 to 20 g straw/day/pig, and the straw racks were refilled approximately twice a week.
- Hygiene in the liquid feed troughs did not deteriorate when straw dropped into the troughs.



Pigs are assured of easy access to straw when all of the front of the rack is covered by mesh.

It is now recommended that straw racks should be placed above liquid feed troughs and be designed and installed according to the following guidelines:

- Incorporating mesh across the whole width of the front or another device that prevents blocking and ensures that pigs have easy access to straw
- Adjustable mesh.
- Placed 40-50 cm from the access passage to enable staff to refill the rack from there.
- Close to the slurry emptying point of the pen.

It is also recommended to design the slurry systems according to these guidelines:

- Maximum of two pens per slurry plug
- The slurry pump must be sufficiently powerful to pump slurry mixed with straw, for instance a pump able to cope with cattle slurry
- Slurry emptied a minimum of twice a week.

Overall, the straw rack from Jyden and the straw rack Rotecna from AP scored "good"; the straw rack Domino 60 and a smith-made rack scored "less good"; and Domino 35 scored "poor".

Straw for finishers

For a two-year period, Pig Research Centre investigated whether the provision of different quantities of straw affected abnormal behaviour – defined as pen mate-directed behaviour. The investigation was undertaken on two finisher farms, one with ad-lib dry feeding in tube feeders and one with liquid feeding in long troughs, and comprised approximately 7,600 finishers.

Results demonstrated that:

- The pigs were active for approximately 5 hours a day corresponding to approximately 30% of the time, and they displayed pen mate-directed behaviour for on average 16 and 35 minutes a day, respectively, corresponding to 2.8% and 9.5% of the time.
- The provision of 25, 50 or 100 g straw/pig/day did not significantly affect the level of pen mate-directed behaviour.
- 100 g straw/pig/day split into 1, 2 or 4 provisions did not significantly affect the level of pen mate-directed behaviour.
- The time of provision whether morning or afternoon did not affect either the level of activity or the level of pen mate-directed behaviour.
- Pigs weighing approx. 40 kg were more active and displayed more straw-directed behaviour than pigs weighing 80 kg.

The project was financially supported by the Pig Levy Fund and the Ministry of Food, Agriculture and Fisheries of Denmark, and The European Agricultural Fund for Rural Development. Journal no. 32101-U-12-00194 and 32101-U-12-00196.

DANISH Product Standard

DANISH Product Standard, the Danish pig producers' own quality control programme, was introduced in 2007. Pig producers with a DANISH certificate are assured of access to important markets where requirements for quality, food safety and traceability are strict. This applies to export of pork as well as live pigs. Everybody in the Danish pig industry is therefore prepared to support and comply with the requirements specified in the product standard.

Impartial audit

The scheme is managed by a group of representatives from all sectors of the Danish pig industry. Currently, Baltic Control handles the audits at the pig farms, which is regarded as a guarantee of impartial third party audits.

Quantification is maintained

In the period July 1, 2011, to December 31, 2012, a detailed count of pigs was made concerning specific non-compliances related to animal welfare. The purpose was to monitor the development and to determine if intervention was necessary. In autumn 2012, the management group concluded that one assessment visit a year produces the same measurable result at lower costs. Consequently, as from 2013 just one assessment visit per year will take place in the second quarter.

Technical zero-tolerance

In 2013, 'a technical zero-tolerance' was introduced for pigs that ought to have been destroyed. On all farms, there is a risk that a pig becomes so sick or injured that it must be euthanised and that this is not actioned until the next time a staff member enters the pig building. If, in the meantime, the farm is audited, auditors may find a pig that ideally should have

been removed earlier. In such a case, it cannot be reported that supervision of the pigs has failed. A technical zero-tolerance means that on sow breeding units of up to 1,000 sows/year the DANISH audit will tolerate finding one sow that ought to have been destroyed. Under the zero tolerance regime, weaner and finisher producers are allowed one pig up to 1,000 place units, and one pig for each subsequent 2,000 place units above 1,000.

Only few pigs are found

In the 2013 DANISH audit, 6.0% of the auditors reported pigs that should have been euthanised prior to the visit. The results of the welfare assessment visit show that 1,259,200 pigs were audited in that period. Overall, at these inspections 48 pigs were detected which according to the new assessment criteria should have been euthanised; this corresponds to four pigs in 100,000.

Improved use of hospital pens

In 17.7% of the DANISH audits in 2013, auditors reported pigs that should have been moved to a hospital pen. This is not good enough as Pig Research Centre have repeatedly informed pig producers that

using the hospital pens is not only correct animal welfare, but also economically sensible. Fortunately, in actual numbers, 17.7% only corresponds to 19 pigs in 100,000. This, however, is an area that needs priority attention.

Self-help

Once the basic routines on a farm are in place, it becomes easier to obtain a DANISH approval. The fact box shown below draws attention to six priority areas on which all pig farmers should have a strong focus. The six items of advice are forwarded to all pig producers about to be audited. The full checklist used at the audit is available at www.danish.lf.dk.

6 steps to a successful DANISH audit

1. Correct recording of drug use
2. Correct tail docking
3. Correct hospital pens
4. Well-functioning alarm system
5. Rooting and enrichment material for all pigs
6. Correct registration in the CHR register

All Danish pig producers are capable of complying with the requirements of the DANISH audit. Preparation and the right attitude is a good starting point. Photo: Axel Søgaard.



Group-housed gestating sows in Denmark

The requirement for group-housing of gestating sows commenced on January 1, 2013. Pig Research Centre subsequently contacted all 2,374 farmers with sow breeding units in Denmark to ensure that they all comply with this requirement.

DANISH audits require that gestating sows must be group housed. To obtain a complete impression of the situation, the board of Pig Research Centre and the management group of the DANISH scheme decided in June 2013 to issue a declaration of honour to all farmers with sow breeding units that had not been subject to a DANISH audit in 2013.

Two farms lost their DANISH certificate due to non-compliance, and approximately five farms were still not quite ready. However, the local authorities have spent on average as much as 43 months on case-review administration on environmental approvals for these farms, which means that the owners have in fact acted with due care in the attempt to be ready for the deadline. These farms are expected to be ready within a few months, and were therefore allowed to keep their DANISH certificate.

New guidelines on rooting and enrichment material

In March 2013, the Ministry of Food, Agriculture and Fisheries released an updated version of the guidelines on rooting and enrichment materials. The aim of the guidelines is to clarify the Ministry's interpretation of the legislation applying in this area.

The guidelines state that "wood in an upright stand fulfills the requirement for rooting and enrichment provided specific conditions are met." This is an acceptance of the ruling in the city court in 2011 that "wood in a coil" may fulfill the requirement for rooting as well as enrichment.

Wood in a holding device fulfills the requirement for rooting and enrichment materials, but must according to the guidelines of the Danish Ministry of Food, Agriculture and Fisheries the provision should comply with the following specifications:

- The wood must be moveable to the degree that it would be possible to place three pieces of wood in the stand at once.
- Minimum diameter / shortest side: 10 cm.
- Minimum distance from floor surface: 25 cm.

And:

- The wood used must be soft wood, e.g. pine, spruce, birch or poplar, and must match the size of the pigs.
- Minimum distance between two stands is specified at 40 cm.



