



1st edition, October 2008

© Danish Pig Production

Layout/print: Tafdruk&co

Photo front page: Mads Armgaard, GAB

ISBN 87-91460-10-7

# Preface

## **Economy and feed prices**

Turbulent times. This is the situation in the pig industry in two words.

Grain prices reached new heights in the autumn 2007 with prices of up to DKK 200 per 100 kg, and this knocked the bottom out of the economy if you look at pig production only.

Fortunately, many pig producers are self-sufficient in grain, which has saved the economy for many producers.

Lately, over the summer and autumn 2008, grain prices have been decreasing and the pig prices are increasing. The cash flow is heading for balance. Hopefully, 2009 will bring significantly better terms of trade, enabling the pig producers to cover the increasing fixed costs and fill last year's gap.

## **International competitiveness**

Costs have increased drastically over the last years with an average break-even point of DKK 12.50. Nevertheless, Danish pig producers have maintained their competitiveness – at least in Europe.

The top 25% sow producers have a little more than 28 piglets per sow/year, and the top 25% finisher producers have a feed conversion ratio of 2.6 FU<sub>pp</sub> per kg gain. This indicates that it will be possible to make money on pigs in the future.

It is the ambition of Danish Pig Production to maintain the basis of further progress. Not just for the best producers; we will also work for a better economy for the average producer.

We will do this through close co-operation with pig advisors and vets to ensure that know-how is communicated to the producers and implemented. To achieve this, we will focus on projects that affect the bottom line positively.

The DanBred sow is minimum five years ahead of its competitors. Compared with leading breeding companies such as PIC and the Dutch Topigs, we have an advantage of DKK 70-80 per produced finisher on the LY

sow alone. It is common knowledge that we are leading in litter size, but now an impartial German study has documented that we are also leading in gain and feed conversion.

We should be proud of that! And we believe that the model created in terms of DanBred is so efficient that we can increase the lead in the genetic area. We are already now preparing for a situation where 30-35 piglets sow/year is normal.

## **Animal welfare in the right direction**

Last year, Danish Pig Production introduced the quality assurance scheme "DANISH Product Standard" to meet the requirements for access to the German market. It is the intention that the audits must guarantee that the requirements for animal welfare are met.

2,500 production units were audited in the first year, and many have a very high level of animal welfare, although there is still room for improvement in terms of rooting material and hospital pens.

Shoulder ulcers have been an integral part of the animal welfare agenda, and fortunately the number of reports to the police has dropped. Sow producers should be praised for recognising and solving the problem. Veterinarians also report of decreasing problems with shoulder ulcers.

In 2009, it is expected that action plans for shoulder ulcers will become an obligatory part of the self-audit programme for animal welfare in the herds.

In Danish Pig Production, we have initiated the campaign "Sow Life" in co-operation with the local advisors. The aim is to bring attention to sow mortality, and it is our ambition to reduce sow mortality by 25% in the next five years.

## **Pig production in the future**

In several municipalities, hundreds of projects have been stopped due to slow review processes and very strict environmental approval requirements.

Danish Pig Production and the agricultural institutions have exerted a great deal of pressure to resolve the situation and kick-start the process.

The situation is unacceptable and is part of the reason why the production of pigs is decreasing. We are also witnessing an uneven trend in structure towards sow units and export of weaners.

At a seminar on the future production systems, this trend caused concern, and the task of Danish Pig Production was clear: a basis must be created for both sow units and finisher production in the future by intensifying the development of high-technological and environmentally correct facilities.

## **Thank you**

This summary of the past year's events in the pig industry is just a small extract of the many topics and progress described in the annual report 2008.

We would like to thank everybody for close co-operation and for the support of Danish Pig Production throughout the year, and we hope you will enjoy reading this.

Yours sincerely

Danish Pig Production  
Lindhardt B. Nielsen  
Nicolaj Nørgaard



# Danish Pig Production



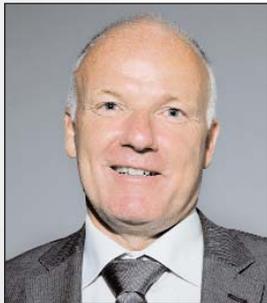
*Chairman, farmer Lindhart Nielsen,  
Elected by Danish Agriculture*



*First vice-chairman, farmer Asger Krogsgaard,  
Elected by the Danish Bacon and Meat Council*



*Vice-chairman, farmer Erik Larsen,  
Elected by Region 1 (Eastern part of Denmark)*



*Vice-chairman, farmer Torben Poulsen  
Elected by Danish Pig Producers' Association*



*Farmer Per Bach Laursen,  
Elected by Danish Agriculture*



*Smallholder Knud Madsen,  
Elected by Danish Agriculture*



*Farmer Claus Nørgård,  
Elected by Region 3 (North and Central Jutland)*



*Farmer Henrik Buhl,  
Elected by Region 2 (Southern Jutland and Funen)*



*Farmer Boye Bill Jensen  
Elected by Danish Pig Producers' Association*



*Farmer Peter Mølgaard  
Elected by Danish Pig Producers' Association*



*Farmer Erik Bredholdt  
Elected by Danish Bacon & Meat Council*



*Farmer Thorkild Jensen,  
Elected by the Danish Bacon and Meat Council*



*Director Nicolaj Nørgaard,  
Danish Pig Production*



# Contents of the annual report 2008

	Page	
Preface .....	1	
Danish Pig Production .....	2	
Contents of the annual report .....	3	
Budget and strategy .....	4-5	STATISTICS
Production systems in the future.....	6	
Productivity and economy .....	7-9	ECONOMY
Genetic progress and sale of breeding stock .....	10-11	BREEDING
Research and development.....	12-15	
Quality control of semen and AI projects .....	16-17	REPRODUCTION
Increased farrowing rate .....	18	
Management of the gilt unit .....	19	
Feeding of highly prolific sows .....	20	NUTRITION
Feeding of weaners .....	21	
Feeding of finishers .....	22	
Corn and sorghum .....	23	
Control of mineral feed .....	24	
Phosphorus and phytase .....	25	ENVIRONMENT
Feed – ammonia and odour .....	26	
Environmental approvals .....	27-28	
Environmental technology .....	29-31	
Environment .....	32	
Partial purification and central exhaust ducts .....	33	
Lactating sows.....	34-36	HOUSING
Solid floor with no mess.....	37	
Weaner and finisher facilities.....	38	
Animal welfare .....	39	ANIMAL WELFARE
Suitability for transport .....	40	
Sow Life .....	41-43	
Shoulder ulcers.....	44-45	
Alternatives to castration .....	46	
Antimicrobial resistance.....	47	HEALTH
Vaccination against coli diarrhoea .....	48	
PMWS .....	49	
Guidelines for Eradication .....	50	
DKK +25 per finisher .....	51	MANAGEMENT
Follow-up with a specialised advisor .....	52-53	
Information from Danish Pig Production .....	54	INFORMATION
Published results 2007/2008 .....	55	
Subject index.....	56	



# Budget and strategy

## The new DANISH PIG PRODUCTION

On October 1, 2007, the new, independent Danish Pig Production was established.

It was a desire from the three basis organisations that Danish Pig Production, which was already a professionally strong organisation, should play a more powerful and independent role politically and in terms of communication.

The board includes 12 pig producers:  
 3 from the Danish Bacon and Meat Council  
 3 from Danish Pig Producers' Association  
 3 from Danish Agriculture  
 3 from the local pig production committees

Danish Pig Production employs approx. 150 people and has four office locations in Copenhagen, Århus, Kjellerup and Vejle, and three trial stations and a veterinary lab. They conduct national research, development and service tasks that create capital gain for the Danish pig producers.

