Preface

Economy
Demands keep increasing to the Danish slaughterhouse and pig producers. This is nothing new. It is, however, something new that the Danish slaughterhouses have failed to match the German slaughterhouses for a long period of time.

The National Committee has conducted an analysis of the situation to clarify the economy of both Danish and German pig producers. The main conclusion is that settlement prices are higher in Germany, but so are the production costs, not least in the sow herds. Overall, German and Danish pig producers have the same economy. This analysis also showed that with the current settlement systems and export costs, there must be a price difference of DKK 1.92 per kg before it is an advantage for a producer delivering 5,000 finishers to export his pigs.

Increasing exports and decreasing number of slaughterings
If the level remains the same for the rest of 2005, there will be a dramatic increase in weaner exports, but the exports of finishers will also have increased significantly. Overall, this results in a decrease in slaughterings of almost one million finishers. This is a completely new situation in Denmark after many years with steadily increasing production.

This development is sped up by cultural and environmental legislation that almost forces young pig producers to establish large sow herds with or without weaner production, but hardly ever finisher herds. If the advantages of large operations can be utilized, the economy of a finisher production is the same as in a sow herd.

If we want our pig industry to be competitive in 5-10 years, it is time to start dealing with framework conditions such as:
- Reduced requirement for ownership of land
- Increased flexibility in terms of collecting the livestock units of a farm on few sites
- An increase in or elimination of the ceiling on number of livestock units
- An increase in the number of pigs
- Adjustments of standards, the addition of phytase and generally a higher efficiency, the pig sector will be able to reach a sustainable level in the slurry within a number of years that corresponds to the plants’ need.

Animal welfare
Besides a number of scientific animal welfare projects concerning rooting materials, reduced mortality, loose lactating sows etc., the National Committee conducted an extensive animal welfare campaign. All pig producers received posters to be placed in the housing unit concerning, for instance, enrichment and rooting materials, hospital pens, and destruction.

The 5% inspections made by the Danish Veterinary and Food Administration showed that further measures still need be taken to comply with animal welfare legislation.

Health and antibiotics
PMWS is a widespread disease. The cause has not been established fully, and it has been abandoned to make a declaration system at sale of breeding stock and weaners. PMWS can cause great problems, and it is documented that many herds have an increased consumption of antibiotics. This is, unfortunately, also reflected in the national figures for consumption of antibiotics, which gives rise to concern and to negative publicity of pig production. We must, however, keep in mind that the level is very low in Denmark compared with virtually all other countries.

Efficiency and productivity
The new breeding objective, LP5 (live piglets on day 5), has been incorporated in the breeding work and this will hopefully result in stronger pigs and reduced mortality within a few years. The National Committee will give a high priority to feed conversion and mortality in the coming years. Many improvements can still be made in both areas.

Thank you
The most important task by far of the National Committee is to ensure the Danish pig producers new scientific knowledge and thereby competitiveness in the future. On behalf of the National Committee, we would like to thank everybody contributing to the development of the Danish pig industry. A special thank you goes to the pig producers who, during the year, have made their herds available to the many research projects and trials.

Yours sincerely
The National Committee for Pig Production
Lindhart B. Nielsen / Orla Grøn Pedersen
The National Committee for Pig Production

Chairman, farmer
Lindhart Bryder Nielsen, Løgstør
Elected at the annual meeting

Vice-chairman, farmer
Hans Peter Steffensen, Sanderborg
Elected by Region 2
(Southern Jutland and Funen)

Vice-chairman, farmer
Jens Gade Holm, Hurup
Elected at the annual meeting

Farmer Asger Krogsgaard, Ringkøbing
Elected by the Danish Bacon and Meat Council

Farmer Jens Jørgen Henriksen, Thisted
Elected by the Danish Bacon and Meat Council

Farmers Jens Ejner Christensen, Jelling
Elected by Danish Agriculture

Farmer Erik Larsen, Dalmose
Elected by Region 1 (Eastern part of Denmark)

Farmer Claus Nergård, Hadsund
Elected by Region 3 (North and Central Jutland)

Smallholder Søren Hansen, Snedsted
Elected by the Danish Family Farmers’ Association

Farmer Boye Bill Jensen,
Elected by the Danish Pig Producers’ Association

Smallholder Knud Madsen,
Elected by the National Council for Pigs of the Danish Family Farmers’ Association

Director Orla Grøn Pedersen,
The National Committee for Pig Production
## Contents of the annual report 2005

<table>
<thead>
<tr>
<th>Contents</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preface</td>
<td>1</td>
</tr>
<tr>
<td>The National Committee for Pig Production</td>
<td>2</td>
</tr>
<tr>
<td>Contents</td>
<td>3</td>
</tr>
<tr>
<td>Budget and strategy</td>
<td>4</td>
</tr>
<tr>
<td>Productivity</td>
<td>5</td>
</tr>
<tr>
<td>Production economics</td>
<td>6</td>
</tr>
<tr>
<td>Increased weight limits for finishers</td>
<td>7</td>
</tr>
<tr>
<td>Genetic progress</td>
<td>8</td>
</tr>
<tr>
<td>Production level</td>
<td>9</td>
</tr>
<tr>
<td>Research and development</td>
<td>10-13</td>
</tr>
<tr>
<td>AI and insemination</td>
<td>14-15</td>
</tr>
<tr>
<td>Nursing sows</td>
<td>16</td>
</tr>
<tr>
<td>Management of body condition</td>
<td>17</td>
</tr>
<tr>
<td>Feeding of weaners</td>
<td>18-20</td>
</tr>
<tr>
<td>Fat in feed</td>
<td>21</td>
</tr>
<tr>
<td>Feed conversion in finishers / Liquid feed</td>
<td>22-23</td>
</tr>
<tr>
<td>Segregation</td>
<td>24</td>
</tr>
<tr>
<td>Energy value of cereal</td>
<td>25</td>
</tr>
<tr>
<td>Phosphorus and phytase</td>
<td>26</td>
</tr>
<tr>
<td>Environmental efforts</td>
<td>27</td>
</tr>
<tr>
<td>Odour / Ammonia / Purification of air</td>
<td>28-31</td>
</tr>
<tr>
<td>Diffuse air intake in farrowing units / Ventilation</td>
<td>32-33</td>
</tr>
<tr>
<td>Housing of sows</td>
<td>34-35</td>
</tr>
<tr>
<td>Lactating sows</td>
<td>36-37</td>
</tr>
<tr>
<td>Tail biting / Housing of weaners and finishers</td>
<td>38-39</td>
</tr>
<tr>
<td>Animal welfare and legislation</td>
<td>40</td>
</tr>
<tr>
<td>5% inspections</td>
<td>41</td>
</tr>
<tr>
<td>Good environment in hospital pens</td>
<td>42</td>
</tr>
<tr>
<td>Pain relief</td>
<td>43</td>
</tr>
<tr>
<td>Healthy sows</td>
<td>44</td>
</tr>
<tr>
<td>Multi-site and respiratory disorders</td>
<td>45</td>
</tr>
<tr>
<td>Salmonella</td>
<td>46</td>
</tr>
<tr>
<td>Focus on PMWS</td>
<td>47</td>
</tr>
<tr>
<td>Antibiotics</td>
<td>48</td>
</tr>
<tr>
<td>Health economics</td>
<td>49</td>
</tr>
<tr>
<td>Free-living wild boars and swine fever</td>
<td>50</td>
</tr>
<tr>
<td>The digital pig facility of the future</td>
<td>51</td>
</tr>
<tr>
<td>The Minigris gives an updated overview of the housing facility</td>
<td>52-53</td>
</tr>
<tr>
<td>Development of advisory tools</td>
<td>54</td>
</tr>
<tr>
<td>Successful weaner production</td>
<td>55</td>
</tr>
<tr>
<td>Published results 2004-2005</td>
<td>56</td>
</tr>
<tr>
<td>Subject index</td>
<td>57</td>
</tr>
</tbody>
</table>
The National Committee for Pig Production is founded by three basis organisations: the Danish Bacon & Meat Council, Danish Agriculture, and the Danish Pig Producers’ Association. Besides representatives from these organisations, the National Committee consists of pig producers elected at the annual meeting and members elected by the regional pig production committees.

The National Committee for Pig Production safeguards strategy, development and information tasks concerning the live pig, and has an ordinary net budget for the year 2005/2006 of DKK 103.9 million.

Strategy and new projects of the National Committee

For a long period of time, the National Committee has been making an extra environmental effort, not least in terms of reduction of odour and ammonia emissions.

In the past couple of years, the National Committee has focused intensively on animal welfare with a campaign aimed at pig producers and their advisers.

In an attempt to improve efficiency and economy in finisher production, a number of projects are initiated focusing on feed conversion and mortality.

On adoption of the budget for 2005/2006, the National Committee decided to initiate the following new projects:

**Environment:**
- Environment economics for nitrogen and odour
- Reduction of odorants
- Development of methods for measuring odour
- Herd variation in odour
- Reduced ventilation and partial air purification
- Biological air purification in ventilation funnels
- Open burning of animal biomass

**Efficiency:**
- Characterisation and management of liquid feed quality
- Enzymes for improving feed conversion
- Focus on soybean meal
- Improved feed conversion
- Fusarium toxins
- Feed that improves satiety
- Dimensions of feeding points during restrictive feeding
- Efficient young females
- Joint platform for exchanging data
- Solid floors without mess

**Housing and production systems**
- IT in health surveillance
- The use of hospital pens and hospital sections
- Relief pens for weaners and finishers
- Automatic weighing of finishers
- Automatic washers
- Frame conditions in selected EU countries
- Alternative destruction of dead pigs

**Health and immunity**
- Pain relief of infection diseases
- Prevention of ear necrosis
- Leg health in young females
- Vaccine against Mycoplasma arthritis

---

**Budget and strategy**

The National Committee for Pig Production Annual Report 2005

- **Statistics**
  - Breeding and Multiplication
    - Breeding consultancy
    - Breeding calculation
    - Experimental stations
    - Meat and slaughter quality
    - Breeding objectives
    - Genetics
    - KerneStyring®
    - Guidelines for breeding and multiplication
  - Housing and production systems
    - Odour from housing units
    - Ammonia
    - Slurry treatment
    - Unproblematic weaning
    - Service and gestation units
    - Sow longevity
    - Farrowing pens for loose sows
    - Tail biting
    - Slurry systems
    - Enrichment and rooting materials
    - Batch production
    - Climate and ventilation in the housing unit
    - Liquid feed for weaners
    - Work environment
    - Production and health economics
    - Product trials
    - Information technology
    - Outdoor production
    - Ecology
    - The Danish Applied Pig Research Scheme
  - Nutrition & Reproduction
    - Feed and nutrients
    - Commercial diets
    - Product trials
    - Gastric health
    - Unproblematic weaning
    - Regulation of behaviour by way of nutrition
    - Feeding techniques
    - Reduction of N and P
    - Feed evaluation
    - Reproduction
    - AI studies
    - Management of immunity
    - Experimental stations
  - Veterinary department (live pig)
    - Respiratory disorders
    - Management of disease and immunity
    - Health-promoting production systems
    - PMWS
    - Intestinal diseases
    - Arthropathy
    - Salmonella
    - Pain relief
    - Vaccination
    - Reduced consumption of antibiotics
    - Eradication models
    - Health surveillance
    - Service tasks
    - Laboratories
  - Management and co-ordination
    - The National Committee for Pig Production
    - Information
    - Contact to the authorities
    - Economy
    - Co-ordination of projects
  - Advisory service
    - Software and service
    - Environmental advice
    - Advisory offices
    - Production statistics and economics
    - Quality control
    - Supplementary training

- **Net budget, DKK million**
  - Breeding and Multiplication: 24.7
  - Housing and production systems: 22.8
  - Nutrition & Reproduction: 21.2
  - Veterinary department (live pig): 16.9
  - Management and co-ordination: 10.5
  - Advisory service: 7.7
Development
After a small drop in the sow population from 2003 to 2004, the population has increased again to 1,041,000 sows in 2003 and a population of 1,044,000 sows is expected in 2004. Overall, this results in a production of 24.7 million finishers in 2004.

Results from herds with Production Reports
Sows
The number of pigs born and produced in all herds is still increasing. 23.7 pigs were produced per sow/year and efficiency increased by 0.2 piglets per sow/year versus 0.4 last year. This increase is based on 12.9 live born piglets per litter, which is an increase of 0.3 piglets compared with 2003. Of these pigs, 11.1 pigs are weaned per litter, which is an increase of 0.2 piglets compared with 2003. Non-productive days still average 16 for all herds, and the average daily gain has increased slightly to 420 g.

The best herds are characterised by a much better utilization of their breeding stock. The sows in the top 25% of the herds have 2.31 litters per sow/year versus 2.16 in the bottom 25%. They have significantly fewer non-productive days – 11.7 for the top 25% versus 20.6 for the bottom 25%. This higher utilization is also found in the daily gain among the weaned pigs that grow 25 g more a day and thereby take 7 days less in reaching 30 kg.

Finishers
For finishers, the average daily gain is unchanged, but the feed conversion has generally worsened slightly, as the feed consumption has increased by 0.03 to 2.88 FUgp per kg gain. When comparing the top 25% with the bottom 25%, the top have a higher daily gain of 888 g versus 760 g a day for the bottom 25%. Furthermore, the figures for dead, rejected and incidences of pleurisy recorded at slaughter indicate that the top 25% of the herds generally have a better health status.

Productivity

<table>
<thead>
<tr>
<th>Year</th>
<th>1999</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003***</th>
<th>2004</th>
<th>2005*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sows, 1,000</td>
<td>1080</td>
<td>1070</td>
<td>1130</td>
<td>1128</td>
<td>1141</td>
<td>1144</td>
<td>1150</td>
</tr>
<tr>
<td>Prod. million**</td>
<td>22.5</td>
<td>22.4</td>
<td>22.9</td>
<td>24.0</td>
<td>24.3</td>
<td>24.7</td>
<td>25.2</td>
</tr>
<tr>
<td>Slaughter weight, kg</td>
<td>76.6</td>
<td>77.1</td>
<td>77.9</td>
<td>78.1</td>
<td>77.7</td>
<td>78.5</td>
<td>80.0</td>
</tr>
<tr>
<td>Lean meat %</td>
<td>60.0</td>
<td>60.0</td>
<td>60.0</td>
<td>60.0</td>
<td>60.0</td>
<td>60.0</td>
<td>60.0</td>
</tr>
</tbody>
</table>

** incl. export of live animals, and sows, boars, young sows etc.
*** 53 weeks

<table>
<thead>
<tr>
<th>Year</th>
<th>2002 All</th>
<th>2003 All</th>
<th>Average production results</th>
<th>2004 All</th>
<th>2004 Bottom 25%</th>
<th>2004 Best 25%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight/sold pig, kg</td>
<td>29.9</td>
<td>29.9</td>
<td>30.6</td>
<td>30.8</td>
<td>29.6</td>
<td></td>
</tr>
<tr>
<td>Feed/produced pig, FUgp*</td>
<td>106</td>
<td>108</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Prod. pigs/sow/year</td>
<td>23.1</td>
<td>23.5</td>
<td>23.7</td>
<td>20.6</td>
<td>26.6</td>
<td></td>
</tr>
<tr>
<td>Litters/sow/year</td>
<td>2.25</td>
<td>2.25</td>
<td>2.24</td>
<td>2.16</td>
<td>2.31</td>
<td></td>
</tr>
<tr>
<td>Sows/year</td>
<td>267</td>
<td>284</td>
<td>303</td>
<td>239</td>
<td>364</td>
<td></td>
</tr>
<tr>
<td>First parity litters, %</td>
<td>21.0</td>
<td>22.0</td>
<td>22.3</td>
<td>22.8</td>
<td>21.6</td>
<td></td>
</tr>
<tr>
<td>Live born/litter</td>
<td>12.3</td>
<td>12.6</td>
<td>12.9</td>
<td>12.3</td>
<td>13.4</td>
<td></td>
</tr>
<tr>
<td>Stillborn/litter</td>
<td>1.3</td>
<td>1.4</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td>Weaned/litter</td>
<td>10.7</td>
<td>10.9</td>
<td>11.1</td>
<td>10.3</td>
<td>11.8</td>
<td></td>
</tr>
<tr>
<td>Age at weaning, days</td>
<td>30</td>
<td>31</td>
<td>31</td>
<td>32.3</td>
<td>29.7</td>
<td></td>
</tr>
<tr>
<td>Weaning weight, kg</td>
<td>7.2</td>
<td>7.3</td>
<td>7.3</td>
<td>7.4</td>
<td>7.1</td>
<td></td>
</tr>
<tr>
<td>Mortality post-weaning, %</td>
<td>3.6</td>
<td>4.2</td>
<td>4.4</td>
<td>6.8</td>
<td>2.7</td>
<td></td>
</tr>
<tr>
<td>ADG post-weaning, g</td>
<td>410</td>
<td>416</td>
<td>420</td>
<td>404</td>
<td>429</td>
<td></td>
</tr>
<tr>
<td>Age at 30 kg, days</td>
<td>86</td>
<td>86.1</td>
<td>86.1</td>
<td>89.7</td>
<td>82.8</td>
<td></td>
</tr>
<tr>
<td>Non-productive days/litter</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>20.6</td>
<td>11.7</td>
<td></td>
</tr>
</tbody>
</table>

* incl. feed for young sows

<table>
<thead>
<tr>
<th>Year</th>
<th>2002 All</th>
<th>2003 All</th>
<th>Average production results</th>
<th>2004 All</th>
<th>2004 Bottom 25%</th>
<th>2004 Top 25%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prod. pigs</td>
<td>3,748</td>
<td>4,143</td>
<td>4,242</td>
<td>3,646</td>
<td>4,198</td>
<td></td>
</tr>
<tr>
<td>Daily gain, g</td>
<td>831</td>
<td>832</td>
<td>833</td>
<td>760</td>
<td>888</td>
<td></td>
</tr>
<tr>
<td>Feed/kg gain, FUgp</td>
<td>2.87</td>
<td>2.85</td>
<td>2.88</td>
<td>3.13</td>
<td>2.68</td>
<td></td>
</tr>
<tr>
<td>Weight at transfer to finisher unit, kg</td>
<td>31.7</td>
<td>31.6</td>
<td>32.4</td>
<td>32.7</td>
<td>32.4</td>
<td></td>
</tr>
<tr>
<td>Av. slaughter weight, kg</td>
<td>77.7</td>
<td>77.1</td>
<td>78.0</td>
<td>77.7</td>
<td>78.1</td>
<td></td>
</tr>
<tr>
<td>Av. lean meat %</td>
<td>60.1</td>
<td>60.1</td>
<td>60.2</td>
<td>60.2</td>
<td>60.2</td>
<td></td>
</tr>
<tr>
<td>Dead and culled, %</td>
<td>3.8</td>
<td>4.0</td>
<td>4.5</td>
<td>5.8</td>
<td>3.8</td>
<td></td>
</tr>
<tr>
<td>Incidence of pleurisy rec. at slaughter</td>
<td>20.1</td>
<td>22.7</td>
<td>26.5</td>
<td>29.9</td>
<td>23.9</td>
<td></td>
</tr>
<tr>
<td>Total incl. deduction, %</td>
<td>12.0</td>
<td>13.7</td>
<td>16.8</td>
<td>18.6</td>
<td>15.4</td>
<td></td>
</tr>
</tbody>
</table>
Financial results
Danish herds have doubled in size over the last ten years.

In 1995, the average herd size was 124 sows/year, which increased to 257 in 2004. Correspondingly, the number of produced finishers increased from 1,757 to 3,043 per herd in the same period. Productivity increased by 1.4 pigs per sow/year from 21.7 to 23.1. The land of the herds increased from 66.7 ha to 111 ha per farm.

Figure 1 shows the net price index of the development in pig prices and gross margin based on contribution accounts and sector production accounts from 1980 to 2004.

The gross margin clearly reflects the annual development in pig prices. If the curves are analysed over the entire period, a decreasing price per finisher is seen. The gross margin curves follow the development in price as the price is essential to the gross margin.

Motivation and binding consultancy
The results of the sow herds’ production reports show that the top 25% have six pigs more per sow/year than the bottom 25%.

There is a great risk that those who do not see themselves among the top 25% feel demotivated by such information. Interplay with one or more advisers may help a producer rise above the negative spiral and change the development.

Experience shows that agreements on goals, time frames and follow-ups are highly efficient tools. In two herds, this resulted in an improved gross margin of DKK 843-1,370 per sow/year. Costs for investments or other expenses must be deducted from this. The efforts primarily included changes in routines and, to a limited degree, investments.

It is crucial to keep in mind that motivation at all levels is essential—from the owner to the youngest farm apprentice. The strategies for maintaining the motivation, however, differ.

Figure 2 shows the results from a study of the mental work environment in which both self-employed and employees were asked to express the qualities they value in their work.

Figure 1. Index of price and gross margin. Correction for development in net price index. Source: Pig leaflet "Production economics 2005, pigs" from the National Centre.

Figure 2. Qualities in work. Source: Pig leaflet "Production economics 2005, pigs" from the National Centre.
In 2005, Danish Crown increased the top weight limit to 84.9 kg and Tican to 82.9 kg. Danish Crown furthermore increased the limit for underweight from 67 kg to 70 kg.

An increase in the weight limits in reduces costs in finisher production. Farms that do not have the possibility for increasing the slaughter weight will instead get a reduced deduction in the price. An increased slaughter weight can have different consequences in the production that are important to the production authorisation or cause a drop in the number of produced pigs. It is up to the individual finisher producer to assess whether an increased slaughter weight will increase the number of livestock units or reduce the number of produced pigs because of an increased in feeding days per pig.

An increased slaughter weight reduces the costs per kg produced meat as long as the increase in variable costs and fixed costs does not exceed the decrease in weaner costs. Particularly feed costs increase dramatically with increasing slaughter weight. Fixed costs also increase because space requirements increase. However, if the pricing system does not give deductions for the smaller pigs, it is possible, through delivery strategy, to keep fixed costs largely constant up to 90 kg slaughter weight. To obtain this, the same number of pigs must be transferred to a finisher pen from the beginning of the growth period, e.g. 30 kg.

The increased space requirement in the last part of the growth period is adjusted through the delivery strategy. Delivery by pens is not possible under these conditions as the pen must be emptied over minimum two times.

### Weighing for slaughter

In order to utilise the possibilities of the new weight limits, it is necessary to revise the guidelines used on the farms in connection with weighing and registration of finishers. When weighing out pigs for slaughter, the producer must be aware of the following.

### Economically optimum slaughter weight

With a basic price in the weight interval 70-85 kg slaughter weight, the economically optimum slaughter weight will be 80 kg with continuous production. In a given housing unit with 2,200 place units, an increased slaughter weight will result in a drop in the number of produced pigs while the number of livestock units (LU) increase at the same time. If the number of LU is to be kept at the same level, the most optimum solution will be to maintain slaughter weight. The slaughter weight should only be increased if doing so does not increase feed conversion per kg gain or reduce lean meat percentage.

#### Prerequisites

<table>
<thead>
<tr>
<th></th>
<th>DKK 8.50</th>
<th>DKK 0.70</th>
<th>DKK 1.14</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic price</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bonus payment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feed price, per FUp</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Production cost per kg carcass under different slaughter weights

<table>
<thead>
<tr>
<th>Slaughter weight, kg</th>
<th>78</th>
<th>80</th>
<th>82</th>
<th>84</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed conversion</td>
<td>2.80</td>
<td>2.82</td>
<td>2.84</td>
<td>2.86</td>
</tr>
<tr>
<td>Lean meat %</td>
<td>60.2</td>
<td>60.0</td>
<td>59.8</td>
<td>59.6</td>
</tr>
<tr>
<td>Price per kg</td>
<td>9.17</td>
<td>9.13</td>
<td>9.06</td>
<td>8.97</td>
</tr>
<tr>
<td>Prod. pigs/place unit, annually</td>
<td>3.89</td>
<td>3.76</td>
<td>3.65</td>
<td>3.54</td>
</tr>
<tr>
<td>GM/pig</td>
<td>130</td>
<td>135</td>
<td>137</td>
<td>137</td>
</tr>
</tbody>
</table>

### Economy in finisher production under different weight limits

<table>
<thead>
<tr>
<th></th>
<th>78</th>
<th>80</th>
<th>82</th>
<th>84</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slaughter weight, kg</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feed conversion</td>
<td>2.80</td>
<td>2.82</td>
<td>2.84</td>
<td>2.86</td>
</tr>
<tr>
<td>Lean meat %</td>
<td>60.2</td>
<td>60.0</td>
<td>59.8</td>
<td>59.6</td>
</tr>
<tr>
<td>Price per kg</td>
<td>9.17</td>
<td>9.13</td>
<td>9.06</td>
<td>8.97</td>
</tr>
<tr>
<td>Prod. pigs/place unit, annually</td>
<td>3.89</td>
<td>3.76</td>
<td>3.65</td>
<td>3.54</td>
</tr>
<tr>
<td>GM/pig</td>
<td>130</td>
<td>135</td>
<td>137</td>
<td>137</td>
</tr>
</tbody>
</table>

With 250 LU, the annual optimum slaughter weight is 78 kg.
Table 1 provides an outline of the genetic progress of the individual breeds over the last four years. The variation in genetic progress between the individual breeds is caused by the different breeding objectives and genetic potential between the sow breeds and the boar breeds. The breeding objectives were revised in June 2004. The number of live piglets per litter five days after farrowing (LP5) is a combined breeding objective of litter size and survival. In particular Landrace has seen great genetic progress, primarily due to an improved survival rate among the piglets. The improvement in LP5 explains a large part of the economic progress in Landrace. Large White follows the LP5 increase of the past years. In the sow breeds, there is a negative trend in killing-out percentage. This trait was therefore included in the breeding objective last year. Progress is, however, not expected until next year, as this trait is not as highly weighted as, for instance, LP5.