However, Pig Research Centre believe that it will be a challenge in practice to meet the specific conditions for "wood in holding device" – not least for auditors. Pig Research Centre also believe that obtaining documentation for such specific measurements and dimensions listed in the guidelines will be difficult. Thus, a new court case may be the outcome if a pig producer who has already installed materials is sanctioned.

Bill on loose housing in insemination/control units

The Danish Parliament are expected to introduce a Bill in November 2013 on group-housing of sows in the entire period from weaning to farrowing. The Act is expected to commence on January 1, 2015, for new facilities and to be implemented in all facilities by 2035.

The Bill states that "sows in the period from weaning until four weeks after

insemination and gilts from transfer to the insemination unit until four weeks after insemination must be housed loose in individual pens or in large or small groups."

With this Bill, empty sows may be crated for up to three days during oestrus. This makes sense in terms of welfare and production as sows may, for instance, injure each other when "mounting" other sows during oestrus.

It will also be possible to have individual pens in the insemination/control unit. Space allowance in these pens will be 3.5m² corresponding to the space allowance in relief pens and pens on farms with a UK contract.

Estimates show that conversion from stalls to group-housing costs approximately DKK 3,500 per place unit, which corresponds to an increase in costs of 30-40%. This increase is primarily attributed to greater space allowance and non-skid flooring.

Gastric ulcer and respiratory disorders

Gastric health varies drastically between pigs in a herd. These differences may be triggered by other diseases that increase susceptibility. Together with Danish Crown, Pig Research Centre investigated the correlation between gastric changes and respiratory diseases, including the PCV2 virus.

PCV2 and gastric ulcers

In 2006, PCV2 vaccination became available in Danish pig production. Many vets and pig producers report that vaccinating pigs against PCV2 also improves health in terms of gastric ulcers.

Lungs and stomachs from pigs from 51 finisher farms were examined at the Laboratory for Pig Diseases (extended health control), and results were forwarded to the herd owners.

PCV2 virus in 18%

Stomach, lungs and lymphatic tissue were analysed for PCV2 virus at the National Veterinary Institute. Results revealed positive findings of PCV2 in 18% of the finishers examined, which indicates more or less severe PCV2 infection in these pigs. Blood sampling was not performed.

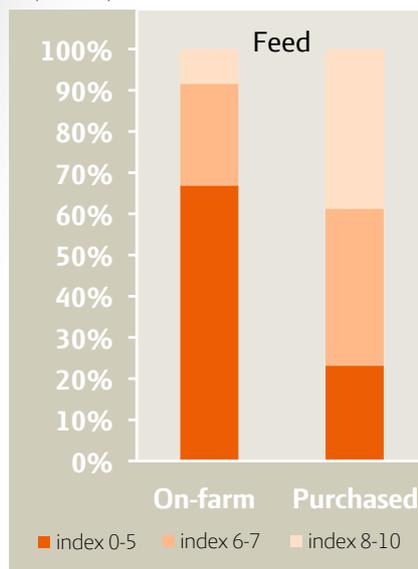
Lung changes in 25%

The aim of the investigation was to analyse the correlation between respiratory disorders and gastric changes, whereby only herds with a high prevalence of chronic adhesive pleurisy were used. In 4% of the finishers, mycoplasma-like lung changes were observed in more than 10% of the lung tissue. Results revealed that 5% of the finishers had symptoms of pleuropneumonia, and 25% of the pigs had chronic adhesive pleurisy in more than 20% of the lung.

No correlation

There was no significant correlation between lung changes and gastric changes, nor was it possible to detect a correlation between gastric changes and PCV2 infection.

Figure 1 - Gastric index of pigs fed purchased compound feed and feed mixed on-farm, respectively.



Pelleted feed and gastric ulcers

As expected, the study demonstrated a significant correlation between feed and gastric changes (high gastric index); finishers fed pelleted purchased feed had a higher gastric index than finishers fed feed mixed on-farm.

The project was financially supported by the Ministry of Food, Agriculture and Fisheries of Denmark and the European Agricultural Fund for Rural Development. Journal no. 3663-U-11-00181.

Leg injuries and pastern lesions

In cooperation with the University of Copenhagen (HERD), Pig Research Centre analysed the frequency of lesions on the hindlegs above the dewclaws. Pastern lesions mainly occur in the farrowing house and are known to peak around weaning. On 33 farms, pastern lesions were monitored on sows in farrowing houses.

This is the first monitoring of pastern lesions. Only hindlegs were examined as

a pilot study revealed that lesions on the front legs were rare. The monitoring included all open wounds, but not callosity (See photo below).



Callosity on front leg.

Pastern lesions in farrowing houses

- Pastern lesions were observed on average in 13.2% of the sows at weaning.
- The highest prevalence at weaning was 32.5%.

Causes must be clarified

Very little is known about the factors triggering pastern lesions. However, it is believed that a long lactation period, suitability of accommodation, flooring and the general health of the sows may increase the occurrence of pastern lesions. Some of these factors are now being investigated, and results are expected in 2014.

Count of shoulder ulcers

From July 1, 2013 to August 31, 2013, practising vets participated in a count of shoulder ulcers on Danish sow farms. All

types of shoulder ulcers were counted once in the farrowing facility and once in hospital pens. The result of this count will form part a political decision as to whether to implement a nation-wide surveillance programme and a Yellow card scheme for shoulder ulcers.

Scale for live pigs

Before the count was initiated, a new scale for assessing shoulder ulcers was made for use on live animals to ensure that shoulder ulcers were assessed in a uniform manner. This so-called “clinical scale” classifies shoulder ulcers into:

- No or small shoulder ulcers
- Mild shoulder ulcers
- Severe shoulder ulcers

Joint venture

The shoulder ulcer measuring card and the clinical scale were developed by the Department of Animal Sciences at Aarhus University, the Faculty of Health and Medical Sciences at the University of Copenhagen, the Danish Veterinary and Food Administration, the Danish Veterinary Association and Pig Research Centre. It is thereby expected that all parties interested in the method for evaluation of shoulder ulcers agree on the classifications used.

Many different people assessed the same ulcers, which made it possible to determine which classification was the one favoured most by the assessors. For instance, all assessors found it far easier to decide on the size of the exposed surface



Figure 2. Mild shoulder ulcer requiring treatment. The sow should be removed to a hospital pen.

area of an ulcer compared to assessing its depth. The descriptions of ulcers that most assessors agreed upon were included in the “new” clinical scale. The result is shown in the fact box below.

- No or small shoulder ulcer. No skin changes; or skin changes/lesions measuring less than 2 cm on the widest part.
- Mild shoulder ulcer. An almost circular ulcer with well-defined edges measuring minimum 2 cm on the widest part, but which is not a severe shoulder ulcer.
- Severe shoulder ulcer. An almost circular ulcer with well-defined edges measuring minimum 5 cm on the widest part and which is surrounded by a crust.

Shoulder ulcer measuring card

From the outset it was a requirement that the clinical scale must be easy to use in practice. As a tool for quick and efficient assessment of shoulder ulcers, a shoulder ulcer measuring card was developed along with the new scale. The card, placed on an ulcer, consists of two circles: one of 2 cm in diameter and another of 5 cm.