Danish Pig Production handles scien-

### Focal points:

- That the accumulation of know-how and development takes place on an international level.
- That know-how and services are readily available to pig producers, advisors, vets and companies.
- That new knowledge is quickly implemented through demonstration projects in co-operation with the local advisors.
- That framework conditions are created in co-operation with politicians and authorities to facilitate competitive pig production in Denmark.
- That the global community is met with pride and openness surrounding our modern production methods and technologies.
- That we are engaged in close co-operation with our basis organisations, universities, advisors, companies, etc.

tific tasks in close co-operation with the local pig advisors, with national research institutes, private companies, and institutions in the agricultural industry such as Danish Meat Association, Danish Agricultural Advisory Service, and Agrotech.

Danish Pig Production plays an important role in setting the agenda and the political goals for the Danish pig industry in co-operation with the three basis organisations Danish Agriculture, Danish Pig Producers' Association and Danish Bacon and Meat Council.

Danish Pig Production is actively involved in the public debate and handles negotiations with the authorities and legislators. Scientifically, Danish Pig Production communicates within the framework of the two-layered advisory structure of the agricultural industry, where general information is communicated directly to the pig producers through information systems and the trade press, while individual advisory services are safeguarded by the local advisors and veterinarians.

The aim is to encourage pig producers, advisors, vets and companies to adopt new efficient technologies as quickly as possible and to implement new management tools to optimise the management of their herds.

### Animal welfare

Animal welfare is still a central element in the development, and the strategy is to create further improvements that benefit the animals and at the same time maintain the competitiveness of the producers.

### Vision

Danish Pig Production is a leading and internationally recognised knowledge company known for its abilities to develop and recommend new production technologies that increase profit and at the same time improve animal welfare and reduce the environmental impact.

Experiments will be made with increased market-driven development adapted to consumer demands and their willingness to pay for the products.

Danish Pig Production wishes to have a strong and open profile in animal welfare questions and to act credibly in relation to animal welfare organisations, politicians, authorities and consumers.

Danish pig producers must be proud to invite consumers to their herds, and clear political and scientific goals for improvements must be set.

### What is the essence?

The essence of Danish Pig Production is to develop, test and recommend the best technologies for producing pigs in Denmark. Our knowledge must be communicated to the producers to maintain the internationally competitive edge of the Danish pig producers. We work to give the producers the best possible framework and work for increased public acceptance of the industry.

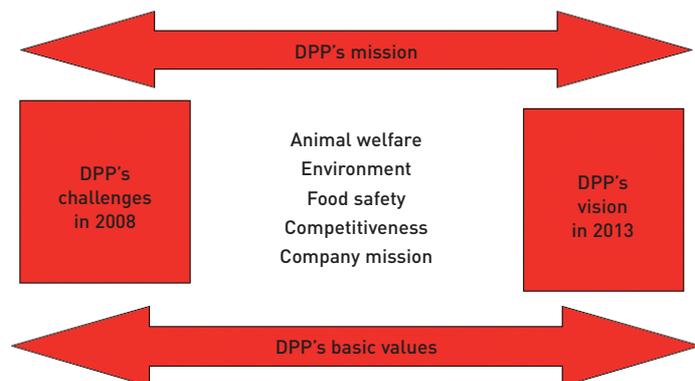


Figure 1. Danish Pig Production's (DPP) strategic efforts until 2013.



## Environment

Environmentally sustainable pig production is a central strategic element in the development of the production of pigs in Denmark.

Danish Pig Production aims to be at the forefront of environmental technologies, and will, in co-operation with research partners, develop and investigate new technologies for reduction of ammonia emissions, reduction and recycling of phosphorus, purification of air for odour and unwanted particles, reduction of the energy consumption and of CO<sub>2</sub> emission, etc. Danish Pig Production is also working for a better working environment.

New technologies must be accompanied by increased reliability and a cost level that does not reduce our competitiveness.

## Food safety and animal health

High levels of food safety and health among the pigs are central characteristics for Denmark and Danish pig production. We constantly work on improving health and on keeping production diseases and zoonoses under control.

Danish Pig Production routinely monitors the trend in the use of antibiotics and in the development of resistance. The aim is to keep the consumption at a low and stable level, and it must at all times be guaranteed that there is no risk for the consumers when they buy Danish pork.

It is attempted to meet the desire to use GMO-based feed through participation in the public debate.

## Competitiveness

The scientific development that creates the decisive competitive edge for the Danish pig producers is still a fundamental area for Danish Pig Production, and the journey from pen to plate is still being optimised.

- Danish Pig Production organises and manages the breeding work in DanBred. This development must continue with unabated strength and speed. New breeding methods and breeding objectives are routinely evaluated and investigated.
- Developments in reproduction

reduce mortality, improve semen quality, improve the utilization of genetic pedigree and introduce the possibility of semen sexing.

- For Danish Pig Production, optimum feeding strategies and a low feed conversion ratio are also important. Quality and correct composition of ingredients, proteins and minerals must match the requirements of the pigs and must be included in diets with technical precision.
- Danish Pig Production routinely evaluates the quality of standard figures, new ingredients, approved additives and techniques in relation to feed conversion ratio, meat quality and environmental impact.
- Danish Pig Production participates in developing efficient and functional pens and production systems that provide optimum safety for the pig producers when investing in new facilities.
- Danish Pig Production is at the cutting edge of structural development and ensures that economies of scale can be utilized.
- Danish Pig Production routinely measures the competitiveness of Danish pig producers in relation to

production costs that are benchmarked between herds in and outside Denmark.

## Company mission and budget

The work of Danish Pig Production is based on income from the Pig Levy Fund, breeding work, public research, development and demonstration funds and commercial income. Activities are geared and co-ordinated as best as possible in relation to other national and foreign (EU) research and development activities.

Table 1. Budget for

Danish Pig Production, 2007/2008

Net costs / DKK thousand	
Management and communication	12,822
Breeding & multiplicat./Bøgildgård	23,359
Nutrition & reproduction	21,600
Housing & production systems	21,523
DANISH product standard	6,000
DPP data	1,800
Health inspection	-150
Laboratory	-150
Aujeszky surveillance	500
Veterinary research & development	9,549
Department for advisory activities	4,380
Danish Pig Production, total	101,233

Table 2. New projects, 2008/2009

- Implementation of shoulder ulcer action plan + self-audit programme
- Work procedures and videos
- Development on the German weaner market in 2008-2009
- Breeding for increased pH in carcass – validation of markers
- Development of new methods for breeding for sow longevity
- Investigation of the market potential of exotic breeds
- Facilities for organic pigs
- Development of the feed evaluation system
- Corn
- Restrictive dry feeding
- Effect of vaccines against PMWS and Lawsonia
- Diagnostic methods – multiplexing
- Castration and anaesthetisation
- Rooting and enrichment materials, handling varying amounts of straw
- Longevity – sows and gilts
  - Sow legs
  - Advisory tools for management of gilt production
- Production systems (joint projects)
  - 5,000 sows and then what?
  - Future feeding system
  - Health and infection protection in large production units
- Environmental efforts of the pig industry
- Costs related to reduction of odour emission from pig facilities
- Separation of slurry and optimum utilization of the separation products
- Partial purification of outlet air



# Production systems in the future

## Focus on weaner production



## The technologically-driven development



## High-value production



Winding up

At the seminar "Production systems in 2020" held in 2008, Danish Pig Production focused on the expected trends, and three scenarios for the future were discussed in detail. The aim was to ensure that the desired development will be supported by the strategy and development of Danish Pig Production. This will also help the individual pig producers to make the right decisions.