Sale of breeding stock

As seen in table 2, the sale of hybrid females is unchanged at a high level, while the decreasing tendency continues among the purebred females. The development towards increased use of AI is reflected in the decreasing sale of boars.

Table 1. Genetic progress in the last four years, per breed and year and stated as average per breed per year.

<table>
<thead>
<tr>
<th>Breed</th>
<th>Year</th>
<th>Daily gain (30-100 kg), g/day</th>
<th>Feed conversion, FUp/kg daily gain</th>
<th>Lean meat, %</th>
<th>LP5</th>
<th>Conformation, points</th>
<th>Daily gain (0-30 kg), g/day</th>
<th>Killing-out percentage, %</th>
<th>Progress, DKK/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duroc</td>
<td>01/02</td>
<td>19.2</td>
<td>-0.04</td>
<td>0.09</td>
<td>0.03</td>
<td>0.03</td>
<td>2.0</td>
<td>+0.16</td>
<td>7.21</td>
</tr>
<tr>
<td></td>
<td>02/03</td>
<td>20.0</td>
<td>-0.04</td>
<td>0.13</td>
<td>0.15</td>
<td>0.03</td>
<td>3.0</td>
<td>+0.06</td>
<td>7.66</td>
</tr>
<tr>
<td></td>
<td>03/04</td>
<td>17.5</td>
<td>-0.04</td>
<td>0.13</td>
<td>0.04</td>
<td>0.05</td>
<td>3.4</td>
<td>+0.16</td>
<td>7.70</td>
</tr>
<tr>
<td></td>
<td>04/05</td>
<td>19.8</td>
<td>-0.03</td>
<td>0.12</td>
<td>0.05</td>
<td>0.02</td>
<td>3.7</td>
<td>+0.20</td>
<td>7.65</td>
</tr>
<tr>
<td>Average 4 years</td>
<td></td>
<td>19.1</td>
<td>-0.04</td>
<td>0.12</td>
<td>0.07</td>
<td>0.03</td>
<td>3.0</td>
<td>+0.15</td>
<td>7.55</td>
</tr>
<tr>
<td>Hampshire</td>
<td>01/02</td>
<td>0.9</td>
<td>0.01</td>
<td>-0.01</td>
<td>-</td>
<td>-0.03</td>
<td>0.2</td>
<td>+0.04</td>
<td>-0.78</td>
</tr>
<tr>
<td></td>
<td>02/03</td>
<td>9.6</td>
<td>-0.01</td>
<td>0.08</td>
<td>-</td>
<td>0.02</td>
<td>0.3</td>
<td>+0.04</td>
<td>3.19</td>
</tr>
<tr>
<td></td>
<td>03/04</td>
<td>13.2</td>
<td>-0.03</td>
<td>0.18</td>
<td>-</td>
<td>-0.01</td>
<td>-0.3</td>
<td>+0.07</td>
<td>5.60</td>
</tr>
<tr>
<td></td>
<td>04/05</td>
<td>12.4</td>
<td>-0.04</td>
<td>0.24</td>
<td>-</td>
<td>0.03</td>
<td>0.9</td>
<td>+0.04</td>
<td>6.92</td>
</tr>
<tr>
<td>Average 4 years</td>
<td></td>
<td>9.0</td>
<td>-0.02</td>
<td>0.12</td>
<td>-</td>
<td>0.00</td>
<td>0.3</td>
<td>+0.05</td>
<td>3.73</td>
</tr>
<tr>
<td>Landrace</td>
<td>01/02</td>
<td>12.2</td>
<td>-0.03</td>
<td>0.04</td>
<td>0.02</td>
<td>0.06</td>
<td>-0.8</td>
<td>-0.02</td>
<td>6.07</td>
</tr>
<tr>
<td></td>
<td>02/03</td>
<td>16.0</td>
<td>-0.03</td>
<td>0.06</td>
<td>0.12</td>
<td>0.03</td>
<td>0.6</td>
<td>-0.04</td>
<td>10.06</td>
</tr>
<tr>
<td></td>
<td>03/04</td>
<td>9.3</td>
<td>-0.02</td>
<td>0.09</td>
<td>0.19</td>
<td>0.03</td>
<td>-1.0</td>
<td>-0.03</td>
<td>11.60</td>
</tr>
<tr>
<td></td>
<td>04/05</td>
<td>20.1</td>
<td>-0.04</td>
<td>0.03</td>
<td>0.33</td>
<td>0.05</td>
<td>0.2</td>
<td>-0.19</td>
<td>19.56</td>
</tr>
<tr>
<td>Average 4 years</td>
<td></td>
<td>14.4</td>
<td>-0.03</td>
<td>0.06</td>
<td>0.17</td>
<td>0.04</td>
<td>-0.3</td>
<td>-0.07</td>
<td>11.82</td>
</tr>
<tr>
<td>Large</td>
<td>01/02</td>
<td>16.0</td>
<td>-0.03</td>
<td>0.07</td>
<td>0.20</td>
<td>0.09</td>
<td>1.6</td>
<td>-0.13</td>
<td>14.86</td>
</tr>
<tr>
<td>White</td>
<td>02/03</td>
<td>11.6</td>
<td>-0.03</td>
<td>0.04</td>
<td>0.17</td>
<td>0.07</td>
<td>2.3</td>
<td>-0.13</td>
<td>11.99</td>
</tr>
<tr>
<td></td>
<td>03/04</td>
<td>15.2</td>
<td>-0.03</td>
<td>0.01</td>
<td>0.28</td>
<td>0.07</td>
<td>0.4</td>
<td>-0.09</td>
<td>16.61</td>
</tr>
<tr>
<td></td>
<td>04/05</td>
<td>6.6</td>
<td>-0.02</td>
<td>0.07</td>
<td>0.25</td>
<td>0.07</td>
<td>-0.5</td>
<td>-0.06</td>
<td>14.74</td>
</tr>
<tr>
<td>Average 4 years</td>
<td></td>
<td>12.4</td>
<td>-0.03</td>
<td>0.05</td>
<td>0.23</td>
<td>0.08</td>
<td>0.9</td>
<td>-0.10</td>
<td>14.55</td>
</tr>
<tr>
<td>Average 4 breeds 4 years</td>
<td></td>
<td>13.7</td>
<td>-0.03</td>
<td>0.09</td>
<td>0.20</td>
<td>0.02**/0.06*</td>
<td>1.0</td>
<td>+0.01</td>
<td>9.41</td>
</tr>
</tbody>
</table>

*: Average of Landrace and Large White. **: Average of Duroc and Hampshire.

Table 2. Sale of breeding stock – sales figures

<table>
<thead>
<tr>
<th>Breed</th>
<th>Female animals</th>
<th>Male animals</th>
<th>Female animals</th>
<th>Male animals</th>
<th>Female animals</th>
<th>Male animals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2003/04</td>
<td>2004/05</td>
<td>2003/04</td>
<td>2004/05</td>
<td>2003/04</td>
<td>2004/05</td>
</tr>
<tr>
<td>Landrace</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPF etc.</td>
<td>5,140</td>
<td>4,689</td>
<td>5,262</td>
<td>2,409</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Own sale</td>
<td>407</td>
<td>284</td>
<td>16</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Large White</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPF etc.</td>
<td>2,115</td>
<td>980</td>
<td>1,845</td>
<td>2,026</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Own sale</td>
<td>78</td>
<td>69</td>
<td>36</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duroc</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPF etc.</td>
<td>79</td>
<td>127</td>
<td>49</td>
<td>197</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Own sale</td>
<td>-</td>
<td>5</td>
<td>63</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hampshire</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPF etc.</td>
<td>-</td>
<td>1</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Own sale</td>
<td>-</td>
<td>1</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All four</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPF etc.</td>
<td>7,334</td>
<td>7,157</td>
<td>1,372</td>
<td>1,230</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Own sale</td>
<td>485</td>
<td>359</td>
<td>125</td>
<td>95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Purebred, total</td>
<td>7,819</td>
<td>5,796</td>
<td>7,516</td>
<td>4,640</td>
<td></td>
<td></td>
</tr>
<tr>
<td>hybrids</td>
<td>SPF etc.</td>
<td>241,211</td>
<td>38,719</td>
<td>236,876</td>
<td>43,452</td>
<td></td>
</tr>
<tr>
<td>Own sale</td>
<td>15,621</td>
<td>18,884</td>
<td>282</td>
<td>304</td>
<td>241</td>
<td>152</td>
</tr>
<tr>
<td>Hybrids, total</td>
<td>295,662</td>
<td>299,212</td>
<td>4,025</td>
<td>3,096</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* incl. export
Tables 3-7 show the production results achieved at the test station and in the nucleus herds in 2004/2005.

Since 2003/2004, farm testing has increased by 6.4% on average. The number of performance tested Large White boars and Hampshire boars have increased by 10% and 12%, respectively.

The testing of young females in the nucleus herds has increased by 8%.

Despite an eradication period of eight weeks due to PMWS, 3,617 boars were tested at Bøgildgård, which is a 17% decrease compared with the year before. Of these, 492 were selected for AI. The other boars were slaughtered and contribute via slaughter records to the estimation of breeding values for killing-out percentage.

Table 3. Average production results of boars performance tested at Bøgildgård, 2004/2005

<table>
<thead>
<tr>
<th>Breed</th>
<th>Number</th>
<th>Daily gain, g/day (30-100 kg)</th>
<th>Feed conversion (FUp/kg gain)</th>
<th>Lean meat %</th>
<th>Killing-out percentage, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duroc</td>
<td>1125</td>
<td>984</td>
<td>2.35</td>
<td>59.8</td>
<td>74.3</td>
</tr>
<tr>
<td>Hampshire</td>
<td>502</td>
<td>873</td>
<td>2.41</td>
<td>62.1</td>
<td>74.4</td>
</tr>
<tr>
<td>Landrace</td>
<td>918</td>
<td>912</td>
<td>2.40</td>
<td>61.2</td>
<td>74.4</td>
</tr>
<tr>
<td>Large White</td>
<td>896</td>
<td>918</td>
<td>2.32</td>
<td>61.4</td>
<td>74.3</td>
</tr>
<tr>
<td>Total</td>
<td>3441</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 4. Nucleus herds – average production results for boars, 2004/2005

<table>
<thead>
<tr>
<th>Breed</th>
<th>Number</th>
<th>Daily gain, g/day (0-30 kg)</th>
<th>Daily gain, g/day (30-100 kg)</th>
<th>Lean meat %</th>
<th>Conformation, points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duroc</td>
<td>10044</td>
<td>375</td>
<td>1025</td>
<td>59.9</td>
<td>2.89</td>
</tr>
<tr>
<td>Hampshire</td>
<td>393</td>
<td>362</td>
<td>839</td>
<td>61.9</td>
<td>2.91</td>
</tr>
<tr>
<td>Landrace</td>
<td>18641</td>
<td>377</td>
<td>965</td>
<td>62.2</td>
<td>2.94</td>
</tr>
<tr>
<td>Large White</td>
<td>14699</td>
<td>360</td>
<td>939</td>
<td>61.4</td>
<td>3.02</td>
</tr>
<tr>
<td>Total</td>
<td>46477</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 5. Nucleus herds – average production results for young sows, 2004/2005

<table>
<thead>
<tr>
<th>Breed</th>
<th>Number</th>
<th>Daily gain, g/day (0-30 kg)</th>
<th>Daily gain, g/day (30-100 kg)</th>
<th>Lean meat %</th>
<th>Conformation, points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duroc</td>
<td>11210</td>
<td>373</td>
<td>975</td>
<td>60.1</td>
<td>2.98</td>
</tr>
<tr>
<td>Hampshire</td>
<td>3802</td>
<td>363</td>
<td>806</td>
<td>61.8</td>
<td>3.05</td>
</tr>
<tr>
<td>Landrace</td>
<td>24415</td>
<td>380</td>
<td>931</td>
<td>62.2</td>
<td>3.09</td>
</tr>
<tr>
<td>Large White</td>
<td>16570</td>
<td>361</td>
<td>908</td>
<td>61.3</td>
<td>3.11</td>
</tr>
<tr>
<td>Total</td>
<td>55997</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 6. Nucleus herds – litter size of purebred litters, 2004/2005

<table>
<thead>
<tr>
<th>Maternal breed</th>
<th>Litter size (purebred litters in nucleus herds)</th>
<th>LP5</th>
<th>Percentage of gilts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duroc</td>
<td>10.1</td>
<td>-</td>
<td>68.5</td>
</tr>
<tr>
<td>Hampshire</td>
<td>8.4</td>
<td>-</td>
<td>70.0</td>
</tr>
<tr>
<td>Landrace</td>
<td>14.7</td>
<td>11.0</td>
<td>57.5</td>
</tr>
<tr>
<td>Large White</td>
<td>13.9</td>
<td>10.8</td>
<td>58.6</td>
</tr>
</tbody>
</table>

Table 7. Selected for AI from the test at Bøgildgård, 2004

<table>
<thead>
<tr>
<th>Breed</th>
<th>Number</th>
<th>Daily gain, g</th>
<th>Feed conversion, FUp/kg gain</th>
<th>Lean meat %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duroc</td>
<td>343</td>
<td>1000.3</td>
<td>2.24</td>
<td>60.5</td>
</tr>
<tr>
<td>Hampshire</td>
<td>26</td>
<td>900.9</td>
<td>2.37</td>
<td>62.7</td>
</tr>
<tr>
<td>Landrace</td>
<td>52</td>
<td>952.2</td>
<td>2.32</td>
<td>61.3</td>
</tr>
<tr>
<td>Large White</td>
<td>71</td>
<td>929.1</td>
<td>2.29</td>
<td>61.7</td>
</tr>
<tr>
<td>Total</td>
<td>492</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Research and development

Breeding for E. Coli 149-F4 resistance

F4 resistance is controlled by a single gene. An animal must be homozygote, RR, to be resistant. The frequency of F4 resistant animals varies greatly between the breeds. In 2003, at the beginning of the project, only 1% of the animals had RR genotype (resistant) in the Landrace population, while 20% of the Large White population had genotype RR. In Duroc, approx. 90% of the animals were resistant, while only resistant Hampshire animals have been found so far.

The objective of the project is to breed resistant finishers. As of 2003, the F4 status is being tested at transfer to quarantine for Landrace and Large White boars for AI. The strategy is to select RR and SR Landrace boars and only RR Large White boars for AI. After approx. two years of selection, the frequency of RR in Landrace has increased to approx. 11%, while the rate of SR is 54%. The selection of RR boars in Large White continues as previously and here the frequency has increased to 49% RR.

In the spring 2005, the project was adjusted in two areas. Now only RR fathers are used in Landrace and mothers of potential AI boars are tested to a limited extent. Particularly for Large White, this is an economic advantage in terms of testing. The strategy will increase the number of the female material with known F4 genotype.

Breeding for longevity

Conformation has been included in the breeding objective since 1996 with the aim of improving position, leg strength and movement. DanBred’s technicians perform an exterior evaluation of all breeding stock and give conformation points in connection with the performance test.

It was previously found that this trait in the nucleus herds corresponds well with longevity up to and including the second litter. It cannot be assessed in the nucleus herds whether conformation is an appropriate objective for longevity after the second litter, as a low index is often the culling reason for sows in the nucleus herds. In 2001, a project was therefore initiated in which conformation, longevity and culling reasons will be recorded in selected production herds.

In 2004, exterior evaluations were performed of the last of 16,450 gilts. The collection of data will be finalized when the last evaluated animals are culled during the next years.

The data material is currently being prepared for analysis. We would like to know whether longevity is a heritable trait and whether there is a correlation between longevity of the production sows and conformation evaluation of the gilts.

When the results are available, it will be evaluated whether the breeding objective needs to be extended to include another trait than conformation to improve longevity of commercial sows.

Salmonella resistance in pigs

Many traits in pig breeding are very difficult or economically impossible to improve through the traditional breeding methods. This is the case with, for instance, Salmonella resistance. The first objective of the trial is to investigate whether there is a heritable resistance in pigs. It has turned out that a small percentage of the examined pigs were not infected with Salmonella and did therefore not form antibodies when they were inoculated with Salmonella bacteria. Apparently, the pigs were resistant to Salmonella infection.

As only a small percentage of the animals displayed resistance, we may deal with a genetically conditioned resistance related to a single gene. The version of the gene (allele) providing resistance will probably be found in a relatively low frequency and be recessive, which means that both alleles in the animals must be of this type to obtain resistance. Carriers of only one resistance allele are expected to be susceptible to infection. However, it cannot be excluded that several genes are important to a display of resistance in the animals.

In hens, a gene that results in resistance to Salmonella infection has been identified. This is another important reason to search for a corresponding resistance in pigs.

In order to investigate whether resistance is controlled by a single gene or by several genes, it is necessary to identify a number of litters from which at least two individuals do not react to Salmonella infection. The percentage of resistant pigs is expected to be less than 5%. The project consists of two parts: part 1 will investigate whether there is a genetic resistance. If the first part is a success, the second part will be initiated, which will identify the responsible locus on the chromosomes.

In the spring of 2005, part 1 was initiated during which 600 trial pigs weighing 20 kg were inoculated with Salmonella Typhimurium through inclusion in the feed. After inoculation, blood and manure samples were collected. Of the 600 animals, 45 had no or a very low serological reaction. When sampling was complete, sero-negative (a negative reaction in the blood sample, tested for the infection) animals were moved to quarantine. It is likely that these pigs are genetically resistant to Salmonella, and this now needs to be confirmed. At the age of 7-8 months, the gilts will be served with the remaining sero-negative boars.

After farrowing, the offspring will be...
Inoculated and sampling will take place according to the same procedure as in part 1. It will then be revealed whether the animals are sero-negative.

If resistant pigs are found, we can start looking for the gene or genes that control Salmonella resistance.

**Pneumonia project**

In a previous trial under the project Breeding for Disease Resistance, offspring from Duroc boars were recorded and analysed for presence of different diseases such as two types of lung lesions. It was concluded that there are significant differences in the frequency of lung lesions between the offspring of the different sires. To study this difference, the variation between the offspring of the boars and the heritability of two economically important respiratory disorders will be elucidated during 2005.

Data will be collected from a sow herd with 350 sows of known pedigree. The sows will be inseminated with approx. 100 specified Duroc boars, and 6-8 litters will be produced per boar. Minimum 800 litters will be produced in this trial, and approx. 10,000 individuals will be monitored until and including slaughter. In the herd, dates of insemination and farrowing, litter size, survival/mortality in the weaner unit and prevalence of hernia are recorded and reported.

At the slaughterhouse in Holstebro, all pigs from the trial will be evaluated and recorded in the extended health control (EHC) for lung lesions. Catarrhal pneumonia (chronic pneumonia, mycoplasmal/SEP) and chronic pleuritis (pleuropneumonia) will be evaluated on a scale from 0 to 3.

The first phase of the trial will be finished in 2005. Analyses of the first 7,000 slaughtered and lung-evaluated pigs were initiated in the summer of 2005. The first results show that there is a difference between the offspring of the sires and that both respiratory disorders have low heritability. Based on data collected in production herds, it is thereby possible to include resistance to pneumonia in breeding for healthier animals.

**Study of survival**

In November 2004, a trial was initiated parallel with the pneumonia project in the same herd to investigate differences in survival from birth to 30 kg in Duroc and HD offspring. For a period of time, the herd will therefore also receive HD semen from two boars each week to produce both HD and D sired litters. In the trial period, survival of 2,000 HD hybrids will be compared with the survival of D hybrids. The trial will provide useful knowledge concerning differences, if any, in survival between offspring of the two boar breeds.

**The pig genome project**

The Department of Breeding and Multiplication and the Danish Institute of Agricultural Sciences, Foulum, are cooperating on a project that will identify important chromosome areas. The project is divided into five phases and is financially supported by the Directorate for Food, Fisheries and Agri Business, the Danish Innovation Act. Phases 1-3 have now been completed, and phase 4 began in 2005. The overall objective of the project (phases 1-5) is to identify chromosome areas where single genes or gene complexes influence economically important traits in the pig production. The project focuses on mapping of genes for traits that are difficult to improve through the traditional breeding methods. These are particularly traits with low heritability, such as genetically conditioned disease resistance to pneumonia. Furthermore, the project includes general disease resistance, production traits and meat quality traits.

Localisation of these genes on the pig genome will make it possible to develop and implement more efficient breeding plans that also include selection for traits with low heritability such as disease resistance. Today, this is biologically and economically difficult and inefficient.

The first phases of the project have been conducted with great success, and genes have already been identified with a highly significant effect on important heritable traits. In the first phase of the project, the basis and expertise were established to conduct the project efficiently. These were used in the second and third phases, during which it was possible to identify significant QTLs for a number of chromosomes (Quantitative Trait Loci, which are genes and gene areas that control other relevant breeding traits) for a series of relevant traits.

SNP-based (Single Nucleotide Polymorphisms describing variations in DNA structure between individuals) genetic maps were calculated for six chromosomes. These constitute the basis of phases four and five in which knowledge of DNA markers and pig traits will be correlated.

The following traits were preliminarily investigated to find QTLs in the population: meat production, birth weight, daily gain in the lactation period, daily gain in the first part of the growth period (up to 30 kg), daily gain in the finisher period (30-100 kg), intensity of respiratory disorders, pH of the meat, and driploss. The preliminary results look very promising and demonstrate that the design and scale of the trial are appropriate in relation to the studied traits. In the following phase of the project, more genome areas will be mapped using SNP markers, and even better methods will be used for describing QTLs for the relevant phenotypes.

The objective of phases four and five is to identify chromosome areas in the pig genome with single genes or gene complexes that influence important pig production traits. Furthermore, data from the project Breeding for Disease Resistance will be used, because they produce phenotypic data that can be...
Breeding

Compared with DNA sequence data that makes it possible to study whether phenotypic differences are conditional upon molecular genetic differences in the genome of the pig.

Sire effect

Since New Year, it has been attempted to optimise the statistical models used for estimation of breeding values for LPS (live piglets day 5 after farrowing). In this connection, a change was seen in data from around New Year 2003/04. From this point on, the importance of the sire of the litter increased by a factor 2-4. A greater sire effect affects the genetic progress negatively.

Changes in the dilution procedures at the AI station may have caused the sudden change in the data material. AI is mentioned because 95% of all litters in the breeding and multiplier herds are sired by AI boars.

Analyses have not been able to pinpoint a definite reason for the increase in sire variance of the litter size records.

In an attempt to reduce the sire variance, the AI stations have agreed to a 20% increase in the amount of semen per dose from Landrace and Large White and furthermore agreed to ensure that at least 4 ml raw semen are added to each ready dose as of August 24, 2005.

Measurement of lean meat percentage in Duroc pigs

In nucleus herds, young breeding stock are performance tested. Animals are performance tested in pens holding 8-20 pigs and all pigs in a pen finish at the same time. All animals in a pen are ultrasonically measured in terms of backfat thickness and weighed on the same day at the end of the performance test. The performance tested animals are therefore measured at different weights, but the pigs must weigh between 65 kg and 115 kg.

Because backfat thickness increases with the animal’s weight, both the measurement of backfat thickness and weight of the pig are included in the calculation of the animal’s lean meat percentage, which is then included in the index calculation. Previously, two trials were completed with the aim of calibrating the lean meat percentage on the basis of backfat thickness and scanning weight.

It is necessary to calibrate the mathematical model for conversion of backfat thickness of the individual pig into lean meat percentage concurrently with the genetic change in the individual breed. At the same time, we had an opportunity to investigate alternative methods to dissection when determining lean meat percentage in the carcass.

In the spring of 2004, the National Committee for Pig Production and the Danish Meat & Research Institute began testing the CT scanning method and comparing the results with the dissection lean meat percentage in a trial with 416 Duroc pigs, of which 37 pigs were CT scanned and totally dissected. The CT scan turned out to be an efficient and objective alternative to dissection.

The calibration curve found in the trial is not significantly different from the one used in the current calculation of lean meat percentage. Implementation of the results in the calculation of lean meat percentage used in the breeding objective will continue.

Genetic causes of boar taint

Boars are castrated in most European countries to reduce the risk of unpleasant odour when meat products are cooked. Boar taint is often caused by a high level of skatole (chemical substance stored in fat) and/or androstenone (sex hormone stored in fat). Castration reduces boar taint, but affects growth negatively. It is therefore interesting to study other methods for reduction of boar taint. Both content of skatole and of androstenone have been found heritable, and in the EU it is desired to find genetic ways for solving the problem.

The aim of the project is to find the gene(s) responsible for boar taint in pig meat. In a genome project initiated by a British group in the spring of 2005, the content of skatole and androstenone in samples from slaughtered Landrace boars was measured. The highest level and the largest variation in skatole content was found in Landrace; approx. 10% of the slaughtered boars had an increased skatole level. It is known that the two mentioned substances are responsible for boar taint, but the genes behind are not yet known.

In the trial in 2005, fat and meat samples will be collected from Landrace boars at three slaughterhouses. Five hundred boars are selected among the samples with a high skatole content and 500 with a low content. Ideally, siblings are desired (one half-/full brother with low skatole and one with a high content). To reach this objective, tissue samples must be collected from all slaughtered Landrace boars from the nucleus herds over a long period of time. Afterwards, the animals will be selected for further work.