Video

A video is available at Pig Research Centre's website showing how to use the card on different types of shoulder ulcers. Evaluation of shoulder ulcers must always be made by measuring the part of the shoulder that is most severely attacked. Correct evaluation is made on a sow standing up on an area measuring 15 x 15 cm with the highest point of the shoulder as the centre.

Prevention

Besides being used for national monitoring, the shoulder ulcer measuring card can also be used on an everyday basis for two important purposes:

- Keeping the frequency of mild shoulder ulcers low
- Preventing the development of severe shoulder lesions

Keeping the occurrence of ulcers low requires routine use of the shoulder ulcer measuring card, which will help monitor the level of ulcers in the herd. Information on the development of ulcers over a long period of time helps determine if interventions are effective.

Furthermore, the card can be used for prevention of severe ulcers by moving sows to hospital pens before the ulcers are categorised as severe. It is particularly important to check for crusting on the edge of the ulcer.

Incidence of ulcers

The most recent audit results from the Danish Veterinary and Food Administration indicate a drop in the occurrence of severe shoulder ulcers, and it is thereby possible that a Yellow Card scheme may be unnecessary. Results of the 2013 count were not available at the time of writing.

The Danish Veterinary and Food Administration intend to use the clinical scale in their audits and at the slaughterhouses.

As a point of departure, pig producers delivering sows that by looking at them have “a mild shoulder ulcer” will not be reported to the police. That is also the case if - post-slaughter - the ulcer turns out to correspond to degree 3 or 4 on the clinical scale.

The Danish Veterinary and Food Administration are currently updating their shoulder ulcer guidelines to include information on the new shoulder ulcer scale.

The project was financially supported by the Pig Levy Fund, the Danish Veterinary and Food Administration, the agreement between Aarhus University and University of Copenhagen, the Ministry of Food, Agriculture and Fisheries of Denmark and the European Agricultural Fund for Rural Development. Journal no. 3663-D-09-00386.

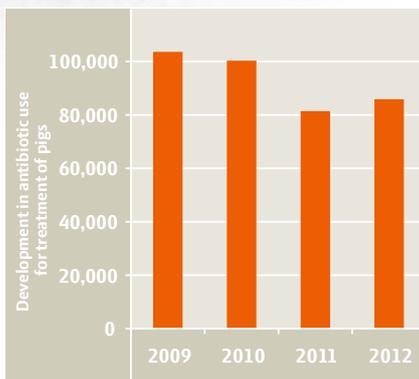
ANTIBIOTIC USE AND MICROBIAL RESISTANCE

HEALTH

Large drop from 2009 to 2012

The Danish pig producers are well on the way to reach their target of reducing antibiotic use by 10% from 2009 to 2013. In the period 2009-2012, usage dropped from 3.86 mg to 2.96 mg antibiotics per finished pig. In this period, the number of pigs produced increased by 2 million. Overall, antibiotic use has dropped by 17% from 2009 to 2012, although a slight increase was seen from 2011 as shown in Figure 1.

Figure 1 - Development in antibiotic use for treatment of pigs



Ban on use of cephalosporins

The voluntary agreement to stop the use of cephalosporins introduced in 2010 remains. Cephalosporins are critical to the treatment of infections in humans. However, it is also generally agreed that to ensure animal welfare and to reduce mortality sick animals must be treated. As a result, a small number of farms are for a brief period allowed to continue using cephalosporins.

The health authorities must remember to ask

Upon contact with the health authorities, patients working with pigs must inform the authorities of this as this will enable the doctor to recommend the most suitable antibiotic for treatment of infections. The new MRSA guidelines from the Danish Health and Medicines Authority include the requirement that doctors need to ask if their patient works with pigs.

MINAPIG

Pig Research Centre participate in an EMIDA-EU project called MINAPIG in which 111 pig production experts from six countries assessed multiple measures for reducing antibiotic use in pig production. Thirty of these experts were from Denmark. Having considered efficiency, practicality and cost-benefit, the group pointed to on-farm biosecurity and increased vaccination as the two most important factors.

Reduction of antibiotic use

111 experts from 6 countries recommend:

- On-farm biosecurity
- Increased use of vaccination
- Zinc at weaning
- Improved feed quality
- Diagnostic / action plans
- External biosecurity

The project was financially supported by the EU and the Green Development and Demonstration Programme. Journal no. 3405-11-0435.



The guidelines are available in Russian, English and Danish.

Good antibiotic practice

The guidelines that provide advice on how to handle antibiotics and on how to reduce antibiotic use were updated in 2013. The guidelines can be downloaded in Danish, English and Russian from Pig Research Centre's website. In Report no. 1306 which is in Danish, 16 pig producers share their experiences in reducing antibiotic use for weaners.

Antibiotics in feed or water

If many pigs in a pen or a section are sick, it may be necessary to treat all the pigs. In such cases, a range of antibiotics is available for administration in feed or water. To ensure that each pig gets the right dosage, careful dosing and handling of the antibiotic are essential. Consequently, Pig Research Centre investigated how to ensure that correct handling of antibiotics.

Medication through water

Administration of antibiotics in the water is a good option if all the pigs in a section need treatment. Stock solution should only be prepared for one day at a time to ensure that the pigs are given the daily dosage prescribed.

Antibiotic in dry feed

If only the pigs in one or a few pens need treatment, mixing antibiotic directly in the feeder is an option.

Thorough mixing is vital

In several practical trials, mixing of antibiotics is studied by using red colouring agent to illustrate the inclusion of antibiotics. Not surprisingly, thorough mixing



Top-dressing in feeder.

leads to a uniform distribution. However, some pig producers choose to apply top-dressing and administer antibiotics for, for instance over two days at the top of the feeder.

Top-dressing is no good

Top-dressing whereby the antibiotic is poured on top of the feed in the feeder – leads to uneven mixing and thereby highly uneven treatment of the pigs in the pen. In this trial, the feeder was emptied and samples were taken from start to finish.



Top-dressing distributes poorly in feed. It is important to mix antibiotics and feed (wear gloves and mask) to ensure a uniform supply and to get the best possible effect of the treatment.

15 seconds make a difference

Results showed that distribution improves if antibiotics/colouring agent is mixed manually in the feed for just 15 seconds. The colouring agent added can be seen in more cups, as shown in the photos, but



If antibiotics/colouring agent is mixed manually with the feed in the feeder for as little as 15 seconds, distribution improves significantly, as shown in this picture.

it still takes a while before feed with antibiotics actually reaches the pigs. In case of acute disease, the affected pigs should always be treated with injection followed by treatment through feed.

Group-treatment in liquid feed

When pigs are fed liquid feed in long troughs, antibiotics are best administered by mixing them in the trough rather than in water. With Medliq™ units it is possible to add drugs to the feed in the pipeline, which will give a uniform distribution of the antibiotic in the feed. A more simple solution may be to give the pigs a stock solution in the trough on the days when treatment is necessary. Research shows that the antibiotic mix is not always uniformly distributed in the feed when it is administered in the trough BEFORE feeding. It is therefore recommended to

administer the solution during feeding though this is difficult with pigs in the pen. If the solution is administered before feeding, it should always be checked that the solution is uniformly distributed, and this is easy to see if a colouring agent is added to the water solution. Uniform mixing is not possible in troughs that are not completely horizontal.