### Scenarios for 2020

In 2020, up to 80% of all weaners will be produced in 400-500 sow herds housing 1,000-5,000 sows. Finishers will be produced in 800-1,000 herds producing 15,000-30,000 finishers annually.

The number of finisher herds may be even lower depending on the development in environmental technologies and the general environmental framework conditions. The production of finishers also depends on a competitive slaughterhouse industry.

Pig herds will often have several owners and consist of 2-10 premises. Pig production companies with large capital requirements will, in the future, make great demands to financing possibilities and new owner structures.

### No limit of 500 livestock units (LU)

With the possibilities for establishing very large pig units, it is essential to thoroughly evaluate the advantages of large-scale production terms of the planning for managers and employees.

Should a producer opt for 4,000 sows in one herd or for two herds next to on another with joint slurry handling systems and feed production? We need more experience and knowledge on pros and cons of large sow herds before these questions can be answered.

### Planning of a production system

Strategic considerations and analyses to be made before making a final decision:

- Development or winding up?
- Where to extend the production?
- Will it be possible to use existing facilities?
- Will it be a possibility to co-operate with other producers?
- How large a part of the value chain from pen to plate will the production include / specialisation?
- Production scope on the individual premises?
- Requirement for environmental technology?
- Costs of environmental technology?
- Requirement for location when investing in new premises?
- Financing, staff, management?
- Quality design?
- Design of facility with a high degree of functionality
- Reliable production system
- High level of productivity – 35 pigs/sow/year!
- Optimum utilization of the production system
- Prepared for extension
- Internal logistics on the individual premises and between premises
- On-farm and external infection protection
- Organisation and management structure
- Good working conditions in a modern company
- Plan and goal for handling the animals – animal welfare

Table 1. Outline of production, investment and staff involved in the various types of production.

Sow units	250 LU	500 LU	750 LU	950 LU
Sows	1,075	2,150	3,225	4,085
Weaned pigs	35,000	70,000	105,000	133,000
Investment, DKK m	19.5	37.7	56.0	70.0
Employees	5	10	15	19
Weaners 7-30 kg	250 LU	500 LU	750 LU	950 LU
Place units	6,800	13,600	20,400	25,900
Weaners produced	43,750	87,500	131,250	166,250
Investment, DKK m	13.9	26.8	39.6	50.0
Employees	2	4	6	8
Finisher production	250 LU	500 LU	750 LU	950 LU
Place units	2,000	4,000	6,000	7,600
Finishers produced	8,000	16,000	24,000	30,400
Investment, DKK m	7.0	12.4	18.5	23.3
Employees	0.8	1.6	2.3	3.0
Land	250 LU	500 LU	750 LU	950 LU
Ha land	178	357	535	678
Investment in land, DKK m	31	62	94	119



# Productivity and economy

## Productivity

The development in sow productivity is shown in table 1. Measured on the number of pigs per sow/year, the efficiency has improved, which is attributed to an increase in liveborn piglets per litter and a reduction in post-weaning mortality.

The number of sows/year was higher among the top 25% sow producers than among the average and the bottom 25% when calculated according to the number of produced pigs per sow/year (see table 1).

The development in finisher productivity is shown in table 2. The average slaughter weight was significantly higher in 2007 than in the years before. This was in particular caused by postponement of slaughtering due to fires in two slaughterhouses. Mortality increased to 4.3%.

The top and bottom 25% producers are ranked according to feed conversion ratio per kg gain. Averagely, the bottom 25% use 0.43 FUGp more per kg gain than the top 25%. Furthermore, the best producers excel in daily gain, mortality and incidence of pleurisy recorded at slaughter (see table 2).

## International competition

The preliminary figures from Interpig are now available. All EU countries report of negative figures on the bottom line in 2007.

## International competitiveness

In 2007, Santa Catarina in Brazil was declared free of foot-and-mouth disease. Santa Catarina represents 25% of the total production of pigs in Brazil. As a result, Brazil gained access to lucrative markets where the producers compete with Danish slaughterhouses, among others.

The sow population dropped in the period 2002-2007, but the efficiency increased drastically by 3.4 produced pigs more per sow/year.

In that period, the slaughter weight increased from 76 kg to 83 kg in Brazil. Consequently, the production of pork increased by 7%.

Table 1. Productivity, sows and weaners

Year	Average production results				
	2005 All	2006 All	2007* All	2007 Bottom 25 %	2007 Top 25 %
Weight/sold pig, kg	31.2	31.3	31.7	32.2	32.2
Feed/produced pig, FUGp**	109	107	109	-	-
Prod. pigs/sow/year	24.3	24.9	25.2	22.2	28.1
Sows/year	327	331	338	276	414
First parity litters, %	22.5	22.7	22.3	22.6	22.5
Liveborn/litter	13.2	13.5	13.6	13.1	14.2
Weaned/litter	11.3	11.6	11.7	10.9	12.5
Non-productive days/litter	15.4	15.7	15.7	21.5	11.6
Mortality post-weaning, %	3.8	3.2	3.1	4.1	2.2
ADG post-weaning, g***	417	428	434	422	453

\* From October 2006 to October 2007. Remaining years from April to April.

\*\* Including gilt feed.

\*\*\* Reference daily gain, ie. comparable over time.

Table 2. Productivity, finishers

Year	Average production results				
	2005 All	2006 All	2007* All	2007 Bottom 25 %	2007 Top 25 %
Prod. pigs	4,472	4,582	4,477	3,746	4,593
Daily gain, g**	838	861	866	791	919
Feed/kg gain, FUGp**	2.81	2.79	2.79	3.02	2.59
Weight at transfer to finisher facility, kg	32.8	33	33.3	33.2	33.1
Avg. slaughter weight, kg	80.2	81.5	82.8	82.5	83.5
Avg. lean meat %	60.2	60.3	60.3	60.3	60.4
Dead and rejected, %	4.3	4	4.3	5.8	3.5
Incidence of pleurisy recorded rec. at slaughter, %	24.8	21	20	22.5	17.5
Total incl. deduction, %	17.7	17.8	18.6	21.2	16.5

\* From October 2006 to October 2007. Remaining years from April to April.

\*\* Reference daily gain, ie. comparable over time.

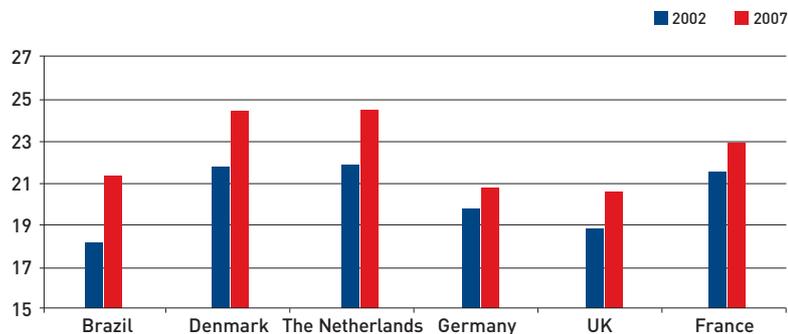


Figure 1. Finishers produced per sow/year



# Productivity and economy

Table 3. Costs, DKK/kg carcass

Country	Costs/kg carcass 2007	Costs/kg carcass, June 2008
Brazil	6.83	8.16
US	7.71	8.39
Denmark	10.38	12.51
The Netherlands	10.74	12.29
France	10.88	12.77
Germany	11.38	13.64
Spain	11.56	12.81
Sweden	11.96	14.04
UK	12.87	13.39

Pig production in the US still increases, and had by June 2008 increased by 6% compared with the year before. An increased efficiency overmatches a drop in the sow population of 2%.