At the slaughterhouse, fat and tissue samples are collected from each animal. All the samples are frozen and subsequently the fat samples will be sent to Norway for androstenone analyses, and the meat samples will be sent to Scotland where the gene technological work with finding individual genes will be done. Until August 2005, samples had been collected from 3,500 slaughtered Landrace boars.

The sow experiment at Grønhøj

The experiment is finished and data will now be analysed. The aim is to calculate the efficiency of the combinations YL, (YD)L and zigzag sows in the same pro-
duction environment. This will provide new knowledge of recruitment strategy in the sow herds.

Hernia
Scrotal hernia in pigs is a defect that is of great inconvenience to the affected pigs, and that is detrimental to the productivity in pig production. Scrotal hernia often occurs in periods, and many producers experience several pigs in the same litter with this defect. Others trace it back to specific boars that pass on an increased prevalence to their offspring.

For years now, the Dept. of Breeding and Multiplication has been co-operating with Norsvin in Norway on a project aimed at establishing whether a single gene is responsible for scrotal hernia in pigs.

Danish breeders have contributed with recordings of hernia prevalence, and have submitted blood samples from families with affected individuals. The analyses will be made in Norway.

Genetic investigations of heritability of scrotal hernia in pigs have not been made before. Geneticists have therefore relied upon research results from hernia studies in humans, among others. A conclusive report is expected at the beginning of 2006.

Kernestyring®
Kernestyring® is an offer to pig producers who do not want to purchase breeding stock and therefore produce breeding stock themselves. When participating in Kernestyring®, the producer routinely gains knowledge of the genetic level of the breeding stock in the herd.

The possibilities of pig producers for optimising their breeding strategy by way of Kernestyring® are based on the tools that are also used in multiplier herds. The breeding sows of the herd are recorded in the Pig Breeding Database and a weekly updated index is made available on the sows. Through information on management lists, producers gain knowledge of the variation in the nucleus herd’s index level and are therefore able to select the female animals with the highest index for production of purebred gilts and use the others for production of crossbred gilts for replacement of the production sows.

When breeding on-farm on the basis of a zigzag strategy, Kernestyring® makes it possible to select female animals with the highest index for further breeding and produce weaners from the rest.

Table 8 shows the average index level in the nucleus herds. The best on-farm breeders achieve good results, as they are able to produce LY/LY and zigzag litters that index-wise are level with the average of the multiplier herds. Generally, however, nucleus herds must expect that gilts of own breed are approx. 10 index points below the level that can be purchased from multiplier herds. There is, however, a great difference in the level between the individual herds.

Feed conversion
At Bagilgård, information is routinely recorded on the visits made by the test pigs to the feeding machines.

Analyses of these data reveal that it is possible to reduce the test period to a limited extent towards the end of the test without causing great changes in expected genetic progress for feed conversion. However, it cannot be recommended to postpone test start, because data from the period 30 kg to approx. 50 kg generate more than 75% of the genetic progress in both Hampshire and Duroc.

In principle, the test could be performed from 30 kg to 70 kg or from 30 kg to 80 kg in terms of feed conversion. Genetic progress is not significantly reduced in Hampshire, but it would result in reduced genetic progress in Duroc.

The preliminary conclusion is that the test period is maintained in its current length at Bagilgård. However, the analyses provide enough information for future strategies for recording of feed conversion, if problems arise again with completing the test in its current form.

<table>
<thead>
<tr>
<th></th>
<th>Purebred nucleus herd</th>
<th>Zigzag herd</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Average female index</strong></td>
<td>82</td>
<td>76</td>
</tr>
<tr>
<td><strong>Average crossbred litter index</strong></td>
<td>91</td>
<td>96</td>
</tr>
<tr>
<td><strong>Top-5; crossbred litter index</strong></td>
<td>103</td>
<td>109</td>
</tr>
<tr>
<td><strong>Bottom-5; crossbred litter index</strong></td>
<td>77</td>
<td>86</td>
</tr>
</tbody>
</table>

Table 8. Average index level in nucleus herds, August 2005. Average of 96 herds using purebred nucleus strategy and 208 using zigzag strategy.
**AI and insemination**

**Sale of semen**
Semmen sale from DanBred’s AI stations increased by approx. 10% compared with 2003/2004. In 2004/2005, DanBred’s AI stations sold a total of 4,407,020 semen doses corresponding to 76% of all services being performed with purchased semen. An estimated sow population of 1,121,000 in Denmark constituted the basis of these calculations. Figure 1 shows the development in semen sale from 2000/2001 to 2004/2005.

**Control of semen cells per processed semen dose**
There is constant focus on ensuring the quality of semen doses from the AI stations. Spot checks are routinely performed of semen doses. The semen doses are examined with a flow cytometer, which is the control measurement instrument of the National Committee for Pig Production. In the past year, this control has also functioned as a tool for further optimisation in the production of semen doses. Focus on the production has improved the control of the production line. Optimisation and improvement will continue to be investigated in future trials.

**Microbiological control of semen**
Different procedures are used for collecting semen to keep the collection as clean as possible. However, bacteria from the environment in the housing unit or the lab in the semen are unavoidable. The addition of antibiotics ensures that the bacteria do not grow, which could destroy the fertilization capacity of the semen and result in flux from the sows. The germ control is a routine control in which doses are submitted for control on a weekly basis. In the past year, only one semen dose was found to be positive in the germ number control, which is a very low number.

**Storage temperature for semen doses**
A study was made of various storage temperatures for semen doses. Previous trials have shown that a constant storage temperature improved production results compared with varying temperatures (report 0306). It was subsequently investigated whether the motility of semen was negatively affected under storage temperatures other than 16-18°.

The preliminary results revealed that temperatures above and below 16-18° produced negative results, but only for those collections in which the raw semen received 80 in motility. This indicates that motility dropped during deviating storage temperatures if the semen was already slightly weakened after collection. It is therefore recommended to store semen at 16-18° (see picture).

**Semen quality**
The National Committee for Pig Production now subjects semen from the individual boar to a much more detailed evaluation than previously. During the above-mentioned trial of storage temperatures for semen doses, differences were found between boars whose semen received 80 or 90 in motility. It is unknown whether these differences also result in small reproductive differences. Over time, the aim is to be able to recognize the small differences in reproduction traits between boars. The idea is that in the future, analyses of a semen sample will reveal these differences. These analyses currently include detailed microscopic examinations of the individual sperm cells. This way, even the smallest deviations in the sperm cells can be recognized. This task is made in co-operation with the project ‘causes of high and low fertility’ at the Royal Veterinary and Agricultural University (RVAU). In connection with the project at RVAU, sperm cell DNA is being analysed. On the basis of an analysis of the sperm cell DNA, the aim is to become able to predict whether a boar has a high or low fertility.

**Reduced semen concentration**
A current trial and a recently finished trial will establish whether it is possible to reduce the number sperm cells in a semen dose and maintain the same reproduction results expressed as total number of piglets born per litter and farrowing rate. All the semen doses used are production semen.

The trial concerning 2 vs 1 bn progressively motile sperm cells per semen dose showed no difference in farrowing rate, but a small tendency to smaller litter size. A two-chamber bag was used for the group with 1 bn sperm cells: one billion sperm cells diluted in 40 ml diluent were used for the insemination followed by 40 ml pure diluent. A regular semen bag with 80 ml diluent was used in the group with two billion sperm cells. When 1 bn were used, a reduction was seen in litter size. Farrowing rate was not affected.

In the current trial that concerns reduced semen concentration too, the semen in the trial group is diluted to 1.5 bn progressively motile sperm cells in 80 ml diluent in a regular semen bag and is compared with 2 bn progressively motile sperm cells in 80 ml diluent. There are so far no differences between the groups in reproduction results.

**Prostaglandin and insemination technique**
Previous trials have revealed that the blood’s content of prostaglandin (PG) increases during insemination. This increase is not seen during mating. Secretion of large amounts of PG restricts the semen transport and is therefore undesirable. A trial studied whether post-cervical insemination also increases PG. The results revealed that PG secretion increases during traditional insemination, post-cervical insemination, insemination with pure diluent and insemination with raw semen. The latter, however, results in a delayed PG increase. As seen previously, PG secretion did not increase during mating. In co-operation with Sweden’s Agricultural University work is continued with the observed increase in PG seen during AI, involving elements such as restriction of...
specific enzymes involved in the creation of PG. The trial is financially supported by Norma & Frode Jacobsen’s Foundation.

A recently finished trial of post-cervical insemination, approved by the Animal Experiments Inspectorate, attempted to clarify whether the same reproduction results could be achieved with post-cervical insemination as with traditional insemination, while at the same time significantly reducing the concentration of sperm cells. The results showed that litter size was reduced during post-cervical insemination and concentration was reduced significantly at the same time. There were no indications that litter size was reduced by the insemination technique, but rather by the reduced semen concentration and the low insemination volume.

Shelf-life of boar semen
The longer semen doses can keep, the easier it will be to plan ahead for the AI station and for the pig producer. Thereby, the workload of the AI stations will be distributed over the entire week. It would be advantageous for pig producers that semen collected and delivered on Monday can last for longer than Wednesday at noon, so that it can also be used for re-breeders and gilts. A current trial will clarify whether it is possible to store diluted semen for more than the guaranteed 2.5 days and still achieve the same reproduction results.

The preliminary results look promising as there were no differences in farrowing rate nor litter size between semen doses produced on Friday and used Monday/Tuesday and doses produced Monday and used Monday/Tuesday.

Reduction in working hours and semen doses
A current trial will clarify whether the same reproduction results can be achieved by inseminating sows only once during heat compared with the “usual” two or more times (in Denmark, an average of 2.3 semen doses are used per heat). The trial is running in three well-managed herds and the results look promising. If the number of inseminations per sow per heat is reduced, time can be saved in the service unit and expenses for semen doses can be reduced.

Figure 1. Development in sale of final diluted semen doses.
Sows often farrow more piglets than they are able to rear. Cross-fostering and nursing sows are therefore required if mortality is to be kept down. Sows are able to rear 13 piglets without affecting mortality, but weaning weight drops with increasing litter size (see table 1).

Look after the antibodies
Piglets are born without antibodies in their blood. They depend on the sow’s colostrum. It is therefore crucial that all piglets have access to the udder and that they are not moved until they have taken in sufficient colostrum. This means that large piglets cannot be moved until six hours after birth. The small piglets have more difficulty getting to the teats and they should have minimum 12 hours to take in colostrum before they are moved. If in doubt as to whether a piglet has received sufficient colostrum, 30 ml milked colostrum can be administered divided into three feedings.

Life as a nursing piglet is hard
Video recordings of nursing sows reveal that the nursing sows quickly accept the new nursing piglets, and after 3-6 hours they attempt to nurse the piglets. However, another 3-6 hours normally pass before the piglets experience the first successful lactation, which means that small piglets in particular that were deficient when they were transferred can become very hungry. It is therefore recommended to use robust piglets as nursing piglets and to make nursing sows that quickly accept the piglets.

How to make a nursing sow
A nursing sow weans her own piglets after minimum 21 days of lactation and then receives a new litter of piglets. The nursing sow is either given excess newborn piglets and is then called a one-step nursing sow, or she is given 4-7-day-old piglets from another sow, and is then called an intermediate sow. The sow providing the 4-7-day-old piglets then becomes a two-step nursing sow to the excess newborn piglets (see table 2).

A trial showed that two-step nursing sows more readily accept the new piglets compared with one-step nursing sows. This reduced mortality and increased weaning weight (see table 3). In the same trial, it was investigated whether the piglets that were moved to an intermediate sow to make a two-step nursing sow were affected by the move. This was not the case. It is recommended to use two-step nursing sows for newborn piglets (trial report 700).

The trial also investigated whether the piglets could handle being transferred to a nursing sow. Piglets that stayed with the sows and piglets that were moved to two-step nursing sows had the same mortality and weaning weight. Mortality was higher among piglets that were moved to one-step nursing sows. Another trial compared the ability of first parity sows with higher parity sows to be nursing sows. The first parity sows performed better than the higher parity sows. A first parity sow was compared with a second parity sow, and there were no differences in productivity when the four replicates in the trial were compared. It is therefore possible that both first parity sows and second parity sows would make suitable nursing sows (trial report 696).

The longer the sow is separated from piglets, the greater is the risk that she will forget the smell of the piglets and the udder will be more charged with milk. In one trial, the sows were separated from piglets for 2 or 18 hours before they were given nursing piglets. Weaning weight was lower if the sow had been 18 hours without pigs before receiving the nursing piglets. Mortality did not vary in this small study (report 0506). Nursing sows are often needed in the herds, but the sows must rear as many of their own piglets as possible as the nursing sows take up space in the farrowing unit.

Table 1. Effect of 11 or 13 pigs in the litter

<table>
<thead>
<tr>
<th>Number of piglets transferred</th>
<th>11</th>
<th>13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weaned/litter</td>
<td>10.1</td>
<td>11.7</td>
</tr>
<tr>
<td>Weaning weight, kg</td>
<td>7.7 a</td>
<td>7.1 b</td>
</tr>
<tr>
<td>a, b: Significant difference</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3. Nursing piglets with one-step or two-step nursing sows

<table>
<thead>
<tr>
<th>Nursing sow</th>
<th>One-step</th>
<th>Two-step</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piglets added per litter</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>Weaned/litter</td>
<td>9.0 a</td>
<td>10.4 b</td>
</tr>
<tr>
<td>Weaning weight, kg/pig</td>
<td>5.5 a</td>
<td>6.4 b</td>
</tr>
<tr>
<td>a, b: Significant difference</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Nursing sows are necessary when litter size is high.
Correct management of the feed dose of gilts and sows is of great importance to their productivity and welfare and to achieve the best feed conversion. The productivity expressed as farrowing rate, total number of piglets born per litter, and weaning weight could be affected negatively if the sows are too thin or too fat. Sows that are too thin or too fat will furthermore be at a greater risk of developing scapula lesions, MMA, etc.

Today, the degree of fattening is determined by visual evaluation of condition or by a slightly less subjective measurement of backfat thickness with ultrasound scanning. Ultrasonic measurements are most frequently made at the P2 point (see figure 1). The P2 point is defined as ultrasonic measurement 7 cm from the spine at a point that is in line with the posterior costal angle of the last rib. In addition, measurements are made 7 cm in front of this.

Ultrasonic measurement has gained ground because it has demonstrated a reasonable correlation with total dissection of the body where bones, fat and muscles are separated. However, the ultrasonic measurement has not been correlated with that part of the fat in the body that animals’ use first – the so-called mobile fat phase. The mobile fat phase can be determined with the latest scanning technique (CT scan), and it is thereby possible to establish the correlation with ultrasonic measurement. Figure 2 denotes the P2 point measured with CT scan.

**CT scan (Computed Tomography)**

A CT scan involves a photographing technique during which the animal – during the scan – is exposed to sliding X-rays that are reproduced on a moving digital X-ray film. Hereby, three-dimensional pictures are recorded that can be read by an image processing programme. The colouring of the film denotes the tissue density, and by knowing the density interval of fat, the fat content of an animal can be determined.

The computer is able to distinguish between different types of fat and is thereby also able to determine which type of fat the animals mobilise easiest for gain, embryo growth and milk production.

A pilot study of gilts fed either a high-energy diet or a low-energy diet has been initiated. After a month with one type of diet, the groups change diets (cross-over trial) whereby it is revealed which type of fat the animals “use” first (the mobile fat phase). The gilts are CT scanned at the beginning of the trial and at the end, and in the middle of the trial period when changing diets. At the same time as the CT scan, backfat is measured with an ultrasound scan, and fat tissue samples are collected for chemical analysis. It will hereby be attempted to correlate the observed mobile fat phase with changes in the backfat of the animals. The overall objective of the trial is to find an instrument and a method for ultrasound scanning of an area on the animals that shows status of the mobile fat phase, and thereby also shows whether the animal is deficient or has reserves of energy.
Feeding of weaners

A number of trials have investigated the importance of feed or feed strategy to the health and productivity of weaners.

Effect of fasting on post-weaning diarrhoea

The time of the first feed intake post-weaning varies greatly between weaners — from less than an hour to more than two days. Immediately post-weaning, the weaners thus more or less fast. Enforced fasting also occurs during transport of newly weaned pigs. Transport time in Denmark varies from very little within a herd and up to eight hours including loading, unloading and actual driving.

The literature states that a period of fasting post-weaning damages the intestinal epithelium, and this is supposed to increase the risk of diarrhoea in the pigs. However, this has not been proved in production trials.

In order to establish the effect of 8 or 24 hours of fasting on the prevalence of post-weaning diarrhoea, a trial was conducted comprising the following groups:

- Group 1: Unrestricted access to feed and water immediately post-weaning
- Group 2: No access to feed and water for 8 hours post-weaning
- Group 3: No access to feed for the first 24 hours post-weaning, but unrestricted access to water for the last three weeks post-weaning.
- Group 4: Coarsely ground meal feed

The trial period was the first three weeks post-weaning.

The average number of treatments for diarrhoea, productivity and the number of dead and culled pigs were not significantly affected by the different treatments.

There were no indications in this trial that the fasting that weaners can be exposed to during eight hours of transport or fasting of weaners for 24 hours increase the risk of encountering post-weaning diarrhoea.

For more information, please see trial report 712.

The stomach as a barrier against pathogenic bacteria

Trials have shown that a high concentration of organic acids in the feed may reduce problems with Salmonella and E.Coli both when using meal feed and pelleted feed.

Coarsely ground meal feed affects the physico-chemical characteristics and the microbial environment of the stomach of finishers. A high concentration of organic acids is thereby formed that together with a low pH cause the stomach to function as a biological barrier against pathogenic bacteria such as Salmonella and E.Coli. Another way of obtaining organic acids in the stomach is to add organic acids to the feed. A trial aimed at investigating how various feeds affect the microbial eco-system in the stomach of weaners and whether these correlations correspond to results achieved with finishers.

The trial was conducted as a two-factor trial comprising the following groups:

- Group 1: Finely ground pelleted feed including 1% lactic acid and 1% formic acid
- Group 2: Coarsely ground meal feed including 1% lactic acid and 1% formic acid
- Group 3: Coarsely ground meal feed
- Group 4: Finely ground pelleted feed

Feeding with coarsely ground meal feed resulted in:

- An increased DM content, an increased pH and a higher concentration of organic acids in the top part of the stomach
- Less sedimentation of gastric content
- A tendency to fewer gastric changes

Feeding with finely ground pelleted feed resulted in:

- A lower pH in the gastric content and the front part of the small intestine
- A reduction in the population of enterobacteria in the gastric content and in the last part of the large intestine
- A reduction in the population of entero-bacteria in the gastro-intestinal tract. A small population of enterobacteria is desirable, as that equals a low population of pathogenic bacteria such as Salmonella and E.Coli.

For further information, please see trial report 713.

Figure 1. Consistency of gastric content in weaners fed finely ground pelleted feed (top) and coarsely ground meal feed (bottom).

Protein and diet

A reduced protein content in weaner feed is used to prevent diarrhoea. It is also claimed that advanced starter diets with a high content of milk products, heat-treated grain etc., reduce diarrhoea, but these diets are not characterized by having a low protein content. The aim of the trial was to investigate the effect of a high protein content vs a low protein content in a cheap diet and an expensive diet for weaners. The trial comprised the following four groups:

- Group 1: Cheap diet/low-protein: Grain/soybean meal, 21% crude protein (155 g digestible protein/FUg/p)
- Group 2: Expensive diet/high-protein: Grain/soybean meal, 21% crude protein (155 g digestible protein/FUg/p)
- Group 3: Cheap diet/high-protein: Grain/soybean meal, 21% crude protein (155 g digestible protein/FUg/p)
- Group 4: Expensive diet/low-protein: Grain/soybean meal, 21% crude protein (155 g digestible protein/FUg/p)
Cheap diet/low-protein: Grain/soybean meal, 18% crude protein (130 g dig. protein/FLugp).
Expensive diet/high-protein: Heat-treated grain/milk products, 21% crude protein (155 g dig. protein/FLugp).
Expensive diet/low-protein: Heat-treated grain/milk products, 18% crude protein (130 g dig. protein/FLugp).

The content of essential amino acids in the low-protein feed was 20% below the recommended standards.

The trial aimed at clarifying the effect of weaning at 26 days compared with 33 days on production results, health and overall economy.

The trial is carried out in three herds. The results from the first herd showed a significantly positive effect on productivity and health in the weaner period by increasing weaning age by a week. The effect on the overall economy in the herds will be calculated when all three herds have completed the trial. More information on the results from the first herd is available in trial report 663.

The preliminary results from herd 2 showed the same tendency as seen in herd 1, but the results were not as significant. There was no significant difference in weight at 11 weeks of age or mortality in the weaner period between the two weaning ages. Diarrhoea prevalence was, however, reduced from 2.1 to 1.6 treatments/pig (significant) among the pigs weaned at 33 days. There was no effect in either of the herds of whether the pigs were given a cheap starter diet (DKK 5.00 per kg) or an expensive diet (DKK 2.50 per kg) until the age of six weeks. In these herds there was therefore no effect of using a more expensive starter diet for the young pigs.

Feeding method
Three different methods for feeding dry feed and gruel feed in long troughs to newly weaned pigs were compared with dry feeding from a simple feeder. The trial showed that four daily feedings in long troughs and supply of gruel feed did not improve production results compared with dry feeding from a simple feeder. Daily gain was almost identical in all groups, which indicates that feed intake was not further stimulated by the use of long troughs. Feed consumption was significantly higher in the trial groups, probably due to an increased feed waste.

For more information, please see trial report 701.

Commercial diets
A trial was conducted of weaner diets 1 and 2 purchased in Northern and Central Jutland from five feedstuff companies. It was concluded that there was no significant difference in the pigs’ productivity. There is no basis for a price difference per FLugp between the six diets, as the pigs produced the same results on all six diets.

The trial comprised the following diets:
Control diets (diet 1 and diet 2)
- Mollerup Mølle: Havre-Guf / Mester-Vita
- Aarhussegnens Andel: Mini Fut with Formi / Amino Byg
- DLG: Grisette United AF / Profil 11
- United AF
- Vestjylland’s Andel: Gut / Piggi Zyme 11
- Hedegaard: Minigris L-3 / Maxi-gris 7

For more information, please see trial report 706.

Figure 2. Gruel feed leads to a great risk of feed waste.

Oats
Oats and naked oats result in a lower output in the field compared with wheat. However, oats in crop rotation increases output in wheat the following year. Compared with regular oats, cultivation of naked oats results in a lower output of approx. 30%. For pig producers who mix their feed on-farm, the choice of grain also depends on the feed value of the different types of grain. A trial was therefore conducted to establish the feed value of naked oats for weaners.

The feed value of naked oats was compared with wheat for weaners. It was concluded that with the current feed evaluation, naked oats does not affect the overall productivity of weaners compared with a diet based on wheat.

Feed in which 15% of the grain was either regular oats or a very finely ground oat product (Ave-Vita) was also compared with a wheat-based diet. The use of
Ave-Vita did not affect the production value significantly. However, the feed containing regular oats resulted in a significantly higher production value compared with the wheat diet.

For more information, please see trial report 710.

**Dried whey**

Lactose is an important source of energy in the period immediately post-weaning. Lactose in its pure form is relatively expensive and difficult to handle in connection with production of feed. Alternatively, dried whey can be used as it has a high lactose content.

*Figure 3. Naked oats did not affect weaner productivity positively.*

Increasing content of sweet dried whey in meal feed for weaners was studied. It was concluded that gain and feed conversion were improved through to 30% dried whey the first weeks post-weaning (see figures), but the increased productivity largely counterbalanced the increased feed costs seen over the entire trial period. Feed containing more than 30% dried whey resulted in more treatments for diarrhoea compared with feed with a low dried whey content. This trial investigated the effect of dried whey in meal feed. It is not possible to transfer these results directly to pelleted feed, as a high proportion of dried milk and a high pelleting temperature is not a good combination.

For more information, please see trial report 680.

**HB-101**

The plant extract HB-101 from Flora Co. was studied for weaners (7-26 kg). HB-101 is an aromatic product extracted from cedar, cypress, pine and plantain.

HB-101 is not approved as an additive, and it is therefore illegal to market and use HB-101 for pigs in Denmark.

The trial comprised two groups:

- Group 1: Control
- Group 2: 400 ml HB-101 were added per tonne feed

No effect was seen on the pigs’ productivity when 400 ml HB-101 were added per tonne feed, and the feed costs were far from paid by the increase in productivity.

For more information, please see trial report 702.

**Cocktail against PMWS**

Several companies have documented that their products affect pigs’ immune system in one or several ways. However, the relevance of the effect and the effect on the well-being of the pigs, including mortality, diseases and productivity is not known.

A combination of so-called immunostimulants added to sow feed and weaner feed was studied in two herds suffering from PMWS.

The cocktail included four products:

- Macrogard (beta-glucane)
- Unimmune (nucleotides)
- Immulin (plant extracts)
- Natur-E Micelle (natural vitamin E)

This combination of products did not reduce mortality in the weaner period.

For more information, please see trial reports 671 and 711.

**Orego-Stim**

The product Orego-Stim from the company Meriden Sweden AB was studied for weaners (7-30 kg). Orego-Stim is an aromatic product consisting of extracts of oregano.