MRSA 398

In the fight against MRSA in humans, it is crucial to avoid spreading the bacterium from the pig environment if MRSA is detected in a herd. MRSA is found in the dust, and the likelihood of MRSA spreading from a farm to a dwelling can be reduced if a few simple hygiene rules are observed.

Stop the transmission of MRSA

- Shower and change clothes when leaving the farm
- Wash work clothes on the farm premises if possible
- Wash hands often and thoroughly
- Use disposable towels
- Use hand disinfectant
- At a doctor's appointment, inform the doctor that you work with pigs

Laboratory for Pig Diseases

The Laboratory in Kjellerup conducts extensive diagnostic examinations for a wide range of pig diseases. These examinations can be divided into four main categories:

- Routine samples submitted from SPF Health Inspection
- Diagnostic submission from veterinarians
- Monitoring schemes
- Research & development

SPF Health Inspection primarily submits monthly blood samples for analysis of pleuropneumonia, pneumonia, PRRS and Salmonella. The Laboratory also handles examinations for rhinitis and pig dysentery. The Laboratory is the only place in



Acute pleuropneumonia

Denmark receiving pigs for post-mortem examinations including sampling of material for bacteriological, virological and parasitological diagnostics. Viral examinations are handled by the National Veterinary Institute within the Technical University of Denmark.

Activities 2013

- Serological examinations SPF: 260,000
- Salmonella meat juice: 300,000
- Post-mortem examinations: 4,000
- Nose swabs: 4,000
- Bacteriological samples: 4,000

The Laboratory participates in numerous research activities in areas such as gastric ulcers, piglet diarrhoea and development of new diagnostic methods for detecting antibodies against SPF diseases.

Another significant activity is assistance to practising veterinarians who contact the Laboratory in connection with, for instance, sampling of material and questions related to lab results.

The Laboratory handles routine microbiological analysis of commercial semen from Danish boar stations in cooperation with Hatting KS and Mors Boar Station. Furthermore, the Laboratory routinely collects samples of relevant material for monitoring Classical Swine Fever and African Swine Fever. These samples are analysed at the National Veterinary Institute when authorised by the Danish Veterinary and Food Administration.

SPF Health Inspection

SPF Health Inspection is performed in all breeding and multiplication herds with red SPF health status. This involves monthly inspections where SPF Health Inspection clinically inspect the animals in the herd and collect blood samples. The blood samples are analysed for antibodies against SPF diseases. On these farms, inspection also includes biosecurity and appraisal of welfare parameters such as stocking density, shoulder ulcers, tail biting and condition of hospital pens.

Nationally, approx. 260 herds are classified as Red SPF herds.

SPF Health Inspection has Health Advisory Agreements with approximately 25% of the breeding and multiplication herds.

In spring 2013, Pig Research Centre bought into a wash site for livestock transport vehicles in Padborg near the Danish-German border. The site was renamed and is now called "DANISH Safety Wash"; annually approximately 20,000 vehicles used for export of livestock are washed and disinfected to prevent the introduction of exotic diseases into Denmark. SPF Health Inspection regularly inspects the wash site, which includes microbiological analyses to ensure that the vehicles are thoroughly disinfected before leaving the site.

The SPF System

The SPF System is administrated and managed by the SPF Health Department, also known as SPF-SuS. The primary purpose of this department is to monitor and develop the SPF system and at the same time to declare Herd Health status and salmonella status of all herds in Denmark. The following diseases are declared by SPF-Sus:

- Pleuropneumonia (APP)
- Enzootic Pneumonia (Myc)
- Swine dysentery
- Atrophic Rhinitis
- PRRS – EU and US strain
- Lice
- Mange

In 2013 records of herds in the SPF system showed

- 270 Red
- 2,800 Blue

SPF Health Status also update SPF Health Regulations and SPF Transport Regulations.



Export vehicle being washed at DANISH Safety Wash in Padborg.

Clinical trials

Pig Research Centre regularly conduct clinical trials. A clinical trial is an investigation of a drug; in most cases, the aim is to document the effect of vaccines or antibiotics.

These trials are usually made in cooperation with medical companies. In some cases, the trials are partially funded by the producer of the drug and in other cases the producer finances the entire trial.

Quality assurance

Before a clinical trial can start, approval must be obtained from the Danish Health and Medicines Authority. This implies that the trial must comply with even stricter requirements than those applying to other types of research activities of Pig Research Centre.

Furthermore, the Danish Health and Medicines Authority occasionally audit a trial to confirm that the trial is in fact being conducted in accordance with the trial protocol. This also includes auditing all routines on the farm where the trial is being performed.

No one knows who gets what

In most trials none of the parties involved are informed about which pigs are assigned to which particular trial group. This includes farm staff, the technical staff, the project manager, staff at the laboratory and the statisticians who carry out the data analysis. They only know whether the pigs belong to e.g. groups "white", "green" etc., but they do not know anything about the group's treatment allocation. It is only after data has been analysed after completion of the trial that treatment details are released and the impact of the drug can be evaluated.

Recent trial activities

In recent years, Pig Research Centre together with a range of collaborators have tested vaccines against PVC2/PMWS, pneumonia, Lawsonia and boar taint. Furthermore, on three farms, the effect of antibiotics and pain-relieving drugs on M.M.A. was investigated. In autumn 2013, an investigation of the effect of pain-relieving drugs and vaccines on pleuropneumonia got underway.

PRRS

Porcine Reproductive and Respiratory Syndrome (PRRS) is just one of many challenges faced by Danish pig producers. However, PRRS is being used increasingly as a trade obstacle to the export of pork, and the industry and the Danish authorities have therefore increased the efforts in the fight against the disease. Recently, the Danish Veterinary and Food Administration established a working group with representatives from Pig Research Centre, among others, that will investigate the possibility for eradicating PRRS in Denmark. One of the tasks of Pig Research Centre in this work is the estimation of the annual loss arising from PRRS in Denmark.

Preliminary estimates suggest an annual loss of approx. DKK 50-300 million. This amount mainly covers productivity loss due to PRRS and lost export revenue. Particularly the loss of export revenue contributes significantly to the annual loss; the deficit depends on whether the price difference between PRRS positive and PRRS negative weaners is expected to remain at the current, high level or to drop to a more realistic level.



Vaccination of a pig in a blinded trial.



Bottles used in a blinded trial; no one involved in the trial knows which pigs are given the vaccine and which are given saline.

Production results for 2012

Records of production of 2012 show that sows in Denmark wean on average 29.6 piglets a year.

- 29.6 weaned piglets per sow/year
- 16.8 total born piglets/litter
- 10.0% stillborn of total born
- 13.7% dead during nursing
- 13.1 weaned piglets/litter

The project “35 weaned piglets/sow/year”, financially supported by the European Agricultural Fund for Rural Development, was initiated in 2009 when production records showed that Danish sows weaned 27.5 piglets/sow/year. The increase of 2 piglets achieved during the project period is the result of an increase in number of piglets born and a decrease in mortality rates during and after farrowing. A few Danish farms were the first to reach the goal of 35 weaned piglets/sow/year in 2012.