### Production costs

Due to feed sold on contract, the rising feed prices were felt in Denmark in 2007. Denmark had the lowest costs per kg carcass in Europe in 2007.

However, with the feed prices of June 2008, Denmark no longer occupies the number 1 spot in Europe, as the lowest production costs are now found in the Netherlands. Producers in the US and in Brazil have not witnessed the same increases in feed costs as in Europe.

The shift in costs also includes fluctuations in foreign currencies in the period 2007 to the middle of 2008. For instance, the British pound devaluated by 13.5% compared with the Euro in this period.

### Development in pig production

The production of pigs has increased over the last years, but in 2008 a slight drop is expected – a drop that will be felt well into 2009. This is due to the sudden deterioration in the economy of the pig producers seen in the second half of 2007 as a consequence of the high feed prices which resulted in a 35% increase in production costs. Feed prices have now dropped slightly and the settlement price has almost adjusted to the new cost level.

### Development in structure

The number of pig units drop by averagely 10% annually, which means that the number of pig units is reduced by 50% every 7-8 years. However, the reduction in the number of herds producing weaners was far greater than the reduction in finisher herds and integrated herds. This is probably due to the fact that sow herds are more labour-intensive, and thereby the advantages of large-scale production are greater, and that it is easier to obtain environmental approvals for a sow herd.

It must be emphasised that the statistics show the development in the number of herds, which is not the same as the development in the number of premises with pigs. Today, it is fairly normal that a unit consists of pig production on several premises.

Table 4. Development in production

Year	2001	2002	2003***	2004	2005	2006	2007	2008*	2009*
Sows, 1,000	1130	1128	1130	1141	1143	1123	1158	1130	1090
Prod. million**	22.9	24.0	24.6	24.9	25.8	25.7	26.3	26.0	25.3
Slaughter weight, kg	77.9	78.1	77.7	78.5	80.7	81.2	83.9	81	81

\* Projection

\*\* Incl. export of live animals, and sows, boars, gilts, etc.

\*\*\* 53 weeks

Table 5. Development in structure

Year	1997	2007
Integrated	Herd type 8,400	Production 2,900
Sow herd	3,300	190 sows/herd 2600 prod. finishers
Finishers	6,200	660 900 sows/herd 4400 produced
Total	17,900	6,860

60% of the sows are housed in herds with more than 500 sows

70% group-housed gestating sows

50% of the finishers are produced in herds with more than 4,000 place units (15,000 prod./year).



## Benchmarking

The Danish Agricultural Advisory Service has developed Business Check Pigs, a benchmarking product that represents the producers who participate individually. The individual producer can use Business Check to benchmark himself with other pig producers. The product is aimed at pig producers with more than 600 sows/year, 9,000 produced finishers or 350 LU.

Business Check includes all income and costs related to the production of pigs. This also includes wages to the owner and rate of return on invested capital. However, it does not include internal transfers and costs for spreading of livestock manure. The bottom line result must thereby cover environmental costs and risks.

If a herd belongs in the good end of the scale in terms of earning capacity, it will be fairly easy to determine which factors form the basis of this and the producer can keep working with these. If, however, a herd belongs at the bottom of the scale, Business Check is a good tool for the producer to form an outline of the areas that need improvement compared with the herds he benchmarks himself with. However, no matter how well a producer performs, it will generally always be possible to improve.

Business Check includes four production categories, and integrated herds are split into another four categories according to the percentage of produced finishers (see table 6). In each category, the herds are listed according to their rate of return. The rate of return expresses the profit of the invested capital in the financial year. The average of the five best producers and of all producers in the various groups is shown in table 6.

Rate of return =  $\frac{\text{Result before interest}}{\text{Tied capital}}$

## Results in 2007

2007 was financially a tough year for the Danish pig producers, which is also reflected in the results from Business Check Pigs 2007. On average,

Table 6. Sow herds, 7 kg etc.

	Number	Rate of return, %		Change in settlement to break-even	
		Top 5	All	Top 5	All
Sow herds – 7 kg	18	-2.6	-7.2	1.33	2.3
Sow herds – 30 kg	27	-1.6	-5.5	1.2	2.15
Integr. 10-30%	10	-0.5	-5.8	1.12	1.88
Integr. 30-60%	16	-0.7	-5.7	0.97	1.69
Integr. 60-90%	12	-0.1	-3.1	1.12	2.29
Integr. > 90%	9	1.5	-2.6	0.3	1.33
Finishers, 30-100 kg	24	3.5	-0.8	0.17	1.07

ge, all production categories in Business Check revealed negative rates of return. This was generally caused by the rising feed prices and low settlement prices. It seems that producers of weaners and of 7 kg pigs in particular were hit hard. Finisher producers had the smallest negative rate of return on average.

For the top 5 producers within each production category, a positive rate of return was obtained for finishers and integrated productions with min. 90% finishers. The remaining categories in top 5 revealed negative rates of return.

In all production categories, the difference between the top 5 producers and the average producer was largely the same. When taking a closer look at the causes of the differences between the financially best producers and the average producers within each category, it is clear that an increased settlement price and more weaned pigs per sow/year for the producers of 7 kg pigs made the difference. The best producers of 30 kg pigs also obtained a higher settlement price and had lower wage costs and interest costs. For finisher producers, a distinctly higher settlement price and lower wage costs made the difference. The best producers among integrated herds also obtained a higher settlement price and had lower costs for feed, wages and interest than the average.

## Break-even point

Business Check Pigs also calculates how much the settlement can drop, all other things being equal, before

the result breaks even. This key figure is also shown in table 6.

In Business Check Pigs 2007, the settlement averaged DKK 9.20. On average, all production categories needed an increase in settlement to reach their break-even point. Producers of 7 kg pigs and producers with integrated herds with 60-90% finishers would have reached their break-even point if the settlement had been approx. DKK 2.30. Finisher producers needed DKK 1.07 more per kg to reach their break-even point.

Among the top 5 producers, the producers of 7 kg pigs needed an increase of DKK 1.33, while finisher producers needed DKK 0.17 more to meet their break-even point, all other things being equal.

Generally, Business Check Pigs 2007 shows that a significantly higher settlement is required for the producers to reach a financially positive result in their production.



# Genetic progress and sale of breeding stock

## Management of the breeding programme

The management of the breeding programme is described in the following three sections: genetic progress, production level and sale of breeding stock.

## Genetic progress

Table 1 provides an outline of the genetic progress of each of the breeds in the breeding programme over the last four years and an average for this period. There are significant differences in the genetic progress between the breeds: the female breeds – Landrace and Large White – show great progress in litter size (on day 5), but limited progress in the production traits. In comparison, a rather significant progress is achieved in Duroc in the finisher traits, while fertility as a

breeding objective is not relevant in this breed.

The average progress for all breeds over the last four years amounts to DKK 11.02 per finisher annually. Genetic progress is still a significant factor to ensure a competitive production of pigs.

## Production level

Table 2 shows the production results obtained at Bøgildgård, and tables 3 and 4 show performance test results for boars and female pigs, respectively. The production level dropped in 2008, and the overall test scope in the performance tests comprises approx. 90,000 animals. The number of performance-tested animals at Bøgildgård (table 2) is largely unchanged, while the percentage of

breeds tested is influenced by the phasing out of Hampshire. In table 5, the average litter size is shown for the purebred litters in the nucleus herds.