The trial comprised two groups:

- Group 1: Control
- Group 2: Diet 1 to which 1 kg Orego-Stim was added per tonne feed, and diet 2 to which 0.5 kg was added per tonne feed.

No effect was found on the pigs’ productivity when these doses of Orego-Stim were added, and thereby the pigs did not pay for the product. For more information, see trial report 692.
Different sources of fat were investigated in relation to the productivity of weaners and carcass quality. At the Danish Institute of Agricultural Sciences, digestibility trials were conducted with the same sources of fat in feed for weaners and finishers.

**Fat in weaner feed**

Three production trials and one digestibility trial were conducted with weaners given the same feed to which 5% of the following sources of fat were added: pig fat, raw rapeseed oil, palm oil, PFAD (Palm Fatty Acid Distillate), 50% palm oil/50% PFAD, coconut oil and soybean oil. The results of the first production trial showed that the feed containing raw rapeseed oil had a 16% lower production value compared with pig fat. The use of PFAD and the combination of PFAD and palm oil resulted in a production value at the same level as with pig fat, which was surprising as PFAD previously was estimated to have an energy value 32% below pig fat. The use of palm oil and coconut oil resulted in a better production value than pig fat.

The production value was the same if soybean oil was used instead of pig fat. It was decided to conduct more trials to verify the result of this trial in terms of the value of raw rapeseed oil and PFAD in relation to productivity.

**Raw rapeseed oil and PFAD**

The production value of raw rapeseed oil varied between the three trials, which is probably an expression of the variations in quality seen in raw rapeseed oils on the market. Overall for the three trials, raw rapeseed oil reduced production value by 9% (see figure 1). The negative effect of adding raw rapeseed oil was probably caused by an off-taste of residues of glucosinolates and other aromatic compounds in the oil. Overall for the two trials, the use of PFAD as an alternative source of fat turned out to be level with pig fat (see figure 2).

**Alternatives to pig fat**

Palm oil, soybean oil, PFAD and coconut oil are real alternatives to pig fat.

**Carcass quality**

Finishers were produced for analyses of meat and fat quality at the Danish Meat and Research Institute. 3% of the fat sources were added to the finisher feed, but coconut oil was replaced by mixed oil (Scanfedt S).

Analyses of meat and fat quality revealed that the quality of fat greatly reflects what is added to the feed. The carcass from pigs given raw rapeseed oil contained more unsaturated fat. The iodine number in fat was 84 indicating a risk of rancidity. A lower processing yield of ham and bacon, a longer drying time and a softer texture of fermented sausages were found in pigs given feed with 3% raw rapeseed oil.

In terms of meat quality, it cannot be recommended to use 3% raw rapeseed oil in finisher feed.

**Digestibility of fat**

Overall, the digestibility trial showed that feed with 5% raw rapeseed oil or coconut oil had the highest digestibility of fat relative to the addition of animal fat, while mixed oil (palm oil/PFAD 50/50) and Scanfedt S had the lowest digestibility.

**Conclusion**

Despite the high fat digestibility in feed to which raw rapeseed oil was added, it cannot be recommended to use raw rapeseed oil in the feed because of the negative effects on weaner productivity and carcass quality. As the digestibility of mixed oil is lower than pig fat, it is only a real alternative in cases where the price is lower. The project is continued with the aim of gaining more knowledge of the correlation between the fat quality and the carcass quality.
Feed conversion in finishers

**Improving feed conversion**

Feed conversion is crucial to obtain a good economy in finisher production. Yet, the national average for feed conversion in finishers has not improved over the last ten years.

A study is now trying to establish the most important herd conditions in relation to feed conversion in finishers. The study includes 100 herds with a good feed conversion and 100 with a poor feed conversion. The study concentrates on feed, feeding, housing design, housing climate/ventilation, health, management and breeding.

Preliminary results from 110 herds show that herds with a good feed conversion or a poor feed conversion differ in several areas. The study reveals that the following conditions increase the chances of obtaining a good feed conversion in finishers:

- The use of pelleted, ready-mixed feed
- Consistent batch operation and disinfection of the pens before pigs are transferred
- No grower facility and no moving of pigs in the finisher period
- Absence of respiratory disorders requiring group treatments

**Perlac 7 in liquid feed**

It is essential that the energy value in feedstuffs be estimated correctly to obtain a good feed conversion. This is particularly important for feedstuffs constituting a significant part of the feed such as, for instance, whey in liquid feed.

Perlac 7, which is produced by Arla Foods, is whey containing 7% dry matter. This type of whey was previously called B-whey or enriched permeat.

In one trial, liquid feed containing approx. 70% Perlac 7 was compared with liquid feed containing water as the only fluid (trial report 703). Perlac 7 constituted approx. 20% of the energy in the trial feed. The trial revealed that the production results were at the same level regardless of the inclusion of Perlac 7 in the feed (see table 1).

The feed conversion was very poor in both groups, probably because the pigs were fed liquid feed ad lib and therefore had a very high feed intake. However, the feed conversion was identical in the two groups. This demonstrates that Perlac 7 has the expected energy content, as calculated in the feed evaluation system. The energy value [FUgp] is therefore estimated correctly in Perlac 7.

When the same feed price was used in both groups, there was no significant difference in the production value, which was calculated on the basis of the production results.

The advantage of using Perlac 7 is therefore not improved production results, but significant savings in feed costs. The current feed price was DKK 9 lower per 100 FUgp for the feed containing Perlac 7 compared with the control feed.

Calculations made with the current pig prices and feed prices, including the price of Perlac 7, showed that the production value was 18% higher for the feed containing Perlac 7 compared with the control feed.

---

**Table 1. Perlac 7 til slægtesvin fodret ad libitum ved vådfoder**

<table>
<thead>
<tr>
<th>Group</th>
<th>Control</th>
<th>Trial (Perlac 7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily gain, g</td>
<td>892</td>
<td>916</td>
</tr>
<tr>
<td>Daily feed intake, FUgp</td>
<td>2.86</td>
<td>2.93</td>
</tr>
<tr>
<td>Feed conversion, FUgp/kg</td>
<td>3.20</td>
<td>3.20</td>
</tr>
<tr>
<td>Lean meat %</td>
<td>58.9</td>
<td>58.6</td>
</tr>
</tbody>
</table>

**Production value, prices of the last 5 years, same feed price in both groups**

<table>
<thead>
<tr>
<th></th>
<th>DKK/pen place/year</th>
<th>Index 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>507</td>
<td>100</td>
</tr>
<tr>
<td>Trial (Perlac 7)</td>
<td>515</td>
<td>102</td>
</tr>
</tbody>
</table>

**Current production value, the trial group includes the price of Perlac 7**

<table>
<thead>
<tr>
<th></th>
<th>DKK/pen place/year</th>
<th>Index 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>558</td>
<td>100</td>
</tr>
<tr>
<td>Trial (Perlac 7)</td>
<td>659</td>
<td>118</td>
</tr>
</tbody>
</table>

1) When comparing the production value between the groups, there must be a minimum difference of 4 index points in order for the difference to be significant.  
2) Statistics have not been calculated on the current production value.
Decomposition of synthetic amino acids in liquid feed

Previous trials have shown that synthetic lysine decomposes when liquid feed is fermented. A lab study has now shown that not only synthetic lysine, but also synthetic threonine and tryptophan decompose when liquid feed is fermented (report 0501). The lab study, which was conducted in co-operation with the Danish Institute of Agricultural Sciences, also showed that synthetic methionine does not decompose significantly.

When formulating liquid feed, the guiding minimum standards for crude protein content must be met. Thereby, the requirement for synthetic amino acids is reduced. Ready-mixed liquid feed should not be fermented in the liquid feed tank, but must be fed as soon as possible after being mixed. However, it cannot be avoided that liquid feed standing in the pipelines between the feedings ferments and thereby has a lower amino acid content than freshly-mixed feed.

The problem with decomposition of amino acids during fermentation is greatest in weaner feed because of a high content of synthetic amino acids.

Compensation must be made for the decomposition of synthetic amino acids due to fermentation in the pipelines to prevent the pigs from becoming deficient with amino acids. Technically, this can be done by reducing the digestibility coefficient for synthetic lysine, threonine and tryptophan from 100 to 75% in the feed formulation. Thereby compensation is made for an expected loss of 25% of the synthetic amino acids during fermentation in the pipelines.

SELKO BE+ in liquid feed

Many herds using liquid feed experience problems with growth of yeast and CO2 development in the liquid feed. A lab study was made to investigate whether SELKO BE+ restricts the growth of yeast when 6 ml were added per kg liquid feed. When the dosage was subsequently reduced to 3 ml per kg, the growth of yeast in the liquid feed was no longer restricted.

It may therefore help to add SELKO BE+ in cases of problems with too much yeast in the liquid feed, but minimum 6 ml must be added per kg liquid feed.

Fermented grain for weaners

It was previously shown that fermented grain in liquid feed increases daily gain and improves feed conversion in heavy pigs. A trial was conducted with fermented grain in gruel feed for weaners in the first three weeks post-weaning. That trial also revealed a higher daily gain and improved feed conversion when fermented grain was used. The trial feed was compared with gruel feed without fermented grain.

The improved production results achieved with fermented grain in the first three weeks post-weaning resulted in a 6% increase in production value for the entire weaner period (0-8 weeks post-weaning). In the last part of the period (3-8 weeks post-weaning), the pigs in both groups were given pelleted dry feed. The preliminary results are shown in table 1.

The grain was fermented as in the trial with heavy pigs, i.e. with heated water and without the use of inoculation culture. The temperature in the fermentation tank was 20-25°C. Heating the water is essential to ensure a satisfactory fermentation process.

A trial with fermented grain in liquid feed for weaners from 7 to 100 kg is being conducted in a WTF herd. Results from this trial will show the effect of fermented grain for weaners (approx. 7-30 kg) and finishers (approx. 30-100 kg), respectively.

Table 1. Fermented grain for weaners the first three weeks post-weaning, preliminary results

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Trial</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>First 3 weeks post-weaning (fermented grain in the trial group)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Daily gain, g</td>
<td>153</td>
<td>181</td>
</tr>
<tr>
<td>Daily feed intake, FUgp</td>
<td>0.34</td>
<td>0.35</td>
</tr>
<tr>
<td>Feed conversion, FUgp/kg</td>
<td>2.28</td>
<td>1.99</td>
</tr>
<tr>
<td><strong>3-8 weeks post-weaning (pelleted dry feed in both groups)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Daily gain, g</td>
<td>544</td>
<td>561</td>
</tr>
<tr>
<td>Daily feed intake, FUgp</td>
<td>1.04</td>
<td>1.09</td>
</tr>
<tr>
<td>Feed conversion, FUgp/kg</td>
<td>1.92</td>
<td>1.94</td>
</tr>
<tr>
<td><strong>Production value for the entire period (0-8 weeks post-weaning)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DKK/pig</td>
<td>55.0</td>
<td>58.4</td>
</tr>
<tr>
<td>Index</td>
<td>100a</td>
<td>106b</td>
</tr>
</tbody>
</table>

a, b: significant difference between the groups

BE+ restricted the growth of yeast when 6 ml were added per kg liquid feed. When the dosage was subsequently reduced to 3 ml per kg, the growth of yeast in the liquid feed was no longer restricted.

A trial with fermented grain in liquid feed requires a larger amount of amino acids than dry feed because some of the synthetic amino acids decompose during fermentation in the pipelines.
Reversible feeding systems

Two studies were made of feeding systems that reduce segregation and thereby probably the effect of segregation in connection with feeding dry feed mixed on-farm to finishers (reports 0411 and 0509). In both systems, the direction of the wire in the pipeline alternates each time the feeders are filled with feed.

Segregation is thereby not eliminated, but is systematized, so that the pigs take turns at being "the first" and "the last" on the pipeline. The pigs "take turns" at being over-supplied and under-supplied with minerals, amino acids, vitamins, etc., as primarily these nutrients segregate.

Segregation of sow feed

As when feeding weaners and finishers, it is important to ensure that the feed in the trough in front of the sow contains the nutrients she requires. The risk and the extent of segregation of dry feed mixed on-farm were investigated in ten pipelines divided among six herds. Both gestation feed and lactation feed were studied.

The feed's content of calcium, phosphorus, copper, zinc and iron, and the particle distribution of the feed were used as indicators of segregation.

The investigation showed that the mineral content was significantly higher in feed collected from volume boxes at the beginning of the pipeline compared with the content at the end of the pipeline. All the analysed minerals segregated. There was no interaction between the herds.

The extent of segregation varied between the individual pipelines. Copper represented the largest difference in mineral content at "the beginning" compared with at "the end": 37.3 vs 21.0 mg per kg, a difference of 78%. For the other minerals, the difference between the "the beginning" and "the end" ranged between approx. 2% and approx. 20%.

This trial did not reveal the same extent of segregation as seen in trials with dry finisher feed fed via tube feeders. It is most likely that the finisher feed segregated to a greater extent than the sow feed because different feeding methods were used – tube feeders vs volume boxes.

There were no indications that the diameter or length of the pipeline affected the risk of segregation. There was no greater risk of segregation of gestation feed compared with lactation feed, even though there were almost twice as many volume boxes on the pipelines supplying gestation feed.

There were no indications that the construction and use of the mixing equipment or the composition of the diets affected the extent of segregation.

In conclusion, segregation occurs of sow feed mixed on-farm when fed via volume boxes. Generally, segregation was so small that it is not expected to affect the longevity of the sows or their possibilities for producing optimally.

It cannot be excluded that in some herds there may be conditions that lead to such extensive segregation that it affects the longevity or productivity of the sows. In such cases, it is necessary to take measures to reduce or eliminate segregation.

Dosing via feeding stations

Electronic sow feeding is characterized by the fact that it is possible to control how much feed the individual sow eats. It is important to investigate whether the electronic feeding station doses the expected amount of feed.

A current trial shows that there can be quite a difference between what the computer "thinks" is being fed and what is currently being fed (control weighing).

Sows are fed according to body condition, and at some point, the manager will probably discover that the sows eat too little. However, some time passes when from a sow is being undersupplied with feed and until it can be seen on its body condition. If a sow is undersupplied in the implantation period, she risks becoming a returner or having fewer piglets.

It is important to control the dosing of feed from all feeding stations. There may be a great difference between how much the station is adjusted to dose and what is actually being dosed.
It is documented that the content of feed units differs between winter wheat and spring barley.

In co-operation with the National Centre, Plants, the National Committee for Pig Production studied varieties of winter wheat and spring barley from the Sortsforsøg®.

In 2003 and 2004, the feed unit content was analysed in the seven most commonly used varieties of the two types of cereal. The results revealed significant differences in varieties in both winter wheat and spring barley.

Subsequently, 14 varieties of each cereal were selected with the aim of evaluating the extent of the differences. The difference between the highest and the lowest varieties in this round was 3.5 FUgp per 100 kg in spring barley and 7 FUgp per 100 kg in winter wheat (see figures 1 and 2). It is expected that the differences can be used in plant refinement, so that energy value in the future will constitute one of the selection criteria.

Furthermore, measurement of the energy value can be included in results from the Sortsforsøg®, for instance by stating output as feed units per ha. If output is stated as FUgp/ha instead of as hkg/ha, the order is changed (see figure 3). Compare, for instance, the varieties Nitrogen and SJ2506, which both have index 104 in cereal output. If the output is measured in FUgp/ha, SJ2506 is 7% higher than Nitrogen.

The analysis results shown are used as the basis for calibrations of fast analyses in an attempt to develop a faster and cheaper method for measuring feed units. Such a method will accelerate the possibilities for measuring energy values on the many varieties included in the Sortsforsøg®, and it will furthermore be possible to use the method in connection with cereal settlement.

**Figure 1.** FUgp per 100 kg in selected varieties of wheat. The largest difference between varieties was 3.5 FUgp per 100 kg.

**Figure 2.** FUgp per 100 kg in selected spring varieties of barley. The largest difference between varieties was 7 FUgp per 100 kg.

**Figure 3.** Variety results measured in hkg per ha or in FUgp per ha. The figure shows that the order would look different if the output was measured as FUgp per ha.
New system for calculating phytase

The use of the enzyme phytase increases the digestibility of phosphorus in feed, whereby less phosphorus is required to ensure adequate phosphorus supply to the pigs. A simple calculation model has been used so far that assumed that the same amount of phytase was used every time, which furthermore risked misjudgement of certain types of diets. The new model includes five digestibilities of phosphorus depending on the inclusion rate of phytase – and the five digestibilities vary between feedstuffs.

Table 1 shows the minimum phosphorus content necessary to meet the pigs’ requirement for digestible phosphorus when grain-soybean meal based feed is used without wheat bran, rapeseed meal and sunflower meal. In diets including these products, the total-phosphorus content must be slightly higher because the digestibility of phosphorus is slightly lower in these high-fibre feedstuffs. In feed mixed on-farm, slightly less phosphorus is sufficient because of phytase in the grain.

Phosphorus in finisher feed

A previous trial showed that 4.1-4.2 g total-phosphorus per FUgp was sufficient to secure finisher productivity when the normal dosage of phytase (500 FTU or 750 FYT per kg) was added. The content of digestible phosphorus in this trial was calculated to 2.2 g digestible phosphorus per feed unit.

A trial was initiated to see whether phosphorus in finisher feed could be reduced even further. The trial is carried out in two herds with increasing phosphorus dosage in feed with phytase. The preliminary results from the first herd are shown in table 2.

The preliminary production results show that 3.9 g total-phosphorus is enough for the pigs when a double dosage of phytase is used as productivity is the same as with 4.3 and 4.9 g total-phosphorus per FUgp with the new calculation system, which is the standard of digestible phosphorus for finishers. The trial thereby confirms that the standard of 2.2 g digestible phosphorus to finishers exactly ensures the productivity of the pigs.

Group 1 only included the total-phosphorus that naturally originated from grain and soybean meal (3.4 g per FUgp) together with double dosage of phytase. This is therefore the lowest phosphorus level that can be reached in finisher feed – and also too little to meet the requirements of the pigs as productivity was approx. 6% lower compared with the groups given extra phosphorus.

Overall, the trials show that 3.9 g phosphorus per FUgp with double dosage of phytase and 4.1 g per FUgp with normal dosage of phytase are sufficient to meet the phosphorus requirement of the finishers. With these contents, a herd with the same feed conversion as in this trial will have 19-21 kg phosphorus per ha, which is below the fulcrum for phosphorus on most lands.

Phosphorus in weaner feed and sow feed

A weaner trial is carried out in two herds with increasing phosphorus levels and where phytase is added to the feed. The preliminary results show that a too low phosphorus content is detrimental to the productivity. At the same time, results indicate that the guiding minimum content of phosphorus in feed with phytase is sufficient to meet the requirements of weaners (see table 1). The final results will reveal whether the recommendations for minimum content of phosphorus in feed with phytase can be adjusted slightly.

Corresponding trials running for several years have been initiated with sow feed with phytase to find the minimum content of phosphorus in gestation and lactation diets.

Table 1. Minimum content of total-phosphorus, g per FUgp with increasing inclusion of phytase

<table>
<thead>
<tr>
<th>Phytase, % of standard</th>
<th>0%</th>
<th>60%</th>
<th>100%</th>
<th>150%</th>
<th>200%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finisher feed mixed on-farm</td>
<td>4.5</td>
<td>4.0</td>
<td>3.9</td>
<td>3.8</td>
<td>3.7</td>
</tr>
<tr>
<td>Finisher feed, ready-mixed</td>
<td>5.0</td>
<td>4.4</td>
<td>4.1</td>
<td>3.9</td>
<td>3.8</td>
</tr>
<tr>
<td>Lactation diet, mixed on-farm</td>
<td>5.4</td>
<td>4.9</td>
<td>4.7</td>
<td>4.6</td>
<td>4.5</td>
</tr>
<tr>
<td>Lactation diet, ready-mixed</td>
<td>5.9</td>
<td>5.3</td>
<td>4.9</td>
<td>4.7</td>
<td>4.6</td>
</tr>
<tr>
<td>Weaner diet, mixed on-farm</td>
<td>5.8</td>
<td>5.4</td>
<td>5.3</td>
<td>5.2</td>
<td>5.1</td>
</tr>
<tr>
<td>Weaner diet, ready-mixed</td>
<td>6.3</td>
<td>5.7</td>
<td>5.4</td>
<td>5.3</td>
<td>5.2</td>
</tr>
</tbody>
</table>

Table 2. Total-phosphorus levels for finishers, preliminary production results, 30-105 kg

<table>
<thead>
<tr>
<th>Group</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total-P, (analysed) g/FUgp</td>
<td>3.4</td>
<td>3.9</td>
<td>4.3</td>
<td>4.9</td>
</tr>
<tr>
<td>Addition of phytase per kg, FYT</td>
<td>1500</td>
<td>1500</td>
<td>750</td>
<td>750</td>
</tr>
<tr>
<td>Dig. P (calculated in new system), g/FUgp</td>
<td>1.9</td>
<td>2.2</td>
<td>2.4</td>
<td>2.8</td>
</tr>
<tr>
<td>Production results (30-105 kg)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Daily gain, g</td>
<td>883</td>
<td>898</td>
<td>905</td>
<td>902</td>
</tr>
<tr>
<td>Feed conversion, FUgp/kg gain</td>
<td>2.88</td>
<td>2.81</td>
<td>2.82</td>
<td>2.81</td>
</tr>
<tr>
<td>Production value incl. lean meat %, index</td>
<td>94</td>
<td>101</td>
<td>100</td>
<td>102</td>
</tr>
<tr>
<td>Effect on nutrients accounts</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kg P/pig 30-105 kg</td>
<td>0.33</td>
<td>0.41</td>
<td>0.50</td>
<td>0.62</td>
</tr>
<tr>
<td>Kg P/ha with 1.4 livestock units/ha [46 pigs, 30-105 kg]</td>
<td>15</td>
<td>19</td>
<td>23</td>
<td>29</td>
</tr>
</tbody>
</table>
More livestock and improved environment can go hand in hand. This has been proved by the development of the last 20 years, which is thought to continue.

Increased efficiency – an environmental bonus
It is a well-known fact that competition ensures both development and an increased efficiency. The side effect is a huge environmental bonus.

Since 1985, improved breeding stock and optimised feeding with synthetic amino acids and enzymes have reduced nitrogen discharge per produced finisher (including the sow herd) by 34% – a reduction from 7.7 to 5.1 kg nitrogen. This positive development will continue. In 2015, an average feed consumption of 2.60 KgN per kg gain is expected, which will further reduce nitrogen content in pig manure to 4.3 kg – a 44% reduction compared with the 1985 level of 7.7 kg (see figure 1).

Less ammonia from pigs
Since 1985, ammonia emissions have decreased by 38% per produced finisher, which is entirely due to improved breeding stock and improved feed.

This development is the most significant reason why the overall ammonia emission from Danish pigs in the period up to 2002 has decreased by 22%, while the production of pig meat has increased by more than 54%.

The positive development will continue. In 2015, an overall reduction of approx. 38% in ammonia emissions from housing facilities, storage and spreading is expected compared with 2002 – from 33,800 tonnes ammonia-nitrogen in 2002 to 21,000 tonnes in 2015 with the same level of production.

The type of housing has a significant effect on ammonia emissions. Simply moving finishers to a new facility with partially slatted floors and correct use of sprinkling and good management can reduce emissions to less than 9 kg nitrogen per livestock unit. This is a 50% reduction compared with approx. 18 kg in an old facility with fully slatted floors.

Nitrogen fallout
Since 1985, Danish farming has reduced the ammonia loss by a total of 33%, despite an increased number of livestock measured as livestock units. However, ammonia from farming is not the only important factor in terms of environmental impact due to nitrogen fallout over raised bogs, heaths and other vulnerable natural areas. Industry and traffic also cause nitrogen oxides that cause just as huge an impact.

62% of the nitrogen fallout originates from other countries, either in the form of nitrogen oxides from traffic and energy sectors or in the form of ammonium from foreign farming, while Danish farming accounts for approx. 32% of the fallout. Specifically, Danish farming on average accounted for 6.0 kg nitrogen per ha in 2002, while 13% of the fallout could be attributed to Danish pigs – corresponding to 2.5 kg per ha (see figure 2).

Odour
A high ventilation performance in a facility increases odour emissions to the surrounding environment. In the summer, odour emissions are typically 3-5 times higher than in the winter. It is therefore important not to over-ventilate the housing facility in the summer.

Odour emissions also vary greatly between herds. Correct use of sprinkling reduces the pigs’ tendency to wallow in “dirt” during warm periods, and the pen thereby stays clean and dry. As an example, the National Committee has measured 40% lower odour emissions from finisher pens with less than 30% mess compared with the group that had more than 30% mess.

Keeping pens clean and dry and avoiding over-ventilation increases the chances for reducing odour emissions.

Environmental authorisation – 75 livestock units
As of January 1, 2007, the limit for environmental authorisation will be lowered to 75 livestock units. At the same time, it will become possible for the authorities to require that technology be used to reduce odour nuisances and ammonia emissions. As described on the following pages, establishment of new environmentally friendly facilities together with good management alone can contribute to a significant reduction of odour and ammonia emissions.

Particularly livestock herds located close to nitrogen-sensitive nature areas can expect to be required to use technologies that are capable of greatly reducing environmental impact. Today, we know of some well-tested and efficient technical solutions, but most technical solutions are far too expensive to establish and run.