Piglet welfare in large litters

A report on the importance of litter size to piglet welfare published in 2012 was the result of collaboration between Animal Behaviour & Welfare, SRUC, the University of Edinburgh, the Department of Food and Resource Economics at the University of Copenhagen, and Pig Research Centre. In 2013, two scientific papers were published on the basis of the report. In the first paper, the challenges – in terms of ethics and welfare – related to an increased litter size are described and evaluated. This paper lists piglet mortality as the most important challenge followed by competition at the udder and an increase in the percentage of piglets with low birth weight. The paper provides recommendations for how to overcome these challenges. The second paper focuses on the importance of piglet management as well as that of the sow; the main factors are reported to be management of the weakest piglets and handling of nurse sows. Also, the paper focuses on the importance of humane handling of the sow’s early life



An international survey on piglet welfare shows that optimum management routines are essential when sows are rearing many piglets.

when, in adult life, they will have to rear many piglets.

Breeding for maternal traits

In this project, the heritable traits relevant to genetically improve a sow’s ability to rear a large litter until weaning are investigated. Data from all breeding herds and from five commercial herds are being compiled for analysis of

- Live piglets day 5 after farrowing (LP5)
- Number of piglets day 21 after farrowing when a sow is given 14 piglets to rear (14P)
- Sow longevity (a sow’s time in production)

Data collection was concluded in 2012; the final analysis of 14P and LP5 will be based on 8,150 recordings. In a preliminary analysis, data from the trial and data from purebred animals were included to determine heritability and genetic correlations.

Results show an average number of weaned piglets (14P) of 11.9 piglets/litter on day 21 after farrowing varying from 5 to 14. In the commercial herds, results indicate a heritability of 0.059 for 14P and of 0.055 for live piglets day 5 (LP5).



A sow’s ability to rear 14 piglets may be heritable. It needs to be investigated if breeding for this trait will affect other fertility and production results.

The preliminary phenotypic correlation between the two traits is low: < 0.1, while the genetic correlation is 0.15.

The final results will be published by the end of 2013, and it will subsequently be decided whether to include the trait 14P in the breeding objective. Analysis of data for longevity is not yet finished as this trait requires a vast amount of data.

New types of nesting material

An investigation currently underway aims to determine whether materials such as hemp mats, jute bags and cotton cloths may be useful as an alternative to straw for nesting material.

Research showed that sows are actually using the materials for nesting, and it is now being determined whether the materials remain available to the sow until the time of farrowing. Alternatives to straw can be useful as straw can be pushed beyond the sow’s reach and it easily slip through the slats.

A good-looking udder at first farrowing

Udder development in female pigs was monitored from weaning until first farrow-

ing. Teat number is most accurately counted while holding 3-4-week old piglets on their back. Inverted teats were observed in only a few gestating gilts, and once the gilts farrowed, half of the inverted teats were in fact functional. Before the first farrowing, only three sows out of 190 had 1-3 dysfunctional milk glands. Udder defects at first farrowing are thus rare. For more information, see "Publikationer" at www.vsp.lf.dk (trial report no. 938).

Causes of stillbirths

On six farms, 778 stillborn piglets were subject to post-mortem examination. The preliminary results show that

- 78-91% of all stillborn piglets die during farrowing
- 7-34% of the piglets recorded as stillborn were born alive
- The highest percentage of stillborn piglets was found among thin sows that farrowed their second litter
- Stillborn piglets in the previous litter increases the risk of stillborn in the next litter
- Virus and *Leptospira* were not present in the stillborn piglets
- The time of farrowing does not affect the percentage of stillborn piglets



The day before farrowing, this sow uses a mat made of hemp for nesting.

These preliminary results indicate that the percentage of stillborn may be reduced through monitoring sows at farrowing and by body condition management of sows at most risk. The investigation will continue on four farms in 2013.



Post-mortem examinations will reveal whether a piglet was in fact stillborn or died before or during farrowing.

Colostrum for the smallest piglets

In the period from birth until cross-fostering, many piglets must compete for colostrum. The survival chances among small piglets increased by 10% if they were transferred to another currently farrowing sow immediately after birth. Here litter size was kept to 12 piglets by moving large newborn piglets to other sows that were farrowing. The large piglets moved from these sows were transferred to the sows that had delivered the small piglets. It was ensured that small as well as large piglets that were moved immediately after birth were moved to a sow that was farrowing and thus was producing colostrum. This trial demonstrates that piglets will survive on colostrum from alien sows. However, this strategy cannot be recommended for herds with PCV2, PRRS or diarrhoea among the newborn piglets. For more information, see "Publikationer" at www.vsp.lf.dk (trial report no. 944).

Growth stops after farrowing

Piglet growth was studied by weighing piglets every other hour for the first two days after birth. Overall, satisfactory growth rates were seen for small as well as large piglets immediately after birth. However, piglet growth stopped approximately 16 hours after farrowing has started, and then



Small piglets have increased chances of surviving if they are placed in a small litter immediately following birth.

resumed after approximately 8 hours. As the growth check was defined by the time when farrowing started – and not by the time of birth of the specific piglet – a drop in milk production by the sow is probably the reason why the piglets neither gained nor lost weight for a period of time. The reason for this and the effect on piglet welfare are not known. The knowledge obtained in this study will be included in the planning of further studies of neonatal piglet mortality.

Motivation and productivity

The usefulness of the knowledge available on farrowing and piglet management was tested in practice; for a 12-month-period, four expert advisors from the work group "Experts on Management of the Farrowing Facility" visited four sow farms minimum every two months. In this period, productivity on those four farms was increased by 1.6 weaned piglets/sow/year; in comparison, the national average was increased by 0.7 weaned piglets/sow/year in that same period. Figure 2 shows the progress of each farm.

Among the focus areas were:

- Clear responsibilities for all staff members
- Increased focus on colostrum for the smallest piglets
- Cross-fostering strategies
- Adjustment of sows' feeding level in the farrowing unit
- Improved climate in the creep area

Surprisingly, the largest positive impact of intensive advice was seen on the two farms that already had high production results. This may be a coincidence, but it

may also be that advice has the greatest effect on farms where the staff is already motivated and where strategies are already in place for the implementation of new and improved work routines. For more information, see “Publikationer” at www.vsp.lf.dk (report no. 1209).

Full stomachs

By feeling the volume of the belly of piglets on the day of birth it was possible to identify piglets with increased risk of dying within the next five days. A total of 443 piglets were divided into two groups; one group of 194 piglets with “full stomachs” and another with 249 piglets with “not so full stomachs”. The greatest correlation between “full” stomach and mortality rates was found among the smallest piglets with a birth weight below 1.1 kg. Among small piglets with a “not so full stomach” mortality averaged 29%, while among piglets with a “full stomach” mortality averaged 13%.

It was not established whether the classification “not so full stomach” indicated a piglet without contents in the abdomen or a piglet that had a short length in relation to its volume (BMI). Previous research has indicated high mortality for both factors. Research concerning the volume of the belly in piglets continues in order to improve the identification of piglets in need of special care.