## Sale of breeding stock

The sale of breeding stock is still showing positive trends; particularly the sale of hybrid gilts is increasing and is now close to 400,000 animals annually (table 6). Approx. one fourth of the gilts are exported. The sale of boars is largely unchanged both nationally and internationally. Sale of semen from the AI stations is still increasing.

Hampshire and hybrid boars are not included in table 7. Hybrid boars are used only to a limited extent, and the few remaining Hampshire boars are used for production of HD boars.

Table 1. Genetic progress, 2004-2008.

Breed	Year	Daily gain (30-100 kg), g/day	FCR, FUp/kg daily gain	Lean meat %	LG5	Conformation, points	Daily gain (0-30 kg), g/day	Killing-out %	Longevity, %
Duroc	04/05	20.3	-0.035	0.15	-	0.02	3.5	0.16	-
	05/06	16.4	-0.043	0.22	-	0.02	0.04	-	-
	06/07	20.4	-0.039	0.13	-	0.05	-0.03	-	-
	07/08	19.8	-0.040	0.17	-	0.03	-0.03	-	-
Average	4	19.2	-0.040	0.17	-	0.03	3.2	0.05	-
Landrace	04/05	19.2	-0.040	0.04	0.31	0.03	0.2	-0.1	-0.053
	05/06	12.0	-0.036	0.01	0.46	-1.0	0.13	0.060	-
	06/07	5.9	-0.013	-0.05	0.43	-0.4	0.02	0.041	-
	07/08	-5.2	-0.003	-0.03	0.54	-3.5	0.03	0.003	-
Average	4	8.0	-0.023	-0.01	0.44	0.03	-1.2	-0.07	-0.039
Large White	04/05	6.1	-0.019	0.08	0.31	0.06	-0.7	-0.02	-0.019
	05/06	-2.4	-0.007	0.04	0.58	-0.8	-0.05	0.009	-
	06/07	1.4	0.003	-0.01	0.39	0.05	0.11	-0.002	-
	07/08	-5.3	-0.002	0.03	0.46	-2.1	-0.02	-0.006	-
Average	4	-0.1	-0.006	0.04	0.44	0.04	-0.7	-0.02	-0.005
Average 4 breeds	4	11.6	-0.027	0.09	0.44	0.03	1.1	0.00	-0.011

Table 2. Sale of breeding stock in 2005/2006 and 2006/2007

	Female animals				Boars			
	2005/06		2006/07		2005/06		2006/07	
	DK	Export	DK	Export	DK	Export	DK	Export
Landrace	6,508	2,181	8,632	1,900	67	309	87	357
Large White	3,283	1,546	6,329	3,269	157	403	112	419
Duroc	58	98	10	175	1,022	885	1,053	981
All 3 breeds	9,849	3,829	14,971	5,344	1,262	1,604	1,252	1,757
Purebred, total**	13,682	20,315	2,866	3,009				
Hybrid*	260,886	57,530	313,400	81,000	2,200	183	1,409	147
Hybrid, total**	318,416	-	394,400	-	2,383	-	1,556	-

\* Export incl. F2 females

\*\* Incl. export



Table 3. Average production results from performance test station Bøgildgård, 2007-08

Breed	Number	Daily gain (30-100 kg), g/day	FCR, FU <sub>p</sub> /kg gain	Lean meat %	Killing-out %
Duroc	2,110	969	2.31	60.1	73.6
Landrace	1,358	909	2.38	60.9	73.2
Large White	1,341	883	2.34	61.1	73.7
Total	5,105				

Table 4. Nucleus herds - average production results for boars, 2007-08

Breed	Number	Daily gain, g*		Lean meat %	Conforma- tion, points	Scanning objective, mm	Scanning weight, kg
		0-30 kg	30-100 kg				
Duroc	7,777	384	1,053	60.4	2.92	8.0	95.0
Landrace	19,044	379	976	62.3	2.94	8.3	92.4
Large White	14,224	359	924	61.6	3.05	8.5	91.0
Total	41,045						

\* Note that daily gain 30-100 kg is calculated on the basis of weighing of live animals, which means that the calculation of gain at the performance test did not include differences in killing-out percentage between the breeds.

Table 5. Nucleus herds – average production results for young sows, 2007-08

Breed	Number	Daily gain, g*		Lean meat %	Conforma- tion, points	Scanning objective, mm	Scanning weight, kg
		0-30 kg	30-100 kg				
Duroc	10,033	387	1,004	60.7	2.99	7.7	93.4
Landrace	22,145	383	932	62.2	3.05	8.5	91.0
Large White	16,276	363	892	61.5	3.11	8.6	90.4
Total	48,454						

\* Note that daily gain 30-100 kg is calculated on the basis of weighing of live animals, which means that the calculation of gain at the performance test did not include differences in killing-out percentage between the breeds.

Table 6. Index level and time in production of AI boars.

Race	Boars transferred, 2007/08	Active boars, August 2008	Index level for active boars, August 2008	Months in production of boars departed in 2007/08
Landrace	641	344	120.3	7.1
Large White	677	374	120.5	7.2
Duroc	3,238	2,243	109.3	8.7

Table 7. Nucleus herds – litter size of purebred litter, 2007.

Maternal breed	Litter size	LP5	Per cent gilt litters
Duroc	9.9	-	70.3
Landrace	14.6	11.4	56.7
Large White	14.2	12.3	48.4



# Genetic research and development

## Adjustment of the breeding objective

The breeding objective was revised in the autumn 2007. This resulted in a significant reduction in the importance of litter size for the specialised sow breeds Landrace and Large White, and a significant increase in the expected progress for feed conversion ratio. The expected progress for litter size was reduced from 0.38 day 5 piglets to 0.28 day 5 piglets per generation, while the improvement in feed conversion ratio was significantly increased from 0.03 to 0.05 FUp/kg gain per generation (one pig generation is approx. 15 months in the breeding nucleus). For Duroc, the expected progress in feed conversion ratio increased by approx. 10%. The expected progress in the other traits in the

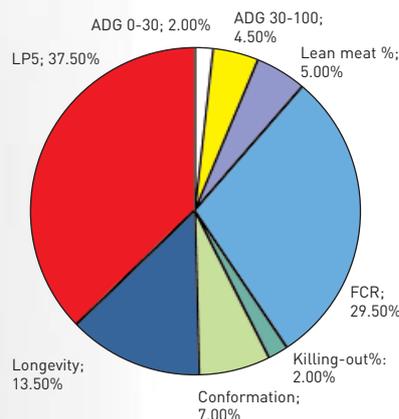


Figure 1. Genetic progress for Large White and Landrace – economic contribution.

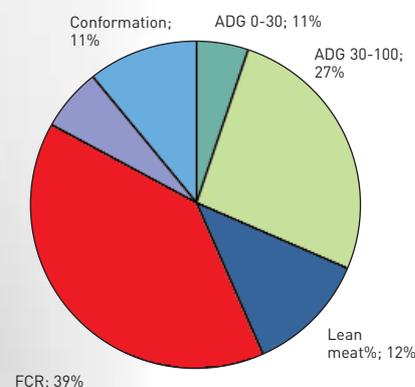


Figure 2. Genetic progress for Duroc – economic contribution.