![Figure 1. Discharged nitrogen per produced finisher (including sows and weaners).](image1.png)

![Figure 2. Fallout of nitrogen from the atmosphere. Average fallout over Danish rural areas in 2002 totalled 18.8 kg.](image2.png)
Distance requirements in relation to odour

No actual order exists concerning odour from livestock production facilities. However, in cases where odour was included in the processing of environmental authorisations, the leaflet “Guidelines for evaluation of odour and reduction of nuisances from livestock facilities” issued by the Association of Environment Staff in the municipal councils is often used. Below, this leaflet is called the FMK instruction; the latest edition was published in May 2002, and the first edition was published in 1994.

The FMK instruction provides recommendations for minimum distances from urban zones, concentrated dwellings and individual dwellings in rural zones, respectively. In the future, an official set of guidelines will be published for evaluation of odour from livestock facilities. These guidelines will be issued by the Danish Forest and Nature Agency. It is the opinion of Danish farming that future guidelines should not be stricter than the FMK instruction, which was also considered satisfactory by the municipal councils.

Being a supervising authority, the municipal board can issue an enforcement notice in pursuance of §42 of the Environmental Protection Act if unhygienic conditions or significant pollution, including nuisances for neighbours, are demonstrated. It is important for all herds to consider odour conditions regardless of size and location. It is highly recommended to include odour in connection with extensions of production, even though distance requirements are met and the producer is not obliged to make an environmental impact assessment.

New standards for odour emissions

When evaluating cases concerning odour nuisances from livestock production facilities today, odour emissions based on measurements in German facilities in the 1980s are used. There is therefore an acute need for odour emission standards from Danish facilities in 2005 to guarantee as correct a calculation of nuisance distances from livestock production as possible.

Through trials, the National Committee is currently establishing new standards for pig facilities. Nine types of pig facility have been selected in which odour emissions will be measured. These nine types include finishers units with either fully slatted floors or partially slatted floors and drained floor in the lying area; weaner units with fully slatted floors or partially slatted floors; farrowing units with fully slatted floors or partially slatted floors; and gestation units with individual housing or group-housed sows. These types of facility constitute the majority of the types present in Danish herds. Four herds are selected for each type, so that both liquid feeding and dry feeding are represented, and so that recordings are made with both diffusion ventilation and radiant ventilation. Odour emissions will be measured in the period June-October 2005 during outdoor temperatures of approx. 20°. The summer period was selected because odour emissions are highest in the summer, and this is the period used in the authorities’ evaluation.

Table 1. Minimum distance between finisher facilities and urban zones, concentrated dwellings and individual dwellings in rural zones, respectively, based on the leaflet “Guidelines for evaluation of odour and reduction of nuisances from livestock facilities”.

<table>
<thead>
<tr>
<th>Housed finishers</th>
<th>Livestock units</th>
<th>Odour emissions</th>
<th>Minimum distance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Odour units/second</td>
<td>Urban zones and summer house areas</td>
</tr>
<tr>
<td>100</td>
<td>11</td>
<td>975</td>
<td>99</td>
</tr>
<tr>
<td>900</td>
<td>100</td>
<td>8,775</td>
<td>296</td>
</tr>
<tr>
<td>1,800</td>
<td>200</td>
<td>17,550</td>
<td>419</td>
</tr>
<tr>
<td>2,250</td>
<td>250</td>
<td>21,938</td>
<td>468</td>
</tr>
<tr>
<td>2,700</td>
<td>300</td>
<td>26,325</td>
<td>513</td>
</tr>
<tr>
<td>4,500</td>
<td>500</td>
<td>43,875</td>
<td>662</td>
</tr>
</tbody>
</table>
**Most significant odorants**

Together, the Danish Meat & Research Institute, LugtTek A/S and the Technological Institute are developing and testing a method for determining the concentration of a number of individual substances. The analyses are made partly with gas chromatography followed by mass spectrometry (GC/MS) and partly with Membrane Inlet Mass Spectrometry (MIMS). The National Committee for Pig Production will afterwards make a number of parallel measurements in pig facilities in which odour is recorded partly with sensory panel and partly with chemical analyses.

So far, parallel measurements have been made in connection with three trials:

- Reduced amount of air
- Biological air purification
- Feed with inulin

The trials have shown that air change can be reduced by reducing the amount of air, and the individual substances reduced are acetic acid, propane acid and butyric acid. Contrary, skatol emissions were increased in all measurements with GC/MS and MIMS meaning that reduced air change increases skatol emissions. On this basis, it must be assumed that skatol is of no significant importance to odour emissions in general, as this was reduced due to a lower air change. Indol emissions were not affected by reduced air change, and indol is not thought to be a crucial odour component. The trials with biological air purification showed that hydrogen sulphide, trimethylamine, sulphur dioxide and butyric acid dropped significantly, while dimethyl sulphide, diacetyl and cresole were unaffected by air purification. Acetic acid did not follow a pattern in any of the samples. The project concerning individual substances will be finished in 2006, and at that time the most significant odorants are expected to be known. Additives to slurry and feed can then be pinpointed, and development of air purifiers and other techniques will be more concentrated.

**Water can remove odour**

Several air purifiers have been tested in the form of “scrubbers” where the housing air that is sucked out passes through a liquid fog. The scrubbers were efficient against ammonia, but not against odour. The question is whether water is actually able to remove odour in housing air? To clarify this, a small model was made in cooperation with FORCE Technology of a scrubber in which a sub-current of air from the exhaust pipe was pulled trough. Odour measurements made before and after the scrubber revealed that pure water was able to reduce odour by more than 90%. The trick for the many companies producing scrubbers will therefore be to ensure that the circulating water is not saturated by odorants and that the contact time between liquid drops and odour molecules becomes sufficient to capture the odour molecules.

**Reduced air change**

In previous trials, a marked seasonal variation was recorded in odour emissions from pig facilities. Odour emissions were particularly high in the summer when air change in the facilities peaks. A trial investigated the effect of reducing the air change by 50% on odour and ammonia emissions from finisher facilities in the summer. The trial showed that a reduced air change with cooling of the inlet air has a significant effect on odour emissions, but only a small effect on ammonia emissions.

The trial was conducted in a herd with two identical housing sections with two batches of finishers in the period August-November 2004. In the trial section, the maximum ventilation capacity was reduced to 50%, while the maximum ventilation capacity in the other section (control) was 100% corresponding to 100 m³/hour per pig. In the trial section, the inlet air was cooled with a cooling system when the ventilation need was more than 50%, and the cooling system was thereby controlled on the basis of a desired housing temperature. In order to simulate summer in November, heat was supplied in the control section.

In total, odour concentration was determined with olfactometer on nine days of measurement. On the days when odour was measured, the air change in the trial section was on average reduced by 50% in block 1 resulting in a 33% odour reduction with 95% confidence interval [21-45] compared with the control section. In block 2, odour was reduced by 47% with the 95% confidence interval [39-54] with a 56% reduced air change.

Ammonia emissions were slightly reduced in the facility with reduced air change. In the first block of pigs, ammonia emissions from the trial section were reduced by 12% with the 95% confidence interval [9-15], while in the second block, it was reduced by 7% with the 95% confidence interval [3-10] compared with the control section.

![Figure 1. Odour emissions from two housing sections with 100 m³/hour per pig (control) and 50 m³/hour per pig, respectively. The study is based on two blocks of finishers. In the first block, odour was measured five days in September. In the second block, odour was measured four days in November. Each point constitutes the average of 2-3 measurements made at the hours 12-13, 14-15 and 15-16, respectively.](image)
A historical statement depicting the development in ammonia emissions was made on the basis of recordings from the herds under the Danish Applied Pig Research Scheme. Furthermore, technical possibilities for reduction and future development will be summarised.

**Historical development**

In connection with a number of trials, a series of individual measurements were made of ammonia and carbon dioxide concentrations. These measurements made it possible to evaluate the development in ammonia emissions from finisher facilities over the last 15 years. The measurements showed that ammonia emissions vary greatly from herd to herd, but also that the emissions have dropped in that period. Over the last years, measurements have been made in many facilities with partially slatted floors, where ammonia emissions are significantly lower than in facilities with slurry containers below the entire facility.

**Revision of standards**

On the basis of the latest measurements of ammonia emissions from facilities with partially slatted floors, the standard was revised for ammonia loss from finisher units with partially slatted floors. With fully slatted floors and partially slatted floors, ammonia emissions of 16% and 12%, respectively, of the discharged nitrogen were used so far in the calculation. However, the loss for partially slatted floors will be reduced to 8% in the manure year 2005/06.

**Ammonia-carbon dioxide method**

Ammonia emissions are determined by measuring ammonia concentration and air output. Air output is measured directly by using e.g. measuring fans or indirectly by using the carbon dioxide balance. This is based on an emit of 185 l carbon dioxide an hour per heat-producing unit (1,000 W total heat-production).

With the ammonia-carbon dioxide method, the ammonia emissions can be determined on the basis of the proportion between the ammonia concentration and the carbon dioxide concentration in ppm, where the ammonia concentration and the carbon dioxide concentration are adjusted for the concentration in outdoor air. This means that it will be relatively simple to assess ammonia emissions from housing facilities in practice. For instance, a ratio of 0.010 between ammonia and carbon dioxide differences will correspond to an annual ammonia loss of 9.43 kg NH3-N per heat-producing unit.

**Gestation units**

A trial in service/gestation units demonstrated a significant difference in ammonia emissions between the following four housing designs:

1. Group-housed, partially slatted floors, wire-type barn cleaner (control)
2. Group-housed, partially slatted floors, wire-type barn cleaner with cooling
3. Stalls, partially slatted floors
4. Stalls, fully slatted floors

Compared with wire-type barn cleaner without cooling (control), ammonia emissions with cooling was 31% lower; 9% lower in partially slatted floors with stalls; while stalls with slurry container below the entire housing facility was 30% higher than the control facility. The trial thus demonstrated that partially slatted floors reduce ammonia emissions and cooling the slurry could further reduce emissions.

**Future reduction**

Measurements have so far shown that reduced protein and thereby reduced discharge of N together with a reduction in the slurry surface through the use of solid floor can reduce ammonia emissions significantly. If a further ammonia reduction is needed, the most obvious solutions are purification of air, either acid purifiers or biological air purifiers, acidification of slurry, and cooling of slurry.
Purification of air

More and more pig producers are required to reduce ammonia emissions or odour or both. This has sped up the development of air purification systems both in Denmark and in countries such as the Netherlands and Germany. Trials and experience have so far demonstrated that systems with acid purifiers and/or biological air cleaners are estimated to be the most suitable for pig facilities. Acid cleaning is most efficient method for reducing ammonia, while biological air cleaners are the most efficient methods for reducing odour. Trials have, however, demonstrated that further development is required to obtain durable stable air cleaners with low maintenance and operating costs.

Types of air purification

Air purification systems for pig facilities can be divided into three main groups in terms of function:
- Acid purifiers
- Biological air cleaners
- Biofilters

The cleaning principles are combined in some of the new air purification systems. Furthermore, air purification systems are characterized according to whether they are central or decentralised. Central systems require complicated control mechanisms for ventilation with collection of the outlet air. The advantage is that the air purification is gathered in one place. Collection of outlet air from several sections with animals of different ages makes it possible to reduce the maximum ventilation capacity to typically 60-80% that of a traditional system. As opposed to decentralised systems, it is normally only realistic to establish central systems in new facilities unless the facility is prepared for collection of the air.

Acid purifier

When acid purifiers are used, the outlet air passes through a set of lamellas that are sprinkled with diluted acid, typically sulphuric acid with a pH of 2-4. The acidified liquid very efficiently transforms ammonia into ammonium. There are currently several systems that remove more than 90% of the ammonia. This ammonia is then stored in separate tanks as ammonium sulphate with an N concentration of typically 5-10%.

Trials

Acid purifiers are not suitable for reducing odour measured by olfactometry. Analyses of individual substances show that the purifier reduces most of the odorants, but it is not capable of eliminating the most significant odorants.

Biological air cleaner

In biological air purifiers, the outlet air passes through a set of lamellas that are moist and are routinely maintained so that the bacteria film is formed on the lamellas. It is a biologically open system, and the bacteria culture will adapt to what performs best under the given circumstances. The bacteria culture can be controlled on the basis of growth conditions, for instance temperature, pH, concentration of mineral nutrients in sprinkling liquid, etc. It will furthermore be possible to control the culture by adding nutrients or other elements that enhance certain cultures.

Trials

Management of water supply and of the mineral nutrients is essential for the efficiency of the purifiers. This applies to both odour and ammonia. Ammonia emissions can be reduced by more than 70% provided sufficient mineral nutrients are emptied from the purifiers.

Odour measurements have shown that odour reductions of 60-70% are possible, but that there are many more or less unknown conditions that for periods of time result in poorer effect of the filters.

Biofilter

With biofilters, housing air passes through a moist, biodegradable material such as straw or wood chips in which the odorants are absorbed and decomposed. Most filters are horizontal.

Trials

The filters can only be impacted with a modest amount of air per square meter, which is why the filters require a lot of space and are thereby not suitable for pig facilities. It is essential that the filters are moist and are routinely maintained by adding or replacing the biological material.

Table 1. Typical characteristics of different types of air purification systems

<table>
<thead>
<tr>
<th>Cleaning effect</th>
<th>Acid purifier</th>
<th>Biological air purifier</th>
<th>Biofilter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonia</td>
<td>++</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Odour</td>
<td>--</td>
<td>+(+)</td>
<td>++</td>
</tr>
<tr>
<td>Impact, m³/h per m²</td>
<td>5,000 – 10,000</td>
<td>5,000 – 10,000</td>
<td>≤300</td>
</tr>
</tbody>
</table>

++ Very good, + Good, = Unsuitable
Several investigations have demonstrated that the feed intake of lactating sows drops when housing temperature rises. This has a negative effect on litter weight at weaning and the sow’s weight loss in the lactation period.

Solarisation
The investigation included two herds with farrowing units ventilated via diffuse air intake. In one of the herds, the roof surface was insulated through the attic, which had a Masonite underliner. As with insulation of the roof surface, the purpose of the underliner was to reduce the transfer of heat from the sun to the inlet air.

Temperature measurements showed that a Masonite underliner was sufficient insulation to reduce the sun’s heating of the inlet air. On days with great solarisation, a 1–2ºC heating was measured when an underliner was installed, while up to 5–6º heating of the inlet air was measured when the roof surface was not insulated. If the roof is insulated or if an underliner is established, condensation drips from the slabs can also be avoided. The benefit in terms of production and frequency of dirt in the farrowing unit is being investigated in a trial in which the air in the housing unit is cooled in the summer, partly by water atomization and partly by increasing the air speed above the animals.

Heat in the pen
In the housing unit without underliner, the farrowing pens had closed pen sides in a height of 70 cm. This herd often experienced problems with mess in the covered creep areas when outdoor temperatures reached more than 10–15ºC. Temperature measurements in the exhaust pipe of the ventilation system and in the pens showed that the temperature in the traditional pens did not drop at the same speed as the temperature in the exhaust pipe. As problems with mess began at relatively low outdoor temperatures, the cause is estimated to be lack of air change among the sows and piglets. Because of the high, closed pen sides, ventilation air was not utilized or mixed as efficiently when the air change was reduced. It is therefore recommended to avoid high, closed pen sides in farrowing units with traditional farrowing pens.

A too warm immediate environment in farrowing pens probably has different solutions depending on the problem in the individual facility. If, for instance, the problem is mess in covered creep areas when outdoor temperatures go below 10ºC, attention should be directed at housing temperature and the immediate environment in the covered creep areas, i.e. temperature of floor heating, effect of heating lamps, and the opening degree of the area. If problems with mess arise when outdoor temperatures reach more than 20ºC, insulation of the roof surface or cooling of inlet air may have an effect in the form of less mess.

### Table: Outdoor temperature and possible solutions

<table>
<thead>
<tr>
<th>Outdoor temperature</th>
<th>Problem</th>
<th>Possible solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 10 ºC</td>
<td>Too warm in pen and housing unit</td>
<td>Modified temperature strategies in housing unit and covered creep area</td>
</tr>
<tr>
<td>10 – 20 ºC</td>
<td>Too warm in pen the pen</td>
<td>Avoid closed pen sides Pit ventilation increases air change in Circulation of air in the housing unit Larger pens</td>
</tr>
<tr>
<td>&gt; 20 ºC</td>
<td>Too warm in pen and housing unit</td>
<td>Limit solarisation by insulating roof surface Cooling in the housing unit</td>
</tr>
</tbody>
</table>

<p>Figure 1. The figure shows measurements of outdoor temperature and temperature of the air in the air intake made at the same time. The air is heated when outdoor temperatures are high, which is expressed by the increasing spread on measured temperature in the attic. The black line represents a hypothetical situation in which heat is not transferred through the roof construction.</p>
Considerable efforts are being made to prevent infections from spreading both between herds and within the individual herd. It is therefore unfortunate that part of the infection protection is lost because building instructions are not closely followed when diffusely ventilated housing facilities are erected. This is demonstrated by experience from many climate investigations.

False air intake between sections
When ventilation takes place via diffuse air intake with air intake through the attic, it is important that the necessary thermal bridges are constructed over inspection alleys, under ceiling joists and around exhaustions. It is also important that the section wall is led to the upper edge of the insulation or that it is sealed in another way to avoid false air intake between two neighbouring sections. In too many cases, the batten is placed across the section wall resulting in air being drawn from one section to another in the air space between two battens and insulation. The problem is greatest when one section contains newly transferred pigs and the ventilation system is running on minimum, while the neighbouring section is occupied by larger pigs and thereby has a higher ventilation rate.

The reason is that diffusely ventilated housing facilities are adjusted with minimum ventilation to a differential pressure of approx. -2 Pa, whereas the differential pressure in a facility with maximum ventilation ranges between -30 and -40 Pa. The pressure difference between the section results in false air intake with a risk of infections spreading. This can furthermore disturb ventilation and heat supply.

To avoid false air intake between sections, the battens must not be led across the section wall, but should simply adjoin the wall, though leaving enough space for the thermal bridge to be led a little down the wall, joined and retained with a batten.

Temperature strategy
In diffusely ventilated facilities, with air intake via the attic, the speed of the air intake is very slow. The air change in diffusely ventilated facilities may therefore be greater than in radiantly ventilated facilities of the same volume without draught occurring. However, diffuse air intake does not have the same cooling effect as when the air is taken in through wall inlets.

Experiences from climate investigations have shown that it often becomes too warm in the animals’ activity zone in facilities with diffuse ventilation, and the risk of tail biting occurring or the lying area becoming dirty is increased because of heat stress among the animals. The temperature in the pen is often somewhat higher than the temperature by the sensor. It is therefore important to pay attention to the difference in temperature down in the pen and up in the housing space, when determining temperatures and sprinkling strategy.

When the finishers grow, it may be necessary to increase sprinkling time slightly. Temperature strategy as well as sprinkling strategy must, however, always be adapted to the behaviour of the animals.

Suggestions for temperature strategy in facilities with solid floors and covers.

<table>
<thead>
<tr>
<th>Weight, kg</th>
<th>7</th>
<th>10</th>
<th>14</th>
<th>18</th>
<th>21</th>
<th>25</th>
<th>30</th>
<th>35</th>
<th>42</th>
<th>50</th>
<th>75</th>
<th>90</th>
</tr>
</thead>
<tbody>
<tr>
<td>Room temperature, °C</td>
<td>22-24</td>
<td>22</td>
<td>21</td>
<td>19</td>
<td>18</td>
<td>17</td>
<td>17</td>
<td>17</td>
<td>16</td>
<td>16</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Temperature without cover, °C</td>
<td>28</td>
<td>28</td>
<td>26</td>
<td>25</td>
<td>23</td>
<td>22</td>
<td>22</td>
<td>21</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Inlet temperature, °C</td>
<td>42</td>
<td>40</td>
<td>35</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

- Outdoor temperature:
- 0-16°C sprinkle only to indicate dunging area and to keep slatted floor elements clean
- 16-18°C sprinkle: 1-2 minutes, once an hour
- >18°C sprinkle: 2 minutes, two times/hour

Figure 1. Air passage between two sections in the cavity between battens and insulation.

Figure 2. There is no risk of air passing through different sections because the battens are interrupted at the section walls.
As increasingly large herds are established, requirements increase for both the planning of the production and the subsequent management of service units and gestation units. Regardless of housing and feeding principles, the daily management is of immense importance to a good result.

### Stall dimensions

New recommendations were published for dimensions of stalls for non-lactating sows. The changes were made on the basis of measurements of Danish crossbred sows. Stall width varies depending on the function of the stall. In a service control section with stalls, two stall widths are necessary: 60 cm and 70 cm, respectively (inside measurements). In the daily management, the size of the individual sow must be assessed when deciding which stall to place the sow in.

### Service units

Behavioural studies of sows in service units with group-housing have shown that during heat, primarily the dominant sows (often older sows) mount the hierarchical weak sows (the young sows). The Danish Applied Pig Research Scheme has therefore conducted two trials to elucidate measures that could benefit the young sows.

### Sorting according to age

In one trial, the sows were sorted according to age – young or elder – or housed in mixed groups. The service unit had group-housing and free access to feeding and insemination stalls. The results showed that young sows in sorted groups had significantly more piglets in total per litter.

### Housing in stalls during heat

In one trial, sows in one group were housed in stalls from the beginning of heat and until after service. In the other group, sows were housed in groups for the entire period in the service unit. The service unit had group-housing and free access to feeding and insemination stalls. The number of culled young sows tended to increase when the sows were not housed in stalls during heat. Housing in stalls during heat is thereby an advantage for young sows.

### Gestation units

Electronic sow feeding (ESF)

When practising ESF, separation of sows in connection with vaccination, management of body condition, and transfer of sows to the farrowing unit causes a risk of accidents during which sows die or are put down due to overcrowding. To a large degree, feeding stations are technically secure against separation accidents, but human errors may occur leading to accidents. Accidents should be completely avoided out of regard to the sows’ welfare. This is the joint responsibility of pig producers, advisers and companies.

Sows do not scream when, over time, they become more and more sows in a limited space, ie. less than 2 m² per sow. Instead they become exhausted and passive. An alarm is being developed that is based on video surveillance of the separation area and constant image processing.

Stable groups or four weeks between transfers to the individual pen would make it unnecessary to reduce the extent of separation and is assumed to reduce labour and ease the transfer procedure. These management factors are therefore included in future activities under the National Committee.

### Table 1. New guiding recommendations for dimensions on stalls for Danish crossbred sows. (Source: Brief 0502)

<table>
<thead>
<tr>
<th>Housing section</th>
<th>Stall type</th>
<th>Width (cm)</th>
<th>Length (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service/control unit with stalls</td>
<td>Standard</td>
<td>60</td>
<td>210</td>
</tr>
<tr>
<td></td>
<td>Large</td>
<td>70</td>
<td>210</td>
</tr>
<tr>
<td>Service/control unit with group-housing</td>
<td>Feeding and insemination stall</td>
<td>65</td>
<td>210</td>
</tr>
<tr>
<td>Gestation unit with group-housing</td>
<td>Feeding and resting stall</td>
<td>60</td>
<td>210</td>
</tr>
<tr>
<td></td>
<td>Feeding stall (cafeteria)</td>
<td>50</td>
<td>190</td>
</tr>
</tbody>
</table>

All are inside measurements. The lengths are stated from the rear edge of the trough, ie. the trough edge closest to the sow.
The sows’ choice of habitat was investigated in several pen designs with one feeding and resting stall per sow, including T pens (nest area with limited bedding) and U pens (deep litter between feeding stalls, and slatted floor in the dunging area). The investigations showed that housing temperature is very important to where in the pen the sows choose to lie. The sows use the area outside the stalls to a smaller extent when temperatures in the housing unit increase. This is probably because a well-bedded lying area feels warmer than a cool floor without bedding. Housing temperature should therefore be relatively low, ie. 17-18° in the periods of the year when this is possible.

Investigations have shown that in pens without a well-defined bedded lying area, the sows primarily stay in the stalls. Less than 10% of the sows stay outside the stalls in a pen where the entire area outside the stalls is placed between the rows of stalls and thereby without clear “distinction of zones” in the pen. In T pens where the lying area is placed in a nest area, approx. 80% of the sows choose to stay in the lying area outside the stalls during resting periods in the evening.

Drained floor may count as solid floor, if the slot width in the floor is max. 10. It is recommended that drained floor be placed as an extension of the lying area in the nest area and in the entire width of the pen. However, the front 90 cm of the stalls must have solid floor. An investigation made in T pens compared two different locations of drained floor. The results showed that it is possible to have drained floor in the area between two rows of stalls and at the same time maintain a good hygiene on the floor. However, there must be very limited bedding to ensure a good hygiene.

Drained floor can constitute part of the pen area that must have solid floor and bedding. The prerequisite is that the slot width is max. 10. In T pens it is recommended to place the drained floor as shown in the drawing.

One feeding and resting stall per sow

Design recommendations:
- Continuous lying area in the form of a nest area separated from stall and activity areas
- Solid floor in the lying area, drained floor in the passage between lying area and activity area
- Stall dimensions cf. recommendations in Brief 0502
- Product test of stalls was conducted in 2004 – Report 0405
- Sprinkling of activity area
- Automatic or mechanized allocation of straw
- Mechanical mucking out

Management recommendations:
- Stable groups
- Sorting according to size and body condition at transfer
- Housing in stalls for four weeks after service, if liquid feed is used
- Monitoring of feeding
- Supplemental feeding of thin sows
- Dosing of liquid feed results in waiting for the sows, also within the individual pen. Feeding order of the feeding valves must ensure that all sows in the same pen are fed as quickly as possible
Housing

Lactating sows

The increasing demands on sows’ milk production because of increasing litter size, and the general requirement for, for instance, low risk of shoulder lesions, bring attention to the sows’ comfort in the farrowing pen. It must be possible for the sows to stand up, lie down and get up without problems regardless of whether they are housed in traditional farrowing pens or in pens for loose housing.