The sow can rear all its own piglets. A pilot study demonstrated that a sow is able to rear 24 piglets if the piglets take turns suckling. The sow was able to recognise the piglets when the two groups were switched, and the piglets easily returned to the hierarchy they had before they were moved to make room for the other group. However, switching the groups around is a labour intensive task. The strategy did not affect survival rates, but health and weaning weight were unsatisfactory, and the strategy therefore needs refining before it can be implemented in practice.

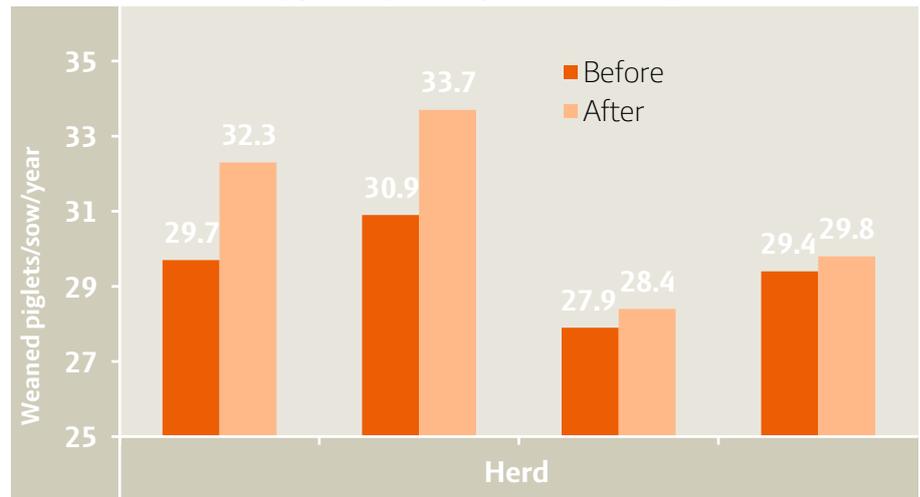
More weaned piglets than teats

Previous research has demonstrated that at cross-fostering a sow should not be given more piglets than it has functional milk glands. However, 10% of all sows can

Figure 1 - Piglet growth in a typical litter the first 40 hours after farrowing has started. Four hours after farrowing started, all piglets in this litter had been born. For more information, see “Publikationer” at www.vsp.lf.dk (report no. 1311).



Figure 2 - Increase in weaned piglets/sow/year during an intensive advisory course



wean more piglets than they have teats. It remains unclear how this capacity can be utilised nor is it clear whether the piglets that share a teat have a lower growth rate. For more information, see “Publikationer” at www.vsp.lf.dk (trial report no. 938).

The project was financially supported by the Pig Levy Fund and the Ministry of Food, Agriculture and Fisheries of Denmark, and The European Agricultural Fund for Rural Development. Journal no. 3663-D-09-00367 and 3663-U-11-00183.

More live piglets on day 10

For a two-year period, piglet survival was monitored in two different types of huts: in a newly developed Vissing hut and in the traditional A hut.

Analysis of data from 419 litters showed that significantly more piglets were alive on day 10 after farrowing in the Vissing hut than in the A hut; averaging 11.8 piglets/litter vs 11.3 piglets/litter. There was no difference in number of pigs/litter between huts after litter equalisation. The difference in the number of live piglets is probably attributed to differences in space and design of the huts.

The Vissing hut is larger than the A hut and is designed in accordance with the sow's space requirements and lying behaviour, which minimises the risk of sows crushing the piglets.

For more information, see trial report 973 at www.vsp.lf.dk.



The Vissing farrowing hut is developed with the space requirements and behavior of sow and piglets in mind.

The Poca hut, version 2

Following the outcome of a study made in 2011-2012 (report no. 1307, Pig Research Centre), the Poca hut was improved in terms of space and production costs.

In 2014, the effect of heat in the Poca hut will be investigated as it is expected that a heated creep area will increase the piglets' survival potential in cold weather, and at the same time encourage them to move away from the sow, thereby reducing crushing rates.



Poca hut, version 2.

Individual feeding

In cooperation with Astute A/S and two pig producers, Pig Research Centre are investigating individual feeding of sows and gilts housed outdoors.

Feed consumption is disproportionally high in outdoor production compared with indoor production, which is primarily attributed to feed waste. The aim of feeding sows and gilts individually in feeding stations outdoor is to reduce feeding costs and to facilitate individual management of body condition in outdoor production.

Production-efficient housing of weaners and finishers

The aim of this trial is to make a set of recommendations for production-efficient accommodation for outdoor pigs and organic pigs in the period from weaning to slaughter.



Feeding station for individual feeding of gilts and sows housed outdoor is currently being tested in cooperation with Astute A/S.

Two housing principles are investigated in this trial: large groups with sorting scales and small groups.

In both principles, the below criteria must be met:

- Sound environment
- High level of hygiene
- Well-functioning outdoor area
- Low mortality rates
- Low feed consumption/high daily gain
- Good working conditions

Identification using ear tags

Correct recording of data is a prerequisite for accurate production control, and this may be a challenge in outdoor production of pigs as ear tags get dirty and the distance between office and pigs is large. With the new electronic ear tags it is possible to record the ID of a pig at a distance of 1-2 m just as it is possible to record more than one pig at a time. Pig Research Centre are currently testing these ear tags on an organic pig farm in cooperation with AgroSoft. Different types of ear tags are being tested while at the same time recording of production results is being implemented through handheld PDA units. This new technology will improve the quality of the data that form the basis of efficient pig production management.

The project was financially supported by the Green Development and Demonstration Programme. Journal no. 34009-12-0446.

The project was financially supported by the Ministry of Food, Agriculture and Fisheries of Denmark and the European Agricultural Fund for Rural Development. Journal no. 32101-U-12-00213.

Lean for pigs

'Lean' is about creating more value with fewer resources; it involves identifying visible methods that facilitate improved daily management and a degree of overview.

The general principle is to encourage staff to take more responsibility and become wholeheartedly committed to an involvement in the delivery of changes. Lean is largely "common sense" reduced to a system, for instance by outlining the daily tasks and putting maintenance, proposals for improvements, objectives and action plans into this system.

Lean tools:

- **5S** – a more systematic approach
- **Week planner** – who works when / does what/ has time for ad hoc tasks / which ad hoc tasks etc.
- **Meetings by the "blackboard"** – brief and efficient weekly meetings focusing on improvements, positive experiences, objectives and action plans
- **TPM** – system for preventive maintenance
- **Value analysis** – thorough analysis of one part of the production to pinpoint inadequacies and areas for improvements.

The target group comprises farmers who can and will take the lead and wish to impose a greater element of structure within the working day. Currently, six certified Lean advisors with specialist knowledge of pig production are available to help pig producers wishing to learn more about Lean.

Sow mortality drops

Farmers with pig breeding units who participated in the projects "Soliv" and "Team Soliv" succeeded in reducing sow mortality. The projects showed that many factors

are recurring in the attempts to reduce sow mortality. Analysis of production and management routines may illustrate challenges, point to solutions and put words into action – all at the same time. This will also increase the chances of reaching production targets. A great deal of knowledge and advisory tools were developed and implemented. This knowledge is being passed on partly through the website www.soliv.dk and partly through on-farm training sessions. One of Pig Research Centre's goals is that the average sow mortality in Denmark must drop to 11.5% by the end of 2013.

www.soliv.dk

This website, which is in Danish, provides information, guidelines and tools for farmers wishing to reduce sow mortality in their herd.