Table 8. Current F4 genotype distribution among the young animals (basis of recruitment of AI boars)

Breed	RR (resistant)	SR (sensitive)
DD	97 %	3 %
LL	72 %	28 %
YY	95 %	5 %

breeding objective for Duroc is therefore only revised minimally.

In brief, it can be concluded that the revision of the breeding objective results in faster improvement for feed conversion ratio (approx. 33%) and a significant reduction in the improvement rate of litter size (approx. 25%), while the expected progress for other traits in the breeding objective remains largely unchanged.

## The F4 project

In 2003, a selection project was initiated to increase the resistance to post-weaning diarrhoea caused by *E. coli* 149 F4. F4 selection takes place parallel with the usual index selection in Landrace, Large White and Duroc.

Since April 2005, use of F4 resistant boars has been compulsory in the nucleus herds, and, as of April 1, 2007, this requirement also applies to multiplication herds.

Boars relevant for breeding are F4 tested at transfer to AI quarantine to ensure that their F4 status is known when they are transferred to the AI stations and become available to the breeders. Breeding sows are in principle not tested for F4. However, there is an economic advantage in testing boar dams as the F4 genotype of many boars will thereby be indirectly determined. Siblings of the boars will naturally obtain known genotype at the same time, and, as the tested sows are indeed the top sows of the breeds, a huge gain will indirectly be obtained in the form of sisters also producing offspring of known genotype. The status for Landrace, Large White and Duroc is shown in table 8.

Both the Duroc and Large White populations are now almost 100% resistant. However, for all breeds the current test strategy will be followed for some years to come. The percen-

tage of resistant animals will thereby increase to nearly 100%, but the genotype will not be known for all animals. When the percentage of resistant breeding stock in a given population reaches 97-98%, it is planned to test the remaining animals of unknown F4 status. This will minimise the costs for F4 testing and the loss in genetic progress for other traits in the breeding objective.

## Genomic selection

For the last eight years, Danish Pig Production has been in charge of several large biotechnological projects. The projects have mainly dealt with identification and mapping of the pig genome to find a correlation between individual genes or gene sequences and the physical and phenotypic traits of pigs.

Genomic selection is a brand new method that combines modern biotechnological techniques with advanced statistical models and estimation techniques. With this method, thousands of genetic markers (SNPs) are used to estimate breeding values that will be considerably more accurate than what can be achieved today. Genomic selection marks a new research area for implementing the biotechnological know-how within livestock breeding and genetics as the method is based on biotechnological analyses of the total genome, which is the carrier of all genetic information.

The use of genomic selection in pig breeding will create an entirely new basis for improving our populations. The new technique has the potential of altering the basic structures and production processes in pig breeding and thereby making it possible to develop a new breeding system with a new paradigm of production traits that can be optimised according to the future objectives in pig production.

To investigate the possibilities of genomic selection in pig breeding, Danish Pig Production has applied for financial support to a project under the Innovation Act in co-operation with Research Centre Foulum, Aarhus University. The project is aimed at illustrating the use of genomic selection in pig breeding and thereby creating a more efficient selection programme for breeding stock with a high level of disease resistance and longevity. Today, it is difficult to select for these traits as records of many animals are required to obtain sufficiently accurate information. The future development of methods for selecting breeding stock will also be ensured through this project; a development that can be obtained through these sub-goals:

1. Development of methods for estimation of genomic selection models for traits in pig breeding based on 6,000 genetic markers.
2. Estimation and evaluation of the theoretic extra genetic progress resulting from genomic selection.
3. Development of a technology for simultaneous typing of 50,000 markers for future implementation of genomic selection.

### Control of inbreeding

Inbreeding can be controlled with a new selection method: optimum contribution selection. The consequences of using this method are currently being analysed. The method balances both breeding value and increase in inbreeding.

The aim of selection is to create progress in the traits of the breeding objective. This is done by mating animals with high indices. However, regard must be taken for the increase in inbreeding as it may lead to inbreeding depression and loss of genetic variation – and thereby of future genetic progress – if the mated animals are too closely related.

Today, the increase in inbreeding is controlled by limiting the number of litters that any one boar can father. Furthermore, for Landrace and Large White there are limits as to how many full or half siblings can be entered on AI stations and thereby be available to

the breeders. This method has worked for years and keeps inbreeding at an acceptable level. However, the down-side is that the prime boars are now also subject to a litter quota, which reduces the short-term genetic progress as it is necessary also to use boars with a lower index to obtain the necessary number of litters.

A relatively new selection method – selection for optimum contribution – combines the calculated breeding value and the kinship to the remaining breeding nucleus for each boar, and with this method it is possible to optimise the use of the boars to control the increase in inbreeding and increase the genetic progress (or vice versa). This is done by determining the “optimum contribution” to the next generation for each boar, and on the basis of this, the number of litters that a given boar can father is determined.

Thereby, all boars and families are no longer subject to the same litter quotas. It is essential to find and use boars with a high index and with very little kinship to the remaining population to keep the increase in inbreeding low and the genetic progress high. For instance, a boar with a very high index that has little kinship with the rest of the breeding population will be allowed to father more litters than today with this new method. On the other hand, top boars that are closely related to the rest of the population will not be used as much as today. The point is to differentiate the litter quotas on the boars in terms of breeding value and average kinship to the rest of the population and not, as today, in determined litter quotas where selection takes place according to breeding value. A significant progress in genetic level is expected, but analyses and details of the selection strategy will need further work before the method can be taken into use.

### Survival project

Improvement in the survival rate of pigs will significantly benefit the economy of Danish pig production. With the breeding objective LP5, survival rate the first five days after farrowing, will be improved. This contribution to



*The testing of Duroc boars at Bøgildgård ensures genetic progress in feed conversion ratio.*

improved survival is a trait in the sow breeds Landrace and Large White.

To further strengthen the survival until slaughter, heritability of the trait “survival” is currently being investigated (definition of survival = an animal lives to slaughter). If heritability is detected, it may be possible to add “survival” to the breeding objective for Duroc (the male line).

Variations have previously been found in survival between HD offspring and offspring of Duroc boars. This formed the basis of further investigations of differences in survival between offspring of Duroc boars. However, a more comprehensive data set is needed for this than obtained in the HD/Duroc project.

In 2006, a trial was therefore initiated in a production herd where the survival of offspring of Duroc boars and YL sows is being investigated. Matings with named semen are recorded and all newborn piglets are ear-tagged before cross-fostering to ensure that the kinship of every single pig in the herd is known. Subsequently, all dead/culled pigs until slaughter are



# Genetic research and development

recorded along with the date of death or culling.

Collection of data is nearly complete, and currently the analyses can be based on approx. 35,000 born piglets, but the last pigs still await slaughter. Subsequently, heritability of survival will be estimated. If results prove positive, survival may be a new trait in the breeding objective for Duroc. In that case, offspring samples from top boars currently being used in the breeding work in several production herds will be required for the evaluation of breeding value.

### Breeding for feed conversion ratio

For years, there has been a lot of talk about the profit in production herds of selecting for feed conversion ratio. Previously, the effect of selection for a number of index traits was studied, and in all cases an effect was found of the estimated breeding value (sub-index) on the production results in the herds that participated in the studies.

An effect of the estimated breeding values was previously demonstrated among finishers housed at Bøgildgård. However, it is desirable to demonstrate the effect of genetic progress in feed conversion under commercial conditions where individual feed intake cannot be measured. A project was therefore initiated under commercial conditions. The project is financially supported by the Rural Development Programme.