Sows’ movement patterns

In one trial, the movement patterns of sows were recorded in two farrowing pens with different stall dimensions and in one loose pen. Third and fourth parity sows were used. The sows were in the middle of gestation, so their movement was not affected by piglets. Two farrowing stalls were used: Stall190 measuring 190 cm (excl. trough) x 55/63 cm (trough end/back gate) and Stall210 measuring 210 cm (excl. trough) x 65/90 cm (trough end/back gate). The dimensions of Stall 210 correspond to the spring 2004 recommendations of the National Committee for Pig Production. The loose pen measured 400 cm x 200 cm.

The sows lay down for a longer period of time – both in lateral position and prone position – in Stall190 compared with Stall210 and the loose pen. However, the sows in the loose pen were more/the most active compared with the sows in stalls.

In Stall190, the sows spent more time lying down and getting up compared with Stall210, but the sows in the loose pen spent the most time on this activity.

The sows spent more room in width and length getting up in Stall210 compared with Stall190. The sows spent more room in width getting up in the loose pen compared with Stall210. Lengthwise there was no difference in space used getting up and lying down in Stall210 and in the loose pen.

Based on the knowledge of sows’ patterns of movement, it is estimated that the 2004 recommendations of the National Committee for Pig Production for dimensions of farrowing pens and farrowing stalls are sufficient for the sows to be able to lie down, rest and get up.

Large farrowing pens

In 2004, the National Committee revised its recommendations for dimensions of farrowing pens and farrowing stalls. This revision was caused by the increases in sow size and litter size, among other things. Space requirement for both sows and piglets has thereby increased.

It is expected that increased space will improve sows’ welfare and increase weaning weight of the piglets. If the sow is able to stand up and lie down without problems, her intake of feed and water and thereby her potential milk production will increase. The milk intake period itself per lactation is furthermore very short (approx. 10-20 seconds), and there is a risk that the piglets do not utilise the sow’s potential for milk production if the lack of space causes unrest/disturbances. It is thus expected that if piglets have unrestricted access to the teats, the battles over teats will be reduced and the milk intake and thereby weaning weight of the piglets will increase. It could furthermore reduce the need for cross-fostering and thereby for removal of pigs between litters. This is an advantage in terms of both labour and health. However, there is a risk that increased space in farrowing pens could reduce hygiene.

The National Committee for Pig Production has initiated an investigation that compares production and hygiene between traditional farrowing pens (160 cm x 240 cm) and farrowing pens measuring 180 cm x 270 cm. The latter meet the National Committee’s recommendations from 2004.

The preliminary production results reveal a significantly higher litter weight with the same number of pigs per litter. Litter weight at weaning is approx. 3 kg higher in the pens meeting the recommendations compared with the litter weight at weaning in the pens measuring 160 cm x 260 cm.

In terms of hygiene, the preliminary analyses show that regardless of pen size, the area around the sow’s trough was humid in approx. 40% of the pens. Humidity was furthermore seen along the pen side opposite the covered creep area in a large part of the farrowing pens measuring 180 cm x 270 cm.

Pens for loose lactating sows

Generally, the latest types of farrowing pens for loose lactating sows cannot be recommended. There is great potential for improvement in terms of, for instance, piglet access to the teats, support for the sow when she lies down, and freedom of movement for the sow. A considerable development task lies ahead.

Table 1. Preliminary comparing statement of activity (standing/walking) and time and room spent on standing up/lying down in Stall190, Stall210 and loose pen, respectively.

<table>
<thead>
<tr>
<th></th>
<th>Stall190</th>
<th>Stall210</th>
<th>Loose pen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time up (standing or active)</td>
<td>Least</td>
<td>More</td>
<td>Most</td>
</tr>
<tr>
<td>Time spent standing up/lying down</td>
<td>More</td>
<td>Least</td>
<td>Most</td>
</tr>
<tr>
<td>Room spent in length when standing up</td>
<td>Least</td>
<td>More</td>
<td>As Stall210</td>
</tr>
<tr>
<td>Room spent in width when standing up</td>
<td>Least</td>
<td>More</td>
<td>As Stall210</td>
</tr>
<tr>
<td>Room spent in length lying down</td>
<td>Least</td>
<td>More</td>
<td>As Stall210</td>
</tr>
<tr>
<td>Room spent in width lying down</td>
<td>Least</td>
<td>More</td>
<td>Most</td>
</tr>
</tbody>
</table>

The farrowing pen meets the recommendations for dimensions of 2.7 x 1.8 m.
before farrowing pens for loose lactating sows can be recommended.

The challenge lies in designing the farrowing pens with a number of conflicting considerations as the requirements for, for instance, immediate environment and design vary for sow, piglets and staff, respectively. The Royal Veterinary and Agricultural University, the Danish Institute of Agricultural Sciences and the National Committee for Pig Production will continue the effort to develop pens that as far as possible meet needs of both sows, piglets and staff.

Support for the sow when she lies down is one element of the development of farrowing pens for loose sows.

Support for the sow when she lies down is one element of the development of farrowing pens for loose sows.

The preliminary results from a trial show that the sows generally prefer to lie with their head towards the covered creep area. The behaviour of lying with her back against the support wall and the head towards the covered creep area increases from day 2 before farrowing towards day 2 after farrowing.

FARROWING PENS

Design recommendations:
• The farrowing pen with farrowing stall should measure 180 cm x 270 cm (inside measurements)
• The farrowing stall should measure 210 cm in length and minimum 65 cm by the trough end and be adjustable to minimum 90 cm by the back gate (inside measurements)
• The corner opposite the covered creep area must be shielded/cast
• Heating lamp (75-100 W)
• Floor heating in the covered creep area
• Water and feed for the piglets
• No floor heating under the sow
• Adjust the farrowing stall outwards 3-5 days after farrowing, i.e. when the piglets primarily rest in the creep area
• Farrowing pens for loose sows cannot yet be recommended

Management recommendations:
• The sows must be transferred 5-7 days before expected farrowing
• The temperature in the farrowing unit must be fitted to the sows, i.e. approx. 20º before farrowing and approx. 18º when farrowing is complete
• The sows must be given nesting material daily in the period until farrowing
• The farrowing stall must be adjusted outwards 1-4 days after farrowing
• The piglets’ requirements to their immediate environment must be met in the covered creep area

It is estimated that the risk of the piglets being crushed to death by the sow is reduced if she leans against a supporting surface when she lies down as opposed to when she lies down in the middle of the pen with no support. A trial revealed that the sows choose other support devices than walls with pig rails. Thus the sows only lay down by the wall with pig rails in 16% of the cases where they lay down by a wall, while in 84% of the cases the sows chose either a level sloping wall or the regular closed pen side.

In two production herds with loose lactating sows, the National Committee is comparing the sows’ choice of lying wall in farrowing pens where the pen side against the neighbour sow has a sloping support wall or pig rails. Preliminary experiences indicate that the sows prefer the wall with the sloping support wall.

The sows often lie with the back against the support wall and head towards the covered creep area.
Tail biting

In many herds, tail biting is both a welfare problem and a financial problem. Many activities aim at reducing and if possible eliminating tail biting in the individual herd. There is probably no universal solution as tail biting is a multifactorial problem with many causes. Often several measures have to be taken to reduce the problem.

Causes of tail biting
Together with the Danish Institute of Agricultural Sciences, the Danish Applied Pig Research Scheme observed 18 herds with tail biting problems for approx. a year. In each herd, housing design and management were changed to eliminate tail biting. Before the changes were made, behaviour was observed and climate studied in these herds both in pens with tail biting and in pens without. The aim was to find the most likely causes of tail biting.

Based on the initial observations, two to four changes of housing design or management were made in each herd. These changes were, for instance, covering up of slatted floors, partial opening of pen sides and reduction of noise from ventilation systems. Subsequently, the number of tail bitten pigs was monitored for a period of time, both in pens with and in pens without changes. The aim of the project is to develop a computer-based analysis tool that is able to pinpoint possible causes of tail biting on the basis of behavioural observations, i.e. a tool for advisers, among others, to be used when trying to eliminate tail biting.

Preliminary results show that reduction of the noise from exhaustions had an effect on tail biting in a couple of herds. The reduction was obtained by moving the motor higher up in the funnel and installing a noise-reducing plate under the funnel. Correspondingly, installing “curtains” in the slurry gutter, covering up of the slatted floors in the inspection alley and partial opening of the pen sides reduced the number of tail bitten pigs by 50%. Several herds have seen an effect of increasing the number of feeding points above the recommendations of the National Committee. This was tried because the behavioural observations showed that the space by the feeder in these herds was overcrowded.

The recommendations of the National Committee for Pig Production still apply to the majority of herds, but an increase may be justified by special circumstances in the individual herd. The need for more feeding points than normally recommended could be caused by, for instance, pigs growing very fast, the design and adjustment options of the feeder, feed texture, location and output of the water supply.

Acute measures against tail biting
Together with the Danish Institute of Agricultural Sciences, the Danish Applied Pig Research Scheme is investigating whether it is possible to temporarily eliminate acute tail biting among finishers by way of ropes, straw or carbohydrate-rich feed. The aim is to discover whether these three measures can buy the pig producer extra time to find the triggering causes of tail biting. When tail biting begins, the pigs are given rope, straw or trial feed for 14 days. These treatments are compared with a control group. The trial runs in 2005/06 in two herds, and preliminary results are available from two herds where the trial is finished.

The frequency of pigs with wounds or scratches on their tails increased as expected in the control group where no measures were taken against tail biting.

Contrary to this, the number of pigs with scratches on their tails tended to decrease among the pigs given rope. The number of pigs with wounds was constant in this group. The wounds did not heal completely in the observation period, which is why the number of pigs with wounds did not drop.

Apparently, straw was also able to eliminate incipient outbreaks of tail biting, because the number of pigs with wounds or scratches on their tails was fairly constant in the trial period. The number of tails with scratches remained unchanged. The reason might be that the pigs did not have permanent access to the straw as they did to rope.

Feeding with carbohydrate-rich feed had no predominantly positive or negative effect, as the tail condition varied somewhat between the batches. One of the reasons for this could be that one herd changed diets during the trials, and that the carbohydrate content of the trial feed was not sufficiently balanced to have an effect.

Scratches on the tail may indicate incipient tail biting.

Effect of “curtains” in the slurry gutter and covering up of the slatted floors in the inspection alley on the frequency of tail bites

Noise from the ventilator is reduced by placing a noise-reducing plate under the ventilation funnel.
Housing of weaners and finishers

Enrichment and rooting materials
There are many different enrichment and rooting materials for pigs. Trials of these have in the past year supported previous analyses that stated that wood and straw given on the floor are among the cheapest materials. Customized materials (both the materials and the dispensers for these) are generally somewhat more expensive than straw and wood. Furthermore, in facilities with fully slatted floors and inappropriate slurry systems, wood is often the most convenient.

In co-operation with the Danish Institute of Agricultural Sciences and the companies W. Domino and Skiodl Echberg, the Danish Applied Pig research Scheme studied wood chips, maize silage and straw for finishers in a pilot study. These materials were selected because the pigs preferred them among many other materials in a previous investigation made by the Danish Institute of Agricultural Sciences. The wood chips consisted of pieces in different sizes. Some of the wood chips ended up in the dunging area. Due to contamination with manure, the pigs lost interest in these wood chips, which had to be removed manually. Even relatively large pieces passed through the slots. Therefore, the slurry could not be spread by conventional slurry spreaders because the wood chips would get trapped in the hosing system. Sparse experience with small wood chips of willow indicated that they will sink to the bottom of the slurry gutters. It thereby becomes difficult to empty the slurry gutters completely.

Experience with maize ensilage was mainly positive. The silage was drier than the one used for cattle. That was probably part of the reason why a relatively small stack could be managed even during the warm, early summer. However, the silage became warm in the dispensers and started to rotten after a short period of time if too much was filled at a time. When hygiene was poor or water was wasted, silage got to the lying/activity area, which the pigs can lie against or seek shelter behind. The scales are placed between the two feeding areas in the transition between pen and feeding area. The pigs pass the scale to get to the feeding area and return to the pen through one-way gates. Depending on their weight, the pigs are sorted to either of the feeding areas. Production data, such as feed conversion, mortality, daily gain, treatments for disease, slaughter weight and slaughter classification are recorded in both herds. Time spent is also recorded in the trial.

Experiences are still sparse, and production results etc. have not been analysed yet. However, in the herd where the large pen principle has been employed for the longest time, the sorting scales and the pen are functioning as intended. Besides the abovementioned advantages, other advantages of the system are said to be minimisation of weight spread, improved control of lean meat percentage because of phase feeding, easier supervision, saving of labour during wash because of less equipment, and routine evaluation of gain. The disadvantages are time-consuming training of animals, risk of accidents during separation, and treatment/culling of individual animals from a large pen. The further process of the trial will establish whether the perspectives of large pens meet the expectations under Danish conditions.

The trial is carried out in co-operation with the Danish Institute of Agricultural Sciences.
New regulations for housing of pigs were introduced in May 2003. The EU directive containing welfare elements, among other things, was implemented into Danish legislation. This resulted in, for instance, increased requirements for enrichment and rooting materials and nesting material for heavily pregnant sows.

Danish pig producers have adjusted management according to the best available knowledge and according to what is practically possible. The legislation is open to interpretation in several areas. In practice, the public welfare inspection sets the level and assesses whether the legislative requirements are met in the herds. The Danish Minister of Justice has ordered the Danish Veterinary and Food Administration to draw up guidelines on current enrichment and rooting materials.

It is at all times the responsibility of the individual producer to ensure that the animals are well cared for in the herd and that animal welfare legislation is met.

**Welfare campaign**

In December 2003, the National Committee for Pig Production initiated a campaign for improved welfare in pig herds. The aim was to help pig producers interpret the legislation, but also to inform them on how to improve animal welfare to the benefit of both the animals and the producers. Both job satisfaction and economy improve when the animals are healthy.

One of the cornerstones of the campaign was direct communication with the pig producers. The campaign began with information material on the prevention and handling of shoulder ulcers and tail biting. The material was sent directly to more than 15,000 pig producers and advisers. Subsequently, the campaign focused on delivery suitability of finishers. In March 2005, more than 10,000 pig producers received letters concerning enrichment and rooting materials, correct destruction procedures, and design and use of hospital pens.

Besides sending letters directly to pig producers and advisers, comprehensive educational material for the agricultural schools was prepared, a number of articles on welfare were published, animal welfare theme days were held as were regional meetings for advisers, and templates were prepared for use in individual herd strategies. Finally, a welfare feature was made in Info Svin, which also included manuals on the prevention and handling of shoulder ulcers and tail biting.

**Hospital pens**

Hospital pens are a huge step in the right direction towards improved animal welfare. A new order on hospital pens commenced on January 1, 2005. All herds must now have a sufficient number of well-designed hospital pens.

**Delivery and transport**

The Animal Protection Committee and the National Committee have co-operated on investigating whether a number of recommendations can be drawn up on delivery facilities and whether these could replace legislation in this area.

So far, the Danish Ministry of Justice has stated that delivery room and delivery trucks must be designed like housing facilities in terms of space, etc. The National Committee for Pig Production is now investigating alternative options.

Delivery of pigs must be as gentle, rational and quick as possible. This is primarily achieved by designing and using delivery facilities with consideration for the behaviour of pigs. For instance, the alley to the truck could be lowered so the pigs are able to walk to the truck without experiencing differences in level. Moving the pigs calmly down the alley non-slip flooring and without interesting objects is also a good place to start.

Besides gentle delivery, delivery facilities also aim at maintaining maximum infection protection of the herd. This is only possible if the delivery facility is considered an unclean zone from which animals are not led back to the remaining herd area.

Use the posters that the National Committee for Pig Production has sent to all pig producers concerning enrichment and rooting materials, hospital pens and destruction procedures.

Example of design of a hospital pen in an existing facility.

It is quicker to load the pigs if they do not have to walk up a loading platform. This can be achieved by lowering the alley to the transport truck.
The Danish Veterinary and Food Administration is responsible for ensuring that animal welfare inspections are made in 5% of all pig herds annually.

In 2003, the Danish Parliament decided that the inspections should be intensified. As a consequence, the number of inspections increased from 2% to 5% of the herds. It was also decided that the inspections should be unannounced, should be risk-based and should be extended to include inspection of compliance with both EU legislation and national legislation. Previously, the inspection only included compliance with EU legislation. The fact that the inspections were made risk-based meant that large sow herds in particular selected on the basis of the CHR register and Vetstat were inspected.

Primary problems
In June 2005, the results of the 2004 welfare inspection were published.

The five main problem areas concerned (in order of priority):
- No or inadequate supply of enrichment and rooting materials
- No exsanguination after stunning with a captive bolt pistol
- Inadequate handling of sick or injured animals
- Inadequate recordings
- No or inadequate supply of nesting material

The results also include a number of other offences that had resulted in injunctions. A total of 1,833 injunctions were granted in 2004. Almost 60% of the injunctions could be grouped within the five main problem areas mentioned above.

The inspection reported 47 of the 824 inspected herds to the police for violation of the Animal Protection Act.

How to improve animal welfare
It is estimated by the National Committee that the problems observed by the 5% inspections can be divided into three groups.

One group comprises the serious offences that result in extremely poor welfare (such as failure to deal with sick and injured animals, serious shoulder lesions, incorrect destruction procedures, etc.).

Another group is a group in which extremely poor welfare arises not from housing and feeding, but from conditions that over a long period of time contribute to poor welfare (for instance, no rooting or nesting materials, too small stalls, no texture in feed for gestating sows (development of gastric changes), incorrect ventilation (development of tail biting) etc.).

A third group includes conditions that fall under the welfare inspection, but which do not directly harm the welfare of the animals. These are in particular no or inadequate recordings of mortality, medication, etc.

The National Committee’s trials indicate that the welfare level varies between herds. Most herds have excellent animal welfare conditions, others have good welfare but lack the final details, and finally there are herds in which several serious conditions can be criticised. It is not just the type of housing system, feeding principle, amount of straw etc. that determine whether welfare is good or inadequate. Management and care of the pigs are also extremely important.

The National Committee for Pig Production recommends that you
- Compare your production with legislative requirements
- Prepare for inspection
- Discuss welfare with other producers or advisers to calibrate welfare in your herd
- Pay more attention to the individual animal – improving the margins improves welfare and economy
- Use hospital and relief pens actively
- Make specific herd welfare strategies together with your adviser
- Have your vet show you correct destruction procedures

Active use of hospital and relief pens improves welfare and economy.

Sufficient enrichment and rooting material must be supplied.
Hospital pens are worth while

All herds must have a sufficient number of hospital pens. Setting up of hospital pens does not have to cost the producer money in the long term. Assuming that mortality can be reduced by 30-40% compared with the herd’s current level, set-up costs will be paid. If mortality can be further reduced, the investment in hospital pens will be profitable. Setting up a hospital pen is estimated to cost twice that of a regular pen because of the increased space and the possibility for supplying heat and cooling.

There will be a considerable potential in many herds for reducing mortality. According to the production reports, mortality and the number of pigs culled post-weaning averaged 8.9% in the period April 2004 to April 2005. In many herds, it will be possible to halve this figure.

Pen area

An individual hospital place unit for sows/gilts must measure 3.5 m², and there must be no more than three sows/gilts per hospital pen. A hospital pen for sows must be minimum 2.8 m² per animal. For growing pigs, the space required is determined by the weight of the pig (see table 1).

Pen design

The environment in the hospital pen must be the best possible with sources of heat and no draught. It must be possible to cool the animal during warm periods. In all hospital pens, minimum 2/3 of the floor area must have soft surface. The animals must not be in direct contact with the concrete floor (see illustration).

The soft surface could be, for instance, a rubber mat or sufficient amounts of straw. Requirements for space and design are specified in Order no. 1120 of November 19, 2004. The regulations took effect on January 1, 2005, without any transition period.

Location of hospital pens

The optimum solution in many herds will be to place hospital pens for finishers together in a separate housing section, so that treatment can be concentrated in one place. Practising consistent all-in all-out in the regular sections will become easier and the risk of infection will be reduced. It is, of course, also possible to use a pen in a regular section, if flooring, design and stocking density can be adjusted.

Advantage for the pig

When performing the daily monitoring, the producer must be aware of pigs showing signs of disease or pigs that do not act normal. These animals must be further examined and it must be decided whether to move them to a hospital pen and administer treatment. A pig should be moved to a hospital pen if the animal’s welfare risks being compromised by staying in the regular pen.

A pig must be moved to a hospital pen if it needs:
- A soft lying area
- Heat
- Space and quiet
- Access to feed and water without competition

Advantage for the producer

Tending to sick or injured pigs is easier when the animals are housed in well-designed hospital pens. It must be easy to move sick pigs to the hospital pen, and the hospital pen should be placed so that it is easy to perform extra monitoring of the sick pigs. A clear strategy for the use of hospital pens should be made/written down in the individual herd, so all employees know their task.

The National Committee has prepared a number of recommendations for the design and use of hospital pens. Hospital pens were also included in the welfare campaign during which the National Committee forwarded campaign material to all pig producers in the spring of 2005.

Table 1. Space for the individual pig in the hospital pen

<table>
<thead>
<tr>
<th>Pigs in weight interval</th>
<th>Pen area, m² per animal with more than one animal per pen</th>
</tr>
</thead>
<tbody>
<tr>
<td>7-15 kg</td>
<td>0.36</td>
</tr>
<tr>
<td>15-30 kg</td>
<td>0.58</td>
</tr>
<tr>
<td>30-60 kg</td>
<td>0.91</td>
</tr>
<tr>
<td>60-100 kg</td>
<td>1.29</td>
</tr>
<tr>
<td>100-130 kg</td>
<td>1.53</td>
</tr>
<tr>
<td>130-150 kg</td>
<td>1.69</td>
</tr>
</tbody>
</table>
Following changes in legislation in 2003, veterinary practitioners have been allowed to prescribe pain-relieving medicine for a period of 30 days. This has resulted in a monthly increase in the consumption of pain-relieving medicine for pigs (see figure 1).

A positive development
Pain relief is not merely pain relief. The type of pain-relieving medicine that can be used for pigs also reduces fever and has an anti-inflammatory effect. This means that the medicine inhibits oedema and swelling. The medicine thereby promotes the healing of damaged tissue and the recovery of the animals.

The increase in the use of pain-relieving medicine must therefore generally be considered a positive development. Pain relief is not just a treatment of symptoms but a treatment that in most cases will affect the course of disease positively.

Earlier investigations in Denmark and abroad have demonstrated that pain relief promotes the recovery of, for instance, arthritis, PPDS in sows and diarrhoea at weaning. The National Committee is currently studying the effect of pain relief on arthritis in finishers, PMWS in weaners and PPDS in sows.

Use and abuse
In connection with the increasing consumption of pain-relieving medicine, it is crucial that pig producers and veterinarians are aware of both the positive effects and the risks of using pain-relieving medicine. It is particularly important to avoid abuse. Pain relief must never replace hospital pens and other forms of care, but should be seen only as a supplement.

Range of application
The majority of the pain-relieving medicines prescribed in 2004 were used for diseases of the leg, brain and skin (see figure 2). Leg disorders are probably responsible for most of the consumption. This is probably because leg disorders are considered painful, but also because there are restrictions on the use of each individual type of pain-relieving medicine. For instance, no injectable medicine is approved for gastrointestinal diseases, respiratory disorders or meningitis. The fact that these restrictions still exist is unfortunate seen from an animal welfare point of view.

It is to be hoped that trials under the National Committee will help broaden the possibilities of using pain relief.

Figure 1. Consumption of pain-relieving medicine (NSAIDs) for pigs in 2003 and 2004. The amounts are calculated on the basis of consumption of active matter (source: Vibeke Frøkjær Jensen, VetStat, the Danish Institute for Food and Veterinary Research) and recommended dosage and should only be seen as approximate figures. Acetylsalicylic acid is not included in the VetStat data.

Figure 2. Consumption of pain-relieving medicine for pigs in 2004. The amounts stated are calculated on the basis of consumption of active matter (source: Vibeke Frøkjær Jensen, VetStat, the Danish Institute for Food and Veterinary Research) and recommended dosage. It is assumed that the average weights of the treated sows, weaners and finishers were 200 kg, 15 kg and 50 kg, respectively. Furthermore, the weight is set to 50 kg in the group of unknown animals. Acetylsalicylic acid is not included in the VetStat data.
Healthy sows

The majority of Danish sows are slaughtered, while the remaining part either die or are destroyed in the herd. Reports to the Danish Veterinary and Food Administration show that Danish sow herds in 2004 lost 14.2% of their sows to destruction.

**Mortality**
The latest investigation of the National Committee concerning culled sows confirms that the effort against sow mortality must focus on the general longevity of sows and minimise sow mortality. Less than half of the herds participating in the investigation delivered more than 80% of the culled sows to the slaughterhouse (see figure 1). An applied effort in many herds is therefore necessary.

Culled sows – slaughtered, destroyed and dead sows – must routinely be analysed in terms of
- The number of culled sows
- When in the cycle the sows are culled
- Parity number of the sow
- Cause
- Whether the sow has previously been treated or been in relief

Together with employees and advisers, the herd owner is this way able to assess the situation and make an applied effort against the problem.