Here, farmers are able to calculate the potential improvements in gross margin (GM) generated by a reduction in sow mortality. An analysis kit is available for making decisions on the right basis. Another tool is a poster that can help farmers in creating and maintaining a general outline when the whole farm is engaged in reducing sow mortality rates. In addition, the website provides technical information on production routines and on management of a sow farm for use in the process of reducing sow mortality.

On-farm training sessions

Knowledge and experiences in reducing sow mortality are also implemented through on-farm training sessions. Five pig advisors and two management advisors are certified leaders of these sessions. The sessions are an efficient forum for the participants to discuss selected problems.

For a limited period of time, approximately seven sow farmers cooperate on reducing sow mortality on each other's farms. All meetings are held on each other's farms, and, together with the leader of the session, the host prepares an agenda for the day. Each visit concludes with action-oriented suggestions for actual improvements on the farm. Sow mortality rates are monitored on a monthly basis on each farm. In addition, three training days are dedicated specifically to production and management.

Demonstration projects

The demonstration project "Speeding up finisher production" was turned into advisory concept focusing on daily routines, objectives and close follow up through valid data. The method was highly successful in TurboPlus, which is the advisory concept that Danish Crown, the local pig advisory centres and Pig Research Centre have been working on in the first half of 2013. In addition, one of the tools from the project "Svinetjek" is incorporated into "GB tjek", which now includes the possibility of getting even closer to a more accurate estimation of the bottom line with more key figures – and the possibility of monitoring own farm data for more than one period.

The project was financially supported by the Pig Levy Fund and the Ministry of Food, Agriculture and Fisheries of Denmark, and The European Agricultural Fund for Rural Development. Journal no. 3663-D-09-00368.

ICT

All sectors in farming apply information and communication technology (ICT) to increase earnings and improve the overview of the whole production unit. Through various research activities, Pig Research Centre help ensure that Danish pig producers also benefit from this. This requires close cooperation – and dialogue – with both pig producers and manufacturers of technical solutions.

Digital data

Much digital data in pig production today is recorded via manual reading of the ID of each individual animal. Correct identification of each animal is essential whether we are talking export of breeding stock to Russia or recording of liveborn piglets in the farrowing field in an organic herd. Either way, Pig research Centre help ensure this through development and testing of electronic ear tags. Electronic identification has been used on breeding and multiplication farms for some years now.

Improvement of data quality in outdoor pig production is currently being investigated in several trials. In these trials,

ESF tags are being used because of high requirements for durability. Electronic identification also requires reading equipment that is appropriate in each working situation and that can function under outdoor conditions. Pig Research Centre are keen to continue developing these activities in the belief that digital identification will assume an increasing role in live pigs.

Daily gain

Recording of daily gain is the pathway towards the optimisation of feed, the key element in pig production. In several projects, Pig Research Centre are currently analysing the value of increasing the monitoring of pig growth rates. These activities include testing of new technical solutions such as the scale shown in Figure 2.

Pigs are weighed when they walk through the scale whereby the daily gain for the pen in question is routinely monitored. Combined with monitoring of feed allocation, this makes it possible to analyse FCR from just a random sample of pigs in a section. Traditionally, daily gain was monitored by weighing batches of pigs



Figure 2 – Pigs are automatically weighed when they pass through the scale.

and using a manual weigh scale. Research with weighing of batches shows that this routine monitoring is highly motivating for the staff as they can clearly see the effects of tending to the pigs – for better or worse.

Recording of current daily gain

- Staff are motivated when they can actually see the pigs' growth curves
- Pigs will respond immediately to system failure
- A representative random sample requires weighing of minimum 10% of the pigs
- Knowledge of daily gain is necessary to be able to calculate current FCR

New tools

In cooperation with AgroSoft, Pig Research Centre are working on developing new tools for monitoring the performance of growing pigs. One important factor is the prerequisite that the pig producer must have access to current productivity figures.

Technologically, the solutions for routine monitoring are available today, but a user interface must be developed to provide pig producers with easy access to key production data. This will provide the pig producers with a whole new set of ways for optimising production.



Figure 1 – Reading of electronic ear tags in the farrowing field.

Strong and impartial pig advisory service

Currently, it is not realistic to set up one pig advisory centre as a joint initiative embracing all Danish advisory centres whereby all would sit around the same table. The chairmen of the local pig advisory offices as well as the leading advisors agree that through the initiative "Development Pigs" many of the benefits that could be obtained through such a nationwide advisory centre are already available.

Until one such pig advisory centre covering all of Denmark becomes a reality, for instance based on a merger of the local advisory centres, Development Pigs is the guarantee that strong and impartial experts will be available for Danish pig producers regardless of the subject matter.

The two-layered advisory system

The knowledge generated by Pig Research Centre is implemented primarily by the local pig advisors and vets. Pig Research Centre *generate* knowledge; vets and advisors *implement* this knowledge. This two-layered system has kept Danish pig producers in the lead for decades.

Modern and future-oriented

The number of vets and advisors has decreased in recent years. The number of pig advisory centres remains unchanged. The number of veterinary practices has decreased and vets increasingly specialise within specific areas. This leads to two questions:

- Is the current organisation of the pig advisory service modern and future-oriented?
- Is the two-layered system modern and future-oriented?

Advice in 2020

The 2020 scenario is a vision of how the Danish pig production industry might look in 2020. The scenario is based on simple projections, which can also be used to project the need for advice in 2020.

These projections will indicate the number of vets and advisors required to meet the need for advice in 2020. This, in turn, leads to the question: How will these vets and advisors be organised?

One pig advisory centre in Denmark

Based on the above projections and questions, chairmen, local committees, leading advisors and the board of Pig Research Centre have discussed the establishment of one pig advisory centre that covers all of Denmark.

Development Pigs

is a joint collaboration between the local pig advisory service and Pig Research Centre.

The purpose of Development Pigs is development of guidelines and to educate expert advisors within all fields of Danish pig production. 65 advisors form part of Development Pigs and are assigned to the specialist groups listed below:

- Liquid feeding
- On-farm mixing of feed
- Growth
- Reproduction
- Management of farrowing and breeding

The pig producer actively participates

Two demonstration projects, financially supported by the EU, focused on cooperation between farmer, vet and advisor, and the outcome was clear: once vet and advisor in cooperation with the pig producer pull in the same directions and pursue the same goals, the chances of success are high. These demonstration projects are the activities in a joint venture between Pig Research Centre and vets/advisors called Vetagro.

Vetagro

The Dept. of Advisory Services and the Dept. of Veterinary Research & Development, Pig Research Centre, vets and pig advisors exchange professional knowledge.

The project was financially supported by the Pig Levy Fund and the Ministry of Food, Agriculture and Fisheries of Denmark, and The European Agricultural Fund for Rural Development. Journal no. 3363-D-11-00508.

2020 scenario:

80% of the production of pigs in Denmark will take place on 700-900 large farms.

The typical weaner producer will have 1,500-3,000 sows on several sites.