The project is conducted in a herd with Landrace animals. The largest possible variation in pen average for breeding value estimates for feed conversion is achieved with Landrace animals. The variation would therefore be limited if three-way crossbred pigs are used. The animals are housed under commercial conditions; in pens according to size and mixed from different litters. From each pen, the identity of the animals are recorded along with estimated breeding value information on overall weight and feed used at the beginning and end of the test period.

The study will comprise 200-400 pens, and it will be possible to document

whether the sub-index for feed conversion has the same effect under conditions different from those at Test Station Bøgildgård.

### Genetic causes of boar taint

In most European countries, boars are castrated to reduce the risk of unpleasant odour and taste when the meat is cooked. Boar taint is primarily caused by a high level of skatole (chemical substance deposited in fat) and/or androstenone (sex hormone deposited in fat). Castration reduces boar taint, but affects lean meat growth negatively. It is therefore interesting to find other methods to reduce boar taint. Heritability of skatole and androstenone levels has been documented, and in the EU there is a desire to find genetic solutions to the problem.

The aim of the project is to find the gene(s) responsible for boar taint in pork. It is known that the two above-mentioned substances cause boar taint, but we do not know the genes behind. Fat and meat samples were collected from Landrace boars in this trial. From these samples, 500 couples of siblings were selected; one with a high skatole content and one with low, and they were then analysed for androstenone.

Researchers are currently working on locating single genes with effect on boar taint as part of the four-year-long European project SABRE (Cutting Edge Genomics for Sustainable Animal Breeding). Results from the project are expected available in 2009.

### Project Pigs and Health

Two of the largest export businesses in Denmark are co-operating on implementing know-how on the pig genome in practice. The project has two aims: partly to develop healthier pigs for meat production and partly to develop model pigs for medical research on human diseases. It is a four-year-long project and the overall budget is DKK 50 million, of which the Danish National Advanced Technology Foundation funds half. Danish Pig Production is in charge of the project. The other parties in the project are the Danish Technical University, the

Faculty of Health Sciences at Aarhus University, the Faculty of Agricultural Sciences at Aarhus University, the Faculty of Life Sciences, Copenhagen University, as research partners, and Leo Pharma, Ellegaard Göttingen Minipigs and PixieGene as business partners.

The project "Pigs and Health" consists of two separate projects that only have the pig and its genome as common denominator. One project, "Healthy pigs" targets breeding of pigs for meat production with improved resistance to a number of diseases. In the other, special model pigs will be bred for use in the pharmaceutical industry in the development of new drugs for treatment of humans.

The project "Healthy Pigs" aims at identifying genes that affect pigs' resistance to diseases, primarily various types of pneumonia and hermia. Areas have been detected in the pigs' DNA that are assumed to control whether the pigs are resistant or particularly susceptible to certain diseases. For pneumonia in pigs, four regions in the genetic mass have currently been located that seem to affect resistance to these types of diseases. Two of the regions of the genome will now be analysed in detail to find the genes that trigger this resistance. If this turns out a success, it will be possible to test pigs for these genes, and, through selection, ensure that the trait is passed on to future generations of pigs. The task



*Genomic selection may become a huge break-through in the breeding programme in the coming years.*

lies in finding the good genes that are already in some of the pigs. The preliminary mapping of the genome of the pig shows that it is possible to be even more determined in locating the genes that make the pigs resistant to certain diseases. This will result in healthier pigs, a lower consumption of medicine and a better economy for the pig producers.

The second project, "Model pigs", is aimed at improving the health of humans. This project concerns development of special model pigs for use in the pharmaceutical industry. Pigs are in many ways much more suitable for pharmaceutical trials than traditional experimental animals as the pig's organ development, physiology and metabolism have a clear resemblance to those of humans. Model pigs are special mini pigs that do not grow big and that are suitable for that kind of investigation.

Development and testing of new pharmaceutical products require time and resources, but hopefully the production of special model pigs will change this. For this part of the project, genes will be transferred to mini pigs that dispose them to certain human diseases and subsequently, by cloning, identical individuals of the pigs will be created, so that lines of model pigs are bred with these diseases or diseases identical to them. Subsequently, the pharmaceutical industry will test the suitability of the pigs as experimental animals. In the first year of the project, pigs sensitive to Alzheimer's disease have been born, and work now continues to create cloned pigs for analysis of treatment of skin diseases such as psoriasis and arteriosclerosis.

### The pneumonia project

In many commercial herds, respiratory diseases in pigs are a big problem that, despite a sound environment in the pig facility, can be difficult to overcome. It is therefore being discussed whether there may be a genetic variation for different respiratory diseases, and this may very well be the case.

In the project "Breeding for disease resistance", offspring of Duroc boars

*Table 9. Remarks for chronic adhesive pleurisy.*

Number of pigs evaluated	9,500
Mycoplasma, %	14.3
Chronic adhesive pleurisy, %	53.8
Pleuropneumonia, %	1.3
Pericarditis, %	9.9

*Table 10. Difference between the offspring of boars*

	Best boar %	Bottom boar %
Mycoplasma (Catharral pneumonia)	1.9	38.1
Chronic adhesive pleurisy (pleuritis)	26.8	72.2
Pleuropneumonia	0	6.3
Pericarditis	0	38.9

were recorded and examined for various diseases, including two types of lung lesions. It was established that there are significant differences in the prevalence of respiratory disorders between the offspring of the boars. To study this further, the variation between the offspring of the boars and the heritability for two economically important respiratory disorders were analysed.

In 2004-2006, 350 sows of known origin were mated to 170 named Duroc boars. For each boar, 6-10 litters were produced. A total of 952 litters were produced for the trial and approx. 9,500 animals that were marked individually were followed until slaughter. At the slaughterhouse, the pigs from the trial were examined and pneumonic lesions recorded at the Extended Health Control. Evaluations were made for catharral pneumonia (Mycoplasma/SEP pneumonia, regular pneumonia), chronic pleuritis (chronic adhesive pleurisy caused by *Actinobacillus Pleuropneumonia*), pleuropneumonia and pericarditis.

The results of lung evaluations from 9,500 pigs have now been analysed. As expected, the phenotypic data reveal differences between herds and differences between the assessors in their evaluations. There are also differences between genders. Furthermore, the occurrence of chronic adhesive pleurisy depended on the parity in which the piglet was born. There was a higher degree of chronic adhesive pleurisy in first parity piglets

than in subsequent parities. Phenotypically, daily gain is lower for pigs with pneumonia, but there are no indications that the lean meat percentage is affected. Heritability of catharral pneumonia and chronic pleuritis was established through analyses (there was a low occurrence of the two other respiratory disorders and they were therefore not analysed). Analyses revealed a 5% heritability for C. pneumonia and a 6% heritability for chronic pleuritis. Analyses of the correlation between pneumonia and daily gain and lean meat percentage demonstrate that the genetic correlation is low, +0.07, between daily gain and chronic adhesive pleurisy. The genetic correlation does therefore not seem important. However, the genetic correlation is higher and negative between lean mean percentage and pleuritis: -0.22. The genetic correlation between the two types of pneumonia is high. This means that some families have a high occurrence of both diseases. This will need further analysis. Subsequently, the genetic results will be analysed in relation to the breeding programme, and it will be evaluated, economically and practically, whether the traits are to be included in the breeding objective.

Tables 9 and 10 show the results of the lung evaluations and variations of Duroc boars with 50 or more offspring. The tables show the best and the poorest boars along with the average figure.