**Shoulder lesions**
Shoulder lesions in sows should be avoided as they are no doubt a nuisance to the animal and at the same time signal lacking care for the sow. There has been focus on the problem for several years, and it now seems that the problem is less extensive than just a couple of years ago.

**Consequences**
Shoulder lesions reduce welfare and result in economic losses due to increased costs for treatment, non-productive days and an increased number of cullings at the slaughterhouse. Deep shoulder lesions can provide a portal of entry for bacteria into the blood stream, which may cause blood poisoning and abscesses in different places in the body.

An effort made quick and in due time will result in
- Improved welfare
- Improved longevity of the sow
- Complete avoidance of serious shoulder lesions
- Fewer culled sows
- Reduced risk of blood poisoning

**Strategies and shoulder lesion manual**
In herds with shoulder lesions, it is important to maintain attention to the problem until it is solved. Together with herd advisers, each herd should prepare a herd strategy for how to reduce the number of sows with shoulder lesions and how to handle the sows. It is essential to write down what to do, who does what, when to do it, and to follow up on what works. Herd strategies can be downloaded from www.infosvin.dk.

The shoulder lesion manual of the National Committee provides pig producers with a tool for preventing and finding causes of shoulder lesions. The manual focuses on management and housing design, so that the sow has the right body condition and gets the correct conditions in the farrowing unit. The manual can be downloaded from www.lu.dk.

**Hoof care**
Hoof lesions play a part in reducing productivity, welfare and longevity of the sows resulting in sows being slaughtered or destroyed “before” their time. Hoof lesions is a common problem in intensive pig production and a cause of lameness. Hoof lesions are frequent and the severity of the lesions is greater among loose sows in housing systems with partially slatted floors than among tethered sows. The outer hooves of the hind leg are more often injured than the outer hooves of foreleg, and the greater the difference between the inner hoof and outer hoof, the more injuries to the outer hoof.

Long hooves and cracks in the side wall of the hoof or toe influence the free movement of the sow – they predispose to lameness and difficulty in walking. It is therefore natural that some form of hoof care is included in health and welfare strategies of a herd.

Hoof care of sows without the use of a hoof trimming stall is generally performed easiest within the first week after transfer to the farrowing unit. Hooves and dew claws are trimmed with a hoof cutting pliers/hoof shears by removing max. 4-5 mm at a time until shiny and fresh hoof horn can be seen. Hooves with deep cracks are cleaned and treated locally, possibly applied with a bandage. The hoof bandage is typically removed after eight days.
New studies have elucidated infection routes in segregated production systems.

Results from previous investigations in multi-site systems have shown that it is possible to produce batches of finishers free of respiratory infections even though the infectious agents are present in the sow herd. However, pleuropneumonia in particular can cause problems in the form of a high prevalence of lung lesions in finishers and acute disease outbreaks late in the finisher period.

But how and when do finishers become infected and how can infection be avoided? The disease symptoms often appear late in the finisher period, but the pigs may have been infected at an earlier stage. Do the pigs become infected from the sows during the suckling period or does it happen later in their lives? Do batches of finishers infect each other through transmission of infections from one room to another? And can a lower level of respiratory infections be expected in small herds that only have one finisher batch on the premises at a time?

**Less infection with all-in all-out management**

Investigations in Danish multi-site systems have shown that the prevalence of infection with pleuropneumonia and enzootic pneumonia was lowest in finisher herds with all-in all-out management on site level (only one batch of finishers present on the site at a time) (see figure 1). In herds with several batches present on the site at a time (all-in all-out management on room level), a higher proportion of the batches were infected.

Results from 65 batches of finishers from 10 finisher sites showed a statistically significant difference between the two types of management in terms of the frequency of infection with pleuropneumonia. An example is shown in table 1. However, for enzootic pneumonia the difference was not statistically significant.

The results indicate that infection between rooms in finisher units can be a significant source of infection with pleuropneumonia on sites with all-in all-out management on room level.

Therefore, an adequate separation between batches is an important part of the disease control in these sites.

Infection from sows is also important. Infection with respiratory disorders was not completely prevented on sites with all-in all-out management on site level in the finisher period. Approximately a third of the studied batches from this type of finisher site were infected with pleuropneumonia at slaughter. Likewise, a third of the batches were infected with enzootic pneumonia. The batches had probably become infected during lactation.

The prevalence of infected finisher batches varied significantly between the sow herds. This indicates that infection pressure and immunity in the sow herds influence the risk of the pigs becoming infected. Therefore, a high level of resistance in the sow herd is also important in the prevention of respiratory diseases in the pigs. A sensible quarantine management and immunisation of gilts are important elements in achieving this.

### Table 1. Infection with pleuropneumonia in 13 finisher batches in a multi-site system at the time of slaughter. All 13 batches originated from the same weaner site and showed no signs of infection at introduction to the finisher site.

<table>
<thead>
<tr>
<th>All-in all-out</th>
<th>Number of batches studied</th>
<th>Number of infected batches</th>
</tr>
</thead>
<tbody>
<tr>
<td>On room level</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>On site level</td>
<td>6</td>
<td>0</td>
</tr>
</tbody>
</table>

**Figure 1. Examples of different types of multi-site systems. Multi-site systems are production systems in which the pigs are transferred from the sow herd at weaning to another site. Weaner sites and finisher sites are managed all-in all-out on room level or on site level.**
Surveillance of herds
The Salmonella surveillance system in finisher herds still reveals a high level of Salmonella. When a laboratory error was corrected in the autumn of 2003, the number of positive meat juice samples almost doubled. As a consequence, many finisher herds are assigned to levels 2 or 3 (see Table 1).

In July 2005, the risk-based Salmonella surveillance system was introduced in which the number of samples is reduced in herds that do not have Salmonella. Only one meat juice sample a month will be collected from finisher herds with a Salmonella index of 0.0 and minimum 10 negative meat juice samples in the last six months. The surveillance of the other finisher herds continues unchanged. If a positive meat juice sample is detected in a herd under the risk-based surveillance, the herd is immediately transferred to the regular surveillance system. The new surveillance system thus reduces the costs of analysing meat juice samples.

Surveillance at slaughterhouses
Every day, the slaughterhouses analyse swabs from pig carcasses for Salmonella. In 2004, Salmonella prevalence was 1.4%, which is a 0.2% reduction compared with 2003. The slaughterhouses have introduced an intensified Salmonella control programme. The programme focuses on the slaughterhouses that have had too many positive Salmonella samples for too long. The slaughterhouse must identify possible causes for the increased prevalence and prepare an action plan. The action plan must describe critical hygiene control points and the measures to be initiated, and the effect of the measures must be documented.

Outbreaks among humans
The number of Salmonella outbreaks among humans peaked in 1997 with more than 5,000 outbreaks. In 2004, 1,538 Salmonella outbreaks were recorded, which is an 11% reduction compared with 2003. The number of Salmonella outbreaks caused by pork has also decreased. In 2004, 142 outbreaks could be attributed to Danish pork [see figure 1]. In 2004, 98 outbreaks among humans were caused by imported pork.

Cost-effective effort
The Salmonella level in Danish pork has decreased significantly since 1995 when the national surveillance plan was initiated. However, an agreement with the Danish Veterinary and Food Administration states that the level must be reduced further by the end of 2006. In order to comply with the agreement, it is necessary to revise the current surveillance plan. Both the authorities and the industry are interested in achieving the greatest reduction in Salmonella reduction for their money. It was therefore analysed where, in the farm-to-fork chain, an effort can be made to reach the agreed goal in the most economically efficient way. Different methods for reducing the Salmonella level were analysed. Overall, it was concluded that it will be difficult to reach the goal through further measures in primary production, and that, instead, measures can be conducted far more cost-effectively at the slaughterhouses.

Table 1. Assignment to levels, July 2005

<table>
<thead>
<tr>
<th>Level</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1</td>
<td>96.1%</td>
</tr>
<tr>
<td>Level 2</td>
<td>2.8%</td>
</tr>
<tr>
<td>Level 3</td>
<td>1.1%</td>
</tr>
</tbody>
</table>

Figure 1. Estimated number of Salmonella outbreaks in humans caused by chicken, pork or eggs in Denmark, 1998-2004 [Source: Danish Zoonosis Centre].

Salmonella-reducing measures are more cost-effective at the slaughterhouses than in primary production.
PMWS has been present in Danish pig production for five years, and as of April this year 541 herds have been diagnosed with PMWS at the lab. This figure corresponds to approx. 5.4% of all Danish pig herds and approx. 10% of all Danish sow herds. However, reports from practice indicate that the actual prevalence of PMWS is higher. A conservative estimate is that at least every fifth sow herd has problems with the disease. The full cause of the disease is not yet known.

New Danish investigations
Together with the Danish Institute for Food and Veterinary Research (DFVR), the National Committee is completing a comprehensive investigation of 150 Danish sow herds – 75 with PMWS and 75 without. If the sick herds are compared with the healthy ones, the following are observed:
- Typical PMWS symptoms occur 3-4 weeks post-weaning
- Weaner mortality is 8% higher and finisher mortality 2% higher
- Daily gain is 25 g lower among weaners and 40 g lower among finishers

Results from post-mortem findings from dead pigs from the 150 herds have improved knowledge of the diagnostic results that can be expected in herds with and without PMWS. In herds with no suspicion of PMWS, there may be more pigs with PMWS-like laboratory findings than previously expected. Thus, a post-mortem of three pigs from the healthy herds resulted in laboratory findings that were compatible with PMWS in 24% of the herds.

The diagnosis
These results led DFVR to adjust the criteria for the PMWS diagnosis. The new PMWS criteria are based on two equally important conditions:

1. Clinical symptoms with unthriving and wasting pigs and increased mortality in the herd
2. Laboratory analyses of 3-5 unthriving pigs must reveal findings in at least one pig that are characteristic of PMWS

It is still essential that herds with many problems are given the correct diagnosis. This is the only way to efficiently prevent disease.

Breeding system
As of September 1, 2005, the National Committee decided that PMWS should no longer be declared in breeding and multiplier herds. Instead, general recording of mortality in breeding and multiplier herds was introduced. With the former requirement for laboratory analyses in cases of increased mortality, breeding and multiplier herds risked being declared PMWS-positive even though the increased mortality could be caused by other diseases. This means that the current diagnostics are not sufficient for a declaration that give the buyers confidence and at the same time give the supplier a fair guarantee against misdiagnoses.

Prevention
So-called autogenous serum produced from finishers in the herd seems to be able to reduce mortality in some herds. In four PMWS herds, the effect of autogenous serum and a PCV2-specific serum was investigated – the results are shown in table 1. However, it is illegal to use autogenous serum in Denmark.

Unfortunately, the addition of a cocktail of so-called immunostimulants to feed did not result in a reduction in mortality. The cocktail was investigated in two herds with the same negative results (see page 20).

Research
Research still concentrates on the cause of PMWS and the possibilities for controlling the disease. A comprehensive joint EU project will be initiated and will run over the next four years. As new results are made available, they will be published on the National Committee’s website (www.lu.dk) where an updated PMWS manual can also be downloaded. The manual reviews possible measures for prevention and control. Results from the EU project can also be found at www.pcvd.org.

Table 1. Trial results of serum against PMWS. Autogenous serum only managed to significantly reduce mortality in the weaner unit in herd 1.

<table>
<thead>
<tr>
<th>Herd</th>
<th>Autogenous serum</th>
<th>PCV2-specific serum</th>
<th>Untreated (control)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.3% dead</td>
<td>4.0% dead</td>
<td>6.1% dead</td>
</tr>
<tr>
<td>2</td>
<td>2.7% dead</td>
<td>2.6% dead</td>
<td>2.9% dead</td>
</tr>
<tr>
<td>3</td>
<td>0.9% dead</td>
<td>1.4% dead</td>
<td>1.0% dead</td>
</tr>
<tr>
<td>4</td>
<td>2.4% dead</td>
<td>2.4% dead</td>
<td>3.9% dead</td>
</tr>
</tbody>
</table>
In Denmark, the consumption of antibiotics per kg produced pork is 0.05 g, which is low compared with other countries. The annual statements from the Danish Veterinary and Food Administration show that the producers comply with withdrawal times. Veterinary medicine residues are hardly ever found in Danish pork. However, the consumption of antibiotics has increased over the last years. In 2004, the consumption increased by 13% compared with 2003, while the increase in production was approx. 3%. The development and distribution are shown in figure 1.

**Disease must be treated**

Sick animals must always be taken care of, and diseases must be treated with antibiotics according to the instructions of the veterinarian. During visits from the veterinarian, the necessity of routine treatments should always be considered, and possibilities for improvements in the herds should be discussed. The consumption of antibiotics varies between herds reflecting differences in the health status of the herd and in the prevalence of current disease problems. Medicine consumption is affected by the choice of medication methods and the possibilities for treating disease in its early stages.

**Mortality is increasing**

Weaner mortality increased by 0.9% between 2000 and 2004, while the number of dead or condemned finishers increased by 0.7%. At the same time, piglet mortality increased by 1.0%. More than 20% of the pigs die before they can be delivered for slaughter. It is assumed that disease prevalence in the herds has increased when increased mortality is recorded.

**Significant increase after PMWS outbreaks**

Outbreaks of PMWS in many herds have increased the consumption of medicine. An analysis made by the Danish Institute for Food and Veterinary Research and the National Committee for Pig Production shows a significant increase in the consumption of antibiotics for weaned pigs in the first six months after an acute PMWS outbreak.

The consumption for sows after PMWS outbreaks has not increased, nor has the consumption for finishers in the first six months after a PMWS outbreak. The analysis does not include the subsequent development. The analysis included relatively few finisher herds, which is why no definite conclusion can be drawn on this area. As of April 1, 2005, a total of 541 herds had been diagnosed with PMWS through laboratory analysis, corresponding to approx. 10% of all sow herds.

Diarrhoea requires group treatment in many herds, diarrhoea problems are the reason for treatment with antibiotics: 78% of the consumption for weaners and 60% of the consumption for finishers are attributed to gastro-intestinal diseases. Many treatments are administered as group treatments. It is important that treatment is directed towards the pens in which disease is present instead of treating all pens in the section.

**Treatment of Lawsonia**

Investigations have shown that injection treatment of weaners for Lawsonia takes one minute per pig. However, injection treatment costs four times that of treatment via the feed. When wages are taken into account, treatment via feed of four pigs (7 days) costs the same as injection treatment (3 days) of one pig with the same antibiotic. Group treatment may be necessary and appropriate if the disease prevalence is high and if it is difficult to detect sick animals sufficiently early in the outbreak.

Results from investigations in one herd show that group treatment administered via feed (7 days) resulted in significantly fewer sick and dead pigs, a significantly higher daily gain, and a lower feed conversion compared with pens in which 55% of the pigs were treated by injection for three days.

**Prudent use of antibiotics**

Antibiotics must be used with care both for the sake of production economy and to ensure that we still have effective antibiotics and a high level of food safety. More efficient treatment and consumption of antibiotics can be obtained through herd strategies such as:
- Evaluation of the effect of the administered treatment
- Use of group treatment directed towards the sick pigs
- Use of hospital pens
- Adequate training of the staff
- Improvement of feed and housing facilities

Herd strategies can be found in Danish at www.infosvin.dk.
Health economics

Disease must be prevented and treated to ensure animal welfare and to reduce the financial losses caused by diseases. With health economics, the losses incurred by diseases and thereby the reduced productivity and the possible profit in preventing disease are calculated. The calculations can be made for one herd, but it may also be necessary to make calculations for an entire area, for instance an entire country.

The best financial return

One must be aware of the most important reasons why disease occurs in a herd. However, when a producer is about to make his final decision on how to treat or avoid diseases, a financial evaluation of the overall effort is also important. The evaluation must include all costs, and they must be compared with the profit the producer can expect from improved health status in the herd. The costs may include, for instance:

- Costs for diagnosing the herd
- Costs for prevention, such as costs for vaccination
- Extra labour during disease outbreaks
- Reduced productivity during disease outbreaks

By counterbalancing costs with potential improvements, the producer is able to select the effort that will give the best financial return in the herd. The National Committee is routinely initiating various activities focusing on the economics of a given effort in the pig production.

What is a vaccine allowed to cost?

Normally, the price of a vaccine must not exceed the production-wise benefits of using the vaccine. For instance, a vaccine against a respiratory infection will be able to reduce mortality among weaners by a couple of percentage points, but how great must this reduction be and how much can the vaccine cost for a producer to obtain a financial profit from using the vaccine on his sows? An example is shown in figure 1. The results of the calculations show that the pig producer will gain a financial profit from the combination of vaccine price and drops in mortality placed above the lines in the figure. With a vaccine price of, for instance, DKK 40, a farrow-to-finisher herd (FTF herd) will obtain a financial profit from using the vaccine if mortality drops by minimum 1.6%, while in a herd with sale of 30 kg pigs mortality must be reduced by minimum 2.3%. This means that the effect in the FTF herd does not have to be as great before a profit is achieved compared with the herd selling 30 kg pigs. The FTF herd gets the entire profit of the vaccination effect when the pigs stay in the herd until slaughter.

Economics of health advice

The herd vet and the producer must together choose between different strategies for treatment and prevention of diseases. The larger the herd, the greater the financial consequences will be of, for instance, increased mortality. As the herds increase in size, it is therefore necessary to make a close financial evaluation of the intervention, for instance by selecting a certain vaccination strategy in the herd.

The example in figure 1 includes average figures for a herd, but in the future it must be possible for the adviser and the producer to use tools for calculating recommendations that will apply specifically to the individual herd.

The implementation of some recommendations will typically have a short time frame, while others will have a longer time frame, such as complete depopulation or renovation. The consequences of both types of decisions must be analysed, but it will require some effort to gather the required information, such as the spread of disease in the herd, specific costs for, for instance, feed, dimensioning of the housing facility etc., to ensure that the calculations are made on a sensible basis.

The National Committee is actively involved in a project aimed at developing a tool for efficient calculations. The aim is that it must be possible to make the calculations simultaneously with the regular advice in the herd, and possibly as an integrated part of the herd's production report.

**Figure 1.** Correlation between the price of a vaccine for sows and the effect, in the form of reduced weaner mortality, the producer needs in order to obtain a financial profit from using the vaccine in his herd. The calculations are based on data from April 2005, and are made for an FTF herd and for a herd selling 30 kg pigs.
Financial consequences
Wildlife organisations have suggested that wild boars be reintroduced into Danish wildlife as part of the national management of biological diversity.

In Europe, wild boars have played a part in outbreaks of Classical Swine Fever, and experiences show that an epidemic lasts longer if wild boars circulate the infection among other wild boars and domestic pigs. The financial consequences of swine fever outbreaks are destructive both for the affected farmer, the entire industry and the national economy. As the world’s largest net exporter of pork, Denmark is particularly vulnerable. In 2004, exports totalled DKK 26 billion. A temporary ban on exports would therefore entail considerable expense.

Slightly increased risk
Denmark has not had swine fever since 1933. Contact with infected wild boars is one of several infection routes through which swine fever can spread. A risk assessment has revealed that the risk of infection with swine fever will increase slightly compared with the current level if wild boars are reintroduced.

Need for forest
Wild boars prefer forests for reproduction and shelter, and they forage in fields up to 1 km away from the forest. A family needs approx. 4 km², and at least 25% of this area must consist of forest (suitable for wild boars) or natural vegetation (partly suitable for wild boar). Approximately 10% of Denmark consists of suitable or partly suitable wild boar areas, and 24% of the Danish pig herds are located close to a potential wild boar area, where it would be possible for wild boars to spread infection to domestic animals.

Cross-border migration
The analysis showed that the natural migration of wild boars from Germany is limited because there is no contact between the wild boar areas in the western part of Southern Jutland and the corresponding areas in Germany (see figure 1). However, wild boars are able to migrate to the forest areas in the eastern part of Southern Jutland. The risk of infection from wild boars is non-existent as long as Schleswig-Holstein is free of swine fever.

Tourists may introduce infection
Tourists may unknowingly bring meat infected with swine fever to Denmark and leave remains of the meat close to wild boars. As the infection can survive in meat for a long time, and wild boars are happy to eat waste food, wild boars can become infected. The risk was highest in two counties in Western Jutland: Ribe and Ringkøbing. The third highest risk was found in Northern Jutland, and the lowest risk was found in North and Eastern Zealand.

Domestic pigs and wild boars
As long as wild boars are kept free of swine fever, they do not constitute a risk for domestic pigs. This has been achieved in some countries. Awareness and quick diagnosis are therefore central elements in the preparedness against swine fever.

If a farm with domestic pigs is located close to a wild boar area (for instance within 0.5 km), domestic pigs can infect wild boars. If the first outbreak is seen in a domestic pig herd, further outbreaks will be seen within few days. If the first outbreak is seen in a group of wild boars, however, domestic pigs will either not become infected or periodic outbreaks will be seen among domestic pig herds.

Other issues
The risk assessment did not include other issues related to wild boars such as damage to crops, road safety and hunting. Likewise, other significant viruses can occur among wild boars, such as Brucella, Aujeszky’s Disease and trichinae. These issues need to be addressed before deciding whether to reintroduce free-living wild boars into Denmark.
In the future pig facility, data will be available anywhere and at any time. Data play an important part in future pig facilities as data can be converted to knowledge, and knowledge is essential to maintain a constant high production level and keep costs down.

IT technology develops fast and provides new possibilities for optimising the production of pigs. The National Committee for Pig Production therefore also focuses on IT development.

In the long term, it is expected that large amounts of data will be exchanged between electronic units controlling, for instance, feeding systems or ventilation, and finally be summarised in management programmes such as the Integrated Farm Management Systems or AgroSoft. The aim is to optimise production the very minute data become available. Some of the first advantages the pig producer will experience with this improved exchange of data will be time saved in connection with, for instance, typings of pigs, which will only have to be done in one place, for instance in the management programme; thereby time is saved for typing this information into the feeding system and ventilation system. Adjustment of electronic sow feeding stations via a PDA attached to another make will also be possible.

In an attempt to push development in a direction where all pig producers obtain the optimum data exchange, the National Committee is evaluating the possibilities for establishing a joint data platform.

**Joint data platform**

A data infrastructure for transport of data (for instance amounts of feed) is necessary to be able to exchange data between electronic units. A data infrastructure consists of a hardware part (network) and a software part; the software part is the object of this investigation. It is a requirement that all the companies delivering software to pig producers use the same standards when they programme. The standards can be divided into two areas:

**Language**

When the equipment of a number of companies needs to speak the same language, it is necessary to collect the words in a system that corresponds to a dictionary. The dictionary is therefore currently the most important part of the research. To utilize resources efficiently, co-operation has been established with a corresponding Dutch project that has defined approx. 75% of the dictionary.

**Form of communication**

A joint language is obviously immaterial, if communication is not the same. Together with German and Dutch organisations, a standard is being developed in this area.

**Intelligent ear tags**

Intelligent ear tags are also being studied. At first, the possibilities for increasing the shelf-life of ear tags and lowering the price are studied.

As a follow-up to this, a project is planned to investigate the practical possibilities for the use of intelligent ear tags for finishers.

**Intelligent alarms**

With the increasing automation, the need for alarms in pig facilities also increases. At first, alarms for ESF systems will be investigated, where overcrowding can occur in separation areas. Image processing is currently being investigated for determining stocking density with the aim of having an alarm go off at a given stocking density.

**PigVision**

The PigVision project is another IT project that can help rationalise the production of pigs. The project consists of developing a camera that is able to weigh the pig simply by filming it and then possibly marking it with a colour. It is expected that the technology will reduce labour in the finisher unit through a reduction in time spent on weighing out pigs for slaughter. Feed optimisation via automatic weighing of the pigs could be another perspective.

The project employs the latest image processing technology. The camera scale is now able to weigh the pigs in the pen rather accurately, but it is not yet able to determine the weight of the individual animal.

![Figure 1. Data must be available any time, anywhere.](image-url)
The Minigris makes the daily recording tasks easier for pig producers and their employees. When one person has recorded a farrowing on a handheld computer, colleagues in other sections of the housing facility are able to see the same information on their pocket computers shortly afterwards. This reduces paperwork and the risk of errors in a production with many employees. There will thereby be more time to tend to the pigs.

Pig production: 1,200 sows with sale of weaners. One owner, one right-hand man, one assistant and one trainee. Noon after lunch. What is the situation of the day in terms of farrowings? Number of live born piglets? With one pocket computer each, the staff work their way through the housing unit and the recordings of the day. With quick strokes on their small handheld computers, they share their knowledge on the herd minute by minute. They tend to pigs. They do not spend time on paperwork, double recordings and errors. They tend to pigs with the help of modern wireless technology – and they do their job well. Because at their weekly staff meeting, they can see that the number of weaners sold increase.

Reduction in labour and increased efficiency
Modern pig production requires many recordings. They provide the best prerequisites for close follow-up on the herd and increase in efficiency. The National Centre, Pigs, has therefore developed the Minigris. Advanced and simple at the same time, the computer programme keeps all vital herd information updated on several handheld computers at a time, also called PDAs. The Minigris is thereby also a strong supplement to the Integrated Farm Management System.

There are many options in the new programme. The pig producer is, for instance, able to:
• Enter recordings into one or more pocket computers. The data will then be transferred to a central computer containing the Integrated Farm Management System. Either immediately - wireless - or later via cable.
• Make his own control lists concerning, for instance, service, heat and gestation control, vaccination, transfer, farrowing and weaning, and sow tables.
• Make the daily recordings more easily. Only one box needs to be ticked in order for the activity to be recorded.