The typical finisher producer will produce 30,000-70,000 finishers on several sites.

Each farm will employ 12-15 employees regardless of type of production (weaners/finishers).

Image

Danish pig producers are all interested in improving the image of the pig industry to safeguard their “Licence to operate”.

Modern Danish pig production is something we can be proud of, and that pride must be reclaimed. Recent surveys showed modest improvement in image.

There is a clear perception in society of the financial contribution of the agricultural industry, but progress in terms of animal welfare and environment has not quite reached society.

A good image must be earned, and as animal welfare and environment have in fact improved, we need to communicate the progress made more clearly to society.

The campaign of Danish Agriculture and Food Council also included facts about the pig industry.

One, as shown in the image to the left, focused on the prime quality of our breeding stock and the export this generates.

Recruitment of employees for the pig industry

As part of improving the image, Pig Research Centre ran a recruitment campaign in spring 2013. The background of the campaign was the drop in applicants for pig-related

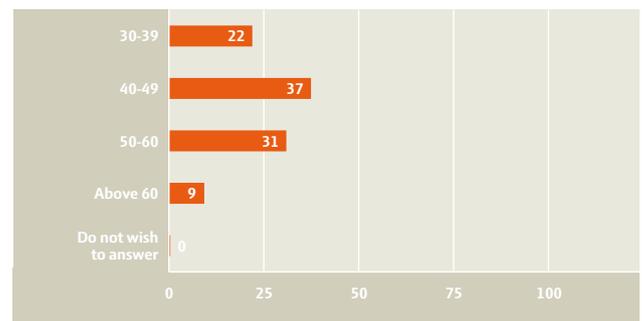
subjects in the agricultural schools, and we need more young people in the pig industry.

Figure 1 shows the age distribution among pig producers, which today does clearly not give cause for alarm. However, ten years down the road, these young farmers will not be so young anymore and farms will have doubled in size.

A new type of business leader will be needed. With emphasis on leader.



Figure 1 - Age distribution among pig producers (survey made by Pig Research Centre in January 2013).



The image of the agricultural industry has improved with the DAFC campaign that promotes facts about the successes of the Danish agricultural industry.

Reports

- No.1209: Intensified advisory course improved productivity on four sow farms
- No.1210: Automatic provision of straw for sows with straw blower
- No.1211: Grinding of grain
- No.1212: Recording of 27 blood parameters in sows one week before farrowing
- No.1301: Conversion of gestation house with crates to group-housing with Simplified Opti-Pen
- No.1302: Straw racks for group-housed gestating sows
- No.1303: Diarrhoea in organic weaners
- No.1304: Bygholm 2 is applicable for all types of pigs
- No.1305: Effect of slurry sticks (Power Packs) on ammonia and odour emissions from finisher facilities
- No.1306: Large drop in antibiotic use
- No.1307: Farrowing huts – material and design
- No.1308: Feed type does not affect prevalence of umbilical hernia
- No.1309: Using pigs' natural behaviour during moving of pigs
- No.1310: Assessment of feeding stations (ESF)
- No.1311: Piglet gain d0-2
- No.1312: Effect of slurry cooling in finisher pens with drained floor in the lying area
- No.1313: Finished diets (2013) complies with guaranteed content
- No.1314: Management of ventilation and heat in pens for loose-housed lactating sows
- No.1315: Reducing feed consumption on sow farms
- No.1316: Large variations in sow weight loss and daily litter gain
- No.1317: Cleaning of grain

Trial reports

- No.951: Floor cooling in farrowing pens with crated sow
- No.952: Fine grinding and BS3 Xylanase improve productivity
- No.953: Acidification system and air cleaning in practice
- No.954: M.M.A. – Effect of treatment with meloxicam and amoxicillin, alone or combined
- No.955: Screening of organic entire males
- No.956: Extra feed for gestating sows for four weeks before farrowing
- No.957: Costs of PRRS in Denmark
- No.958: Separation of liquid manure and solid manure with fertilizer distributor
- No.959: Correlation between leg disorders in sows and floor surface in gestation pens
- No.960: No effect on finisher productivity of Econase XT
- No.961: Effect of socialisation of gilts on longevity
- No.962: Comparison of two vaccines against pneumonia
- No.963: Production traits and economy in production of DLY and LY castrates
- No.964: Large inclusion of rye reduces weaner productivity
- No.965: Validation of device for fully automatic analysis of morphology and morphometry of boar semen
- No.966: Reduction in odour emissions with biological air cleaner from Dorset Milieutechniek B.V.
- No.967: Effect of reduced 5-point plan
- No.968: Two-step nurse sows for small newborn piglets
- No.969: Fertility higher with pooled semen than with semen from one boar
- No.970: Air cleaner with acid from Munters A/S
- No.971: Butirex VFA C4 improves weaner productivity
- No.972: AP Welfare farrowing crate with improved space allowance
- No.973: Comparison of productivity in two different farrowing huts
- No.975: Gastric health in finishers and slaughter sows
- No.976: Mineral diets complied with 2013 guarantees
- No.977: Risk factors for development of PMWS in weaners
- No.978: Effect on tail-biting of housing pigs according to litter
- No.979: Effect of all in-all out at site level

- No.980: No financial gain of phase-feeding with end diet
- No.981: Fine grinding of grain in liquid feed improves productivity

Briefs

- No.1219: Competition for Danish weaners
- No.1220: 2013 key figures
- No.1221: Basis of estimated weaner prices, organic weaners – September 2011
- No.1222: Basis of calculating bonus on Outdoor Weaners – September 2012
- No.1223: Financial state of the art and projections for 2012 and 2013 (September 2012)
- No.1224: Projections for financial results of Danish pig producers 2012-2014
- No.1225: Money in the herds
- No.1226: Nutrient content grain 2012
- No.1227: Organic pig production is profitable
- No.1228: Job satisfaction pays off
- No.1229: Antonius bonus payment 2012/2013
- No.1230: Projection for pig prices, September 2012
- No.1231: Simulation of energy consumption for Dynamic Multistep combined with LPC ventilators from SKOV A/S
- No.1232: Pig production ABC
- No.1233: Projection for pig prices, December 2012
- No.1234: Projections for financial results of Danish pig producers 2012-2014
- No.1235: Basis of calculating bonus on Outdoor Weaners – December 2012
- No.1236: Basis of estimated weaner prices, organic weaners
- No.1237: Basis of estimated weaner prices – December 2012
- No.1301: Financial feasibility studies 2013
- No.1302: Large-scale production benefits
- No.1303: Strategy for buying grain, soy and feed
- No.1304: Preliminary results for pig producers, 2012
- No.1305: Projections for financial results of Danish pig producers 2012-2014
- No.1306: Antibiotics for livestock animals in 19 European countries 2010 – Denmark in the low end
- No.1307: Feed formulation – how to handle effect of phytase, xylanase and acids
- No.1308: Revised amino acid standards for sows and finishers
- No.1309: PCV2 and effect on reproduction
- No.1310: Preliminary results for pig producers, 2012
- No.1311: Spread sheet for reporting changes on pig farms
- No.1312: Background of revision of amino acid standards for lactating sows
- No.1313: Business check pigs 2012
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