Wireless network
To get the optimum use of the Minigris, the pig producer has to invest in wireless network for the housing facility. That way, all employees can be on-line at the same time. The programme on the PDAs then communicates directly with the Integrated Farm Management System running on a central computer.

An example from everyday life: an employee in the farrowing unit observes that sow no. 309 has farrowed. He takes out his PDA and records 12 live born piglets. Five minutes later, the manager decides to check the farrowings of that day via the farrowing list. He reads these on his own PDA. The many farrowings of that day also include sow no. 309.

Furthermore, if a web cam is installed in the farrowing unit, the manager can see that several sows are farrowing. And if there is also a climate computer in the weaner units, he can check the temperature in weaner section no. 3. Both the web cam and the climate computer are able to communicate with the Minigris via the network.

Cable version
Pig producers who are not interested in investing in wireless network can also benefit from the Minigris. They simply need to regularly connect the PDAs to a central computer. Both the Minigris and the Integrated Farm Management System will then be updated.
The Minigris

- For pig producers with several employees, it provides an updated overview of all activities in the herd, such as farrowings, number of live born piglets, and weanings.
- Minimises time spent on paperwork, double recordings and errors.
- Has a user interface well-known from the Integrated Farm Management System for Recording and Management.
- Can be run on several handheld computers, also called PDAs. It can be used with a wireless network that keeps all PDAs and a central computer containing the Integrated Farm Management System constantly updated. Or it can be used with a cable version, in which the PDAs are synchronised with a central computer in mornings and evenings.

Additional software allowing for
- Surveillance of housing sections with web cams
- Information on climate from ventilation systems

Prices

Software
- The Minigris costs DKK 3,000 and DKK 600 in annual subscription. The producer can install the programme on all PDAs in the herd.

Hardware
- Installation of network and Access Point for wireless processing of the Minigris depends on the conditions in the herd. Prices start at DKK 5,000.
- Pocket computers for processing of the Minigris cost approx. DKK 3,000.

The Minigris also requires the use of the Integrated Farm Management System.

Other possibilities with a PDA

A PDA can be used for other things than the Minigris.

It comes with many different programmes, such as a calendar, which provides a good overview of appointments; task management that helps managing when to do what; Word and Excel in which small documents can be made containing either text or calculations.

Some PDAs include a telephone. These are not suitable for the Minigris as they currently do not fulfil the required specifications. Besides telephone, they provide Internet access, and it is thereby possible to use all services on the Internet, such as Info Svin and Landbrugsinfo.

Suppliers of housing equipment often use PDAs as a terminal for managing their systems. This is the case for, for instance, Skov and Big Dutchman. Their PDA programme can run with the Minigris on the same PDA. That is also the case for Lommebedriften, which is the answer of the National Centre, Plants, to the Minigris. With a PDA, the producer can thus enter information for field and housing facility, manage various housing equipment, and much more. The future is here, because the Minigris is already now prepared to cooperate with ventilation and feeding systems (see pictures below).

Users’ experiences

Are the users also able to see and use these possibilities? Yes, they are. Users were called and asked, and they expressed the many advantages they have experienced with the Minigris.

- It is easy to work with – also without prior IT knowledge
- It meets expectations
- It saves time
- It provides an overview
- It can be recommended to the neighbour
- There were teething troubles, but the National Centre provided good service
- A PDA is something one must get to know, but it functions logically and is easy to get started with.

PDA is already an everyday thing for many, so there is no reason to sit and wait to start using it.

In the four fields in the middle of this screen dump of the Minigris, the feed dose for the individual sow can be seen and adjusted.

This screen dump provides various information on temperature in housing section 1.
The pig advisory offices have made an agreement with the National Committee for Pig Production on joint development of advisory tools to ensure implementation of new knowledge and to make it easier for Danish farmers to create and maintain a sustainable development in Danish pig production. The idea is that this joint development will continue as current projects are implemented and the need for new advisory tools arises.

**Growth management and growth manual**

The Growth manual can be used for both weaner production, finisher production and WTF production. It contains an exact day-to-day plan with detailed requirements for climate control and feeding of the pigs. There is furthermore room for noting medication and daily observations concerning treatments, mess, etc. The plan is made by the advisers on the basis of a spread sheet, and prints are made that fit the individual herd. Table 1 shows an example of such data; the final column shows own recordings of diarrhoea in the individual block, while the other columns represent the plan.

Having to be so concrete that they actually have to decide what is going to happen every day is a great challenge for the advisers. The requirements for the manual guarantee that the advisers are straight with the pig producer. “Approximate advice” is not good enough for the manual! This concept is therefore a guarantee to the producer for accurate advice.

For the pig producer, the manual can also be used for keeping advisers and staff up to their marks. A Growth manual on the door to the housing unit is a good place to start to ensure optimum tending to the pigs at all times!

**Purchase of feed**

The spread sheet is another tool that calculates the actual price difference on different diets in connection with purchase of feed. The spread sheet is used to check the diets offered on the basis of a joint data basis for content and price of the ingredients. With the spread sheet, the production price can be calculated of the different diets under common prerequisites and a solid foundation for finding the best deal is thereby obtained.

**Farrowing unit manual**

The latest initiative is the Farrowing unit manual. It is still being developed, and it will be introduced in practice at the end of 2006. In the long run, up to 70% of all Danish piglets will be produced according to this optimised concept.

The manual is, on the other hand, an excellent tool for both advisers and vets when discussing changes in the daily management. Recordings of behaviour and treatments in the manual clearly show where to make an effort. Control weighings will furthermore show whether the development moves in the right direction, as the manual shows the expected weight every day.

For the pig producer, the manual can also be used for keeping advisers and staff up to their marks. A Growth manual on the door to the housing unit is a good place to start to ensure optimum tending to the pigs at all times!

**National advice for outdoor and ecology**

On the initiative of Partnerrådet of the Danish Agricultural Advisory Service, a national advisory team has been established to safeguard specialised productions with ecology and outdoor production. The team consists of three people of whom two are employed regionally and one is employed by the National Centre. Co-operation in the advisory team improves the possibilities for obtaining knowledge and exchanging experiences, so that development can continue with the individual producer.

---

**Table 1. Example of excerpt of data for growth management**

<table>
<thead>
<tr>
<th>Day</th>
<th>Weight</th>
<th>FUGp/day</th>
<th>Diet</th>
<th>Room temp.</th>
<th>Temp. below</th>
<th>+ position of cover</th>
<th>Diarrhoea no. of pens</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>8.0</td>
<td>0.08</td>
<td>Wea</td>
<td>25</td>
<td>30</td>
<td>Whole</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>8.0</td>
<td>0.22</td>
<td>Wea</td>
<td>24</td>
<td>30</td>
<td>Whole</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>8.4</td>
<td>0.36</td>
<td>Wea</td>
<td>23</td>
<td>29</td>
<td>Whole</td>
<td>6</td>
</tr>
<tr>
<td>10</td>
<td>9.4</td>
<td>0.55</td>
<td>70% wea</td>
<td>22</td>
<td>28</td>
<td>Whole</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>30% wea 2</td>
<td></td>
<td>21</td>
<td>Whole</td>
<td>0</td>
</tr>
<tr>
<td>40</td>
<td>23.9</td>
<td>1.25</td>
<td>Wea 2</td>
<td>20</td>
<td>24</td>
<td>Half</td>
<td>0</td>
</tr>
<tr>
<td>70</td>
<td>46.3</td>
<td>2.06</td>
<td>Finish 1</td>
<td>19</td>
<td>19</td>
<td>Up</td>
<td>1</td>
</tr>
<tr>
<td>100</td>
<td>73.9</td>
<td>2.81</td>
<td>Finish 2</td>
<td>18</td>
<td>18</td>
<td>Up</td>
<td>0</td>
</tr>
<tr>
<td>130</td>
<td>103</td>
<td>3.27</td>
<td>Finish 3</td>
<td>17</td>
<td>17</td>
<td>Up</td>
<td>0</td>
</tr>
</tbody>
</table>
Successful weaner production

A high farrowing rate in the herd is essential for successful weaner production. A high farrowing rate eases the daily management and improves the economy. A low and varying farrowing rate results in non-productive days and an uneven production resulting in more work. Successful weaner production requires control with service procedures so that the sows do not become returners. Besides returners resulting in non-productive days, a low farrowing rate causes management problems with large variations in the size of the farrowing batches. When there are sometimes too few and sometimes too many sows farrowing, problems arise with utilisation of farrowing unit capacity. If it is not possible to cross-foster at weaning, the number of sows weaned and the number of pigs weaned will furthermore vary. Thereby, the entire production system from farrowing unit to finisher unit may be modified when there is no farrowing rate control. Planning, management and control are therefore essential key words.

PLANNING, MANAGEMENT AND CONTROL

- Plan the number of sows and gilts in each service batch
- Manage and use correct service procedure
- Gestation control
- A uniform number of sows for farrowing in each batch is a prerequisite for managing the utilization of the housing capacity in the farrowing unit
- A high farrowing rate makes it easier to hit the right number of sows in the farrowing batches
- A low farrowing rate results in housing capacity problems throughout the entire production system from farrowing unit to finisher unit

Losses with non-productive days

In sow herds, sow costs are fixed costs that must distributed on the number of sows weaned annually. Post-weaning, the financial mechanisms function as in finisher herds.

Example

If the number of non-productive days increases by, for instance, 10 days per litter from 9 to 19, the number of litters per sow/year is reduced from 2.30 to 2.16, and the sale of weaners per sow is correspondingly reduced. If the weaners are normally sold at weaning at a price of DKK 200 and 25.3 pigs are sold annually, the annual income will be DKK 5,060 or DKK 13.86 a day. If the housing facilities are dimensioned for more weaners than actually weaned, there will be a further loss in GM per weaned pig until sale of, for instance, DKK 50. The annual GM from weaning to 30 kg constitutes approx. DKK 1,250 or DKK 3.40 a day. This figure must be added to the loss of the weaned pigs.

Management of batch operation

If there is no farrowing rate control, it is difficult to manage a sow herd, not least with several-weeks batch operation. Successful weaner production therefore depends on the following prerequisites and limitations:

Prerequisites

1. A constant number of services per batch
2. Farrowing management of 4, 7, 8 and 9 batches
3. Combined farrowing and weaning management of 11 sow batches (interval between the sow batches is 14 days or less)
4. Dimensioning based on batch operation system
5. Sufficient number of gilts ready for service, gilt pen places and transfer pen places
6. Active heat synchronization of gilts
7. Enjoy planning, managing and controlling production
8. Clear limitations for making nursing sows in the selected batch operation system

Limitations

1. No understanding that planning, management and control are necessary elements
2. Narrow focus on utilization of housing system
3. Unsectioned farrowing units and no compliance with all-in-all-out production
4. Weanings between batches
5. No service stop, ie. continuous services
6. Own production of gilts is a disadvantage as it often results in an unstable number of gilts
7. The necessity of nursing sows should be considered as transfer of pigs between batches always poses an infection risk

It is just as possible to be successful with several-weeks batch operation as with weekly batch operation, and there are no batch operation systems that compared with others can be recommended or advised against. It is a matter of wanting to and being able to plan, manage and control.

NON-PRODUCTIVE DAYS

- A non-productive day is a day when the sow is neither lactating nor gestating
- A low farrowing rate increases the number of non-productive days
- Dry sows must be detected as quickly as possible, for instance by way scanning, in order to reduce non-productive days
- Non-productive days result in more feeding days per litter and thereby fewer litters per sow/year
- The loss connected to a non-productive day corresponds to the average daily income of sale of pigs under normal production
- A non-productive day costs DKK 13-18 in lost income

<table>
<thead>
<tr>
<th></th>
<th>Normal</th>
<th>+ non-productive days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lactation days</td>
<td>29</td>
<td>29</td>
</tr>
<tr>
<td>Gestation days</td>
<td>116</td>
<td>116</td>
</tr>
<tr>
<td>Days until 1st service</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Non-productive days</td>
<td>9</td>
<td>9*10</td>
</tr>
<tr>
<td>Total</td>
<td>159/2.30 litters</td>
<td>25.3 pigs</td>
</tr>
<tr>
<td></td>
<td>169/2.16 litters</td>
<td>23.8 pigs</td>
</tr>
</tbody>
</table>
Published results: 2004-2005

Reports
No. 0406: Design and function of facilities for organic finisher production
No. 0407: Experiences with management in AI service units
No. 0408: Comparison between DanBred AI stations
NucleoCounter® SP-100 instruments and the producer’s reference instrument
No. 0409: The use of AI outdoor in an organic sow herd
No. 0410: Training gilts in systems with ESF
No. 0411: Segregation in reversible dry feeding system
No. 0412: Work environment in service units
No. 0501: Decomposition of synthetic amino acids during fermentation of liquid feed
No. 0502: Deep litter mat with drain in service units for group-housed sows
No. 0503: Pigs’ influence on odour emissions
No. 0504: Successful several-weeks batch operation in sow units
No. 0505: Experiences with farrowing pens for loose sows
No. 0506: Nursing sows – 2 or 18 hours without piglets
No. 0507: Experiences with WTF facilities
No. 0508: Design of unobstructed areas in pens for gestating sows, one feeding and resting stall per sow – “T pen”
No. 0509: Segregation in reversible dry feeding system, part 2

Trial reports
No. 669: Effect of storing ejaculates for 30 minutes, one or two hours before dilution – measurement of vitality and motility
No. 670: Implementation of the NucleoCounter SP-100 at boar station Hatting AI, Ringsted
No. 671: Immunostimulants for sows and weaners in herds with PMWS
No. 672: Respiratory disorders in finishers, part B: analysis of lung lesions in 75 herds
No. 673: Respiratory disorders in finishers, part A: coughing and sero-agents in 95 herds
No. 674: Liquid feeding: meal feed vs pelleted feed
No. 675: Treatment with serum in PMWS herds
No. 676: Analysis of backfat measurers
No. 677: Benzoic acid and lactic acid + formic acid for weaners
No. 678: Correlation between genotype for E.coli 0149-F4ab/ac and traits in the breeding objective
No. 679: Comparison of production results achieved in a traditional farrowing pen and a pen for loose farrowing and lactating sows, respectively
No. 680: Dried whey in feed for weaners
No. 681: The importance of backfat thickness to farrowing and lactation
No. 682: Acid in pelleted feed for sows
No. 683: Treating slurry with sulphuric acid in finisher facility with drained floor
No. 684: Commercial products for weaners: XT4
No. 685: Effect of meal feed on Lawsonia, diarrhoea and productivity
No. 686: Dry fed ad lib for lactating sows
No. 687: Hoof care of group-housed gestating sows
No. 688: Low-protein feed for weaners
No. 689: Leucine and protein in weaner feed
No. 690: Effect of addition of calcium formate and calcium chloride to finisher feed
No. 691: Method for testing influence of feeding on ammonia and odour emissions
No. 692: Commercial products for weaners: Orego-Stim
No. 693: Effect of positive stress in the service section
No. 694: Wire-type barn cleaner with cooling in gestation units
No. 695: Maize in feed for lactating sows
No. 696: Optimum age for one-step nursing sows
No. 697: Housing in stalls in connection with initiation of heat
No. 698: Sorting of sows in the service unit
No. 699: Feeding freshly mixed liquid feed to newly weaned pigs
No. 700: One and two-step nursing sows
No. 701: Feeding methods for newly weaned pigs
No. 702: Commercial products for weaners: HB-101
No. 703: Perlac 7 for finishers
No. 704: Correlation between backfat thickness and lean meat content measured by way of ultrasound, dissection and CT scanning of Duroc pigs
No. 705: Detached lying walls in pens for gestating sows with one feeding and resting stall per sow
No. 706: Commercial diets for weaners – North-West and Central Jutland, winter 2004/2005
No. 707: Release of prostaglandin in sow's during traditional insemination, intrauterine insemination and mating
No. 708: Disruption of infection and productivity in finisher units in multisite systems
No. 709: Segregation of feed mixed on-farm and fed via volume boxes
No. 710: Naked oat and regular oat for weaners
No. 711: Immunostimulants for sows and weaners in herds with PMWS [2]
No. 712: Importance of time until first feed intake post-weaning for the development of post-weaning diarrhoea
No. 713: The stomach as a barrier for pathogen bacteria in weaners

Please note:
You can subscribe to “News in Danish, the National Committee for Pig Production” at www.lu.dk and receive an e-mail with links to the latest publications. Info svin can be accessed at www.infosvin.dk.
### Subject Index

<table>
<thead>
<tr>
<th>Advisory tools</th>
<th>54</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air intake</td>
<td>32, 33</td>
</tr>
<tr>
<td>Alarms</td>
<td>51</td>
</tr>
<tr>
<td>Amino acids</td>
<td>23</td>
</tr>
<tr>
<td>Ammonia</td>
<td>27, 30</td>
</tr>
<tr>
<td>Animal welfare</td>
<td>1, 40</td>
</tr>
<tr>
<td>Antibiotics</td>
<td>48</td>
</tr>
<tr>
<td>Batch operation</td>
<td>55</td>
</tr>
<tr>
<td>Biofilter</td>
<td>31</td>
</tr>
<tr>
<td>Boar semen</td>
<td>14</td>
</tr>
<tr>
<td>Body condition - management</td>
<td>17</td>
</tr>
<tr>
<td>Breeding system</td>
<td>47</td>
</tr>
<tr>
<td>Commercial diets</td>
<td>19</td>
</tr>
<tr>
<td>CT scan</td>
<td>17</td>
</tr>
<tr>
<td>Data platform</td>
<td>51</td>
</tr>
<tr>
<td>Delivery</td>
<td>60</td>
</tr>
<tr>
<td>Development</td>
<td>5</td>
</tr>
<tr>
<td>Diagnosis</td>
<td>47</td>
</tr>
<tr>
<td>Diarrhoea</td>
<td>48</td>
</tr>
<tr>
<td>Digestibility</td>
<td>21</td>
</tr>
<tr>
<td>Digital pig facility</td>
<td>51</td>
</tr>
<tr>
<td>Dimensions</td>
<td>34</td>
</tr>
<tr>
<td>Domestic pigs</td>
<td>50</td>
</tr>
<tr>
<td>Ear tags</td>
<td>51</td>
</tr>
<tr>
<td>Ecology</td>
<td>54</td>
</tr>
<tr>
<td>Efficiency</td>
<td>1</td>
</tr>
<tr>
<td>Efficiency</td>
<td>4, 27, 52</td>
</tr>
<tr>
<td>Energy value</td>
<td>25</td>
</tr>
<tr>
<td>Enrichment and rooting materials</td>
<td>39</td>
</tr>
<tr>
<td>Environment</td>
<td>1, 4</td>
</tr>
<tr>
<td>Environmental authorisation</td>
<td>27</td>
</tr>
<tr>
<td>Environmental effort</td>
<td>27</td>
</tr>
<tr>
<td>Farrowing unit manual</td>
<td>54</td>
</tr>
<tr>
<td>Farrowing units</td>
<td>32</td>
</tr>
<tr>
<td>Fat in feed</td>
<td>21</td>
</tr>
<tr>
<td>Feed conversion</td>
<td>13, 22</td>
</tr>
<tr>
<td>Feed type</td>
<td>19</td>
</tr>
<tr>
<td>Feeding of weaners</td>
<td>18</td>
</tr>
<tr>
<td>Feeding system</td>
<td>24</td>
</tr>
<tr>
<td>Fermented grain</td>
<td>23</td>
</tr>
<tr>
<td>Financial consequences</td>
<td>23</td>
</tr>
<tr>
<td>Financial results</td>
<td>50</td>
</tr>
<tr>
<td>Finishers</td>
<td>5, 39</td>
</tr>
<tr>
<td>Genetic progress</td>
<td>8</td>
</tr>
<tr>
<td>Gestation units</td>
<td>30, 34</td>
</tr>
<tr>
<td>Growth management</td>
<td>54</td>
</tr>
<tr>
<td>Growth manual</td>
<td>54</td>
</tr>
<tr>
<td>Health</td>
<td>1, 4</td>
</tr>
<tr>
<td>Health advice</td>
<td>49</td>
</tr>
<tr>
<td>Hernia</td>
<td>13</td>
</tr>
<tr>
<td>Hoof care</td>
<td>44</td>
</tr>
<tr>
<td>Hospital pens</td>
<td>40, 42</td>
</tr>
<tr>
<td>Housing facilities</td>
<td>4, 34</td>
</tr>
<tr>
<td>Housing in stalls</td>
<td>4, 34</td>
</tr>
<tr>
<td>Housing of weaners</td>
<td>39</td>
</tr>
<tr>
<td>Immunity - management</td>
<td>4</td>
</tr>
<tr>
<td>Infection</td>
<td>50</td>
</tr>
<tr>
<td>Inspection</td>
<td>41</td>
</tr>
<tr>
<td>Kernestyring®</td>
<td>13</td>
</tr>
<tr>
<td>Lactating sows</td>
<td>36</td>
</tr>
<tr>
<td>Large pens</td>
<td>39</td>
</tr>
<tr>
<td>Lawsonia</td>
<td>48</td>
</tr>
<tr>
<td>Lean meat percentage</td>
<td>12</td>
</tr>
<tr>
<td>Liquid feed</td>
<td>22, 23</td>
</tr>
<tr>
<td>Longevity</td>
<td>10, 15</td>
</tr>
<tr>
<td>Mortality</td>
<td>44, 48</td>
</tr>
<tr>
<td>Motivation</td>
<td>6</td>
</tr>
<tr>
<td>Multi-site</td>
<td>45</td>
</tr>
<tr>
<td>New projects</td>
<td>4</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>27</td>
</tr>
<tr>
<td>Nursing sows</td>
<td>16</td>
</tr>
<tr>
<td>Odour</td>
<td>27, 28, 29</td>
</tr>
<tr>
<td>Outdoor</td>
<td>54</td>
</tr>
<tr>
<td>Pain relief</td>
<td>43</td>
</tr>
<tr>
<td>Pattern of movement</td>
<td>36</td>
</tr>
<tr>
<td>PDA</td>
<td>53</td>
</tr>
<tr>
<td>Pen space</td>
<td>42</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>26</td>
</tr>
<tr>
<td>Phytase</td>
<td>26</td>
</tr>
<tr>
<td>Pig fat</td>
<td>21</td>
</tr>
<tr>
<td>PigVision</td>
<td>51</td>
</tr>
<tr>
<td>PMWS</td>
<td>20, 47</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>11</td>
</tr>
<tr>
<td>Production economics</td>
<td>6</td>
</tr>
<tr>
<td>Production level</td>
<td>9</td>
</tr>
<tr>
<td>Production report</td>
<td>5</td>
</tr>
<tr>
<td>Published results 04/05</td>
<td>56</td>
</tr>
<tr>
<td>Purchase of feed</td>
<td>54</td>
</tr>
<tr>
<td>Purification of air</td>
<td>31</td>
</tr>
<tr>
<td>Raw rapeseed oil</td>
<td>21</td>
</tr>
<tr>
<td>Research and development</td>
<td>10, 12</td>
</tr>
<tr>
<td>Respiratory disorder</td>
<td>45</td>
</tr>
<tr>
<td>Results</td>
<td>5</td>
</tr>
<tr>
<td>Sale of breeding stock</td>
<td>8</td>
</tr>
<tr>
<td>Salmonella</td>
<td>10, 46</td>
</tr>
<tr>
<td>Segregation</td>
<td>24</td>
</tr>
<tr>
<td>Semen concentration</td>
<td>14</td>
</tr>
<tr>
<td>Semen doses</td>
<td>15</td>
</tr>
<tr>
<td>Semen quality</td>
<td>14</td>
</tr>
<tr>
<td>Service units</td>
<td>34</td>
</tr>
<tr>
<td>Shoulder lesions</td>
<td>44</td>
</tr>
<tr>
<td>Sire effect</td>
<td>12</td>
</tr>
<tr>
<td>Solarisation</td>
<td>32</td>
</tr>
<tr>
<td>Sorting</td>
<td>34</td>
</tr>
<tr>
<td>Sows</td>
<td>5</td>
</tr>
<tr>
<td>Sprinkling</td>
<td>33</td>
</tr>
<tr>
<td>Strategy</td>
<td>4</td>
</tr>
<tr>
<td>Surveillance</td>
<td>46</td>
</tr>
<tr>
<td>Swine fever</td>
<td>50</td>
</tr>
<tr>
<td>Tail biting</td>
<td>38</td>
</tr>
<tr>
<td>Temperature</td>
<td>33</td>
</tr>
<tr>
<td>The Minigris</td>
<td>52</td>
</tr>
<tr>
<td>Transport</td>
<td>40</td>
</tr>
<tr>
<td>Vaccine</td>
<td>49</td>
</tr>
<tr>
<td>Ventilation</td>
<td>33</td>
</tr>
<tr>
<td>Weaner feed</td>
<td>21</td>
</tr>
<tr>
<td>Weaner production</td>
<td>55</td>
</tr>
<tr>
<td>Weaning</td>
<td>18</td>
</tr>
<tr>
<td>Weighing</td>
<td>7</td>
</tr>
<tr>
<td>Weight limits</td>
<td>7</td>
</tr>
<tr>
<td>Welfare campaign</td>
<td>40</td>
</tr>
<tr>
<td>Wild boars</td>
<td>50</td>
</tr>
<tr>
<td>Wireless network</td>
<td>52</td>
</tr>
</tbody>
</table>