# Quality control of semen and AI projects

## Sale of semen

The sale of semen from DanBred's AI stations increased by 1% compared with 2006/2007. A total of 5,085,064 doses were sold corresponding to 87% of all services being performed with semen from AI stations. The calculations are based on an estimated sow population of 1,130,000 in Denmark. The sale of semen from DanBred AI stations over the last five years is shown in figure 1.

## Boar variance

Analyses of breeding data revealed an increase in the boar's influence on litter size. These analyses were made as some boars caused a reduced litter size – i.e. the boars had, for instance, a poor semen quality. It is normal that some boars have reduced fertility, but now the number of boars with reduced fertility has increased. It is therefore being investigated how to reduce boar variance. This includes, for instance, improvement of semen extenders and analyses of breeding data to pinpoint possible risk factors for reduced litter size.

## Semen quality

The aim of analysing breeding data from the study on boar variance is to find possible explanations for the increase in boar variance. Calculations confirm that the percentage of defect sperm in combination with sperm motility affect litter size. However, the latest calculations reveal a tendency that the dilution of the semen and thereby the concentration of crude semen also affect litter size. Results indicate that heavily diluted semen, as well as less diluted semen, has a lower fertility than semen that has been diluted as the average. Furthermore, analyses indicate that semen from Large White has a slightly shorter shelf-life than semen from Landrace boars.

For the moment, the AI guidelines will not be revised, but the analyses confirm that the measures implemented to reduce boar variance were correct.

## Semen extenders

Ten different extenders were investigated in a lab trial. Semen from Large White boars was diluted with each of

Million doses

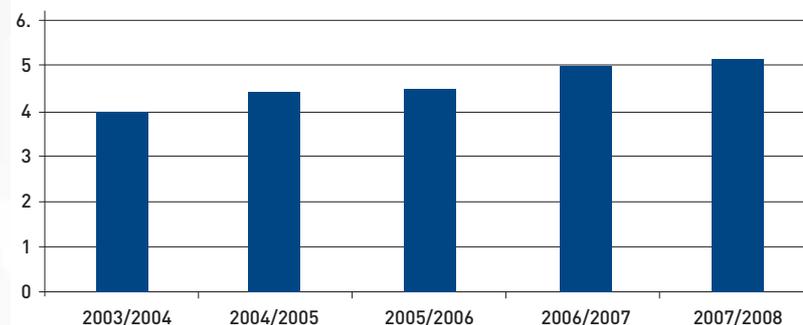


Figure 1. Semen sale in 2003-2008.

the ten extenders. Sperm motility was analysed on day 0, 1, 3 and 7 with CASA (Computer Assisted Sperm Analysis), which is an instrument that, via video recording of the sperm, measures the motility. Preliminary results indicate that some extenders do prolong the shelf-life of semen.

## Hormones during AI

Previous studies have demonstrated that the level of the hormone prostaglandin in the blood increases during AI – an increase that is not observed during natural mating. Prostaglandin affects the transport of semen in the uterus by restricting the muscle contractions in the uterus, which will probably have an adverse effect on fertility. In co-operation with the Swedish University of Agricultural Sciences, it was attempted to elucidate the cause of this increase. The studies revealed that sperm plasma (normal fluid in an ejaculate) reduced the level of prostaglandin, while both the extender and the foam tip of the insemination catheter increased the level of prostaglandin (Brief 0742). Further investigations are now attempting to locate the substance in sperm plasma that can restrict the excretion of prostaglandin. As it is known that prostaglandin restricts the semen transport in the uterus, it would be desirable to be able to add this substance to the semen dose to prevent the prostaglandin level from rising during AI. This may improve semen transport and thereby improve the insemination efficiency.

## Sperm motility and fertility

In two trials, the correlation between

sperm motility measured with CASA and fertility is being analysed [see figure 2]. In one trial, semen from Landrace and Large White will be analysed and it will be illustrated whether examination of individual ejaculates is correlated with the fertility of the individual ejaculate and whether these examinations provide information on the general sperm quality of the individual boar. Commercial semen, which is a mix of semen from various ejaculates, will also be analysed. It will be investigated whether ejaculates with reduced motility on day 3 will actually result in a drop in litter size and/or farrowing rate when mixed with semen with high sperm motility.

If a correlation is found between sperm motility and fertility of the semen, this will form the basis of the quality control of the semen quality for AI boars.

## Quality control of AI stations

The quality control at the AI stations is two-fold: a self-audit programme run by the AI stations and an external audit conducted by Danish Pig Production.

The self-audit programme includes analyses of odour, colour, volume and motility of the semen and of defects of the semen. This ensures a satisfactory quality of the sperm doses at all times. It requires great experience when the AI stations annually analyse the semen of more than 150,000 collections. The AI stations have their own training programme to ensure



that the staff become and stay experienced in semen examination. The staff's know-how is upgraded at an annual course in semen examination and quality assurance. The course is prepared by Danish Pig Production in co-operation with the AI stations.

This will guarantee that the semen doses meet the expected quality. Today, it is possible to analyse for bacteria in the semen (hygiene on the AI stations) and to control the number of sperm per dose. In 2008, hygiene inspections again revealed a very low number of semen doses positive for bacterial growth. The inspection of the number of sperm per semen dose showed that all AI stations complied with the guidelines.

### Sexing of semen

With sexing of boar semen during AI, it is possible to ensure that, for instance, only gilts are produced. This is extremely relevant following the debate on castration of piglets both in Denmark and in the rest of the EU. For two years, Danish Pig Production has been co-operating with Norsvin in Norway and Ovasort Ltd. in Wales on development of a method for sexing of boar semen. In the second year of the project, a protein was found on the surface of the sperm that may be applicable for sorting the sperm into male and female sperm, and antibodies against this protein are now being developed. Once they are developed, they will be mixed with the semen and the fertility will be analysed in a series of services, and the sex of the offspring will be noted. If everything proceeds as planned, a commercial product for sexing of boar semen will be ready in 1 1/2-2 years.

### Intra-uterine insemination

Intra-uterine insemination with reduced semen volume was studied (trial report 808) with Duroc (heterospermic) semen. The semen doses contained 2 bn sperm (control); 0.75 and 0.5 bn sperm (trial groups). A two-chamber bag was used in the trial groups. In all three groups, the insemination volume was 80 ml semen. The trial was conducted in seven different sow herds.



*Cicilie at Hatting AI analyses sperm motility with CASA – Computer Assisted Sperm Analysis.*

The farrowing rate was identical in all three groups, while a slight drop in litter size was observed in the group with 0.5 bn sperm per dose. The results show that it is possible to maintain a high litter size and a high farrowing rate with intra-uterine insemination and a two-chamber bag even when the number of sperm is more than halved. Discomfort was not observed among the sows during intra-uterine insemination compared with the control group where a traditional foam tip catheter was used. Previous studies have shown that the degree and percentage of injuries observed in and around the neck of the cervix during intra-uterine insemination are identical to those seen during traditional insemination and mating. On the basis of these investigations, Danish Pig Production has applied to the Danish Veterinary and Food Administration for general authorisation to practise intra-uterine insemination in Denmark. In this application, Danish Pig Production recommends a brief course in the method for future users of intra-uterine insemination.



# Increased farrowing rate

## Demonstration projects

Danish Pig Production is currently involved in a demonstration project in co-operation with the regional advisors educated as authorised pig inseminators. The project comprises 21 herds, and the aim is to prove that through implementation of existing knowledge on reproduction and planning of services in the sow unit it will be possible to increase the farrowing rate to min. 90. The regional advisor handles the contact to the herd and the routine follow-up. Before the first visit, the advisor analyses the data of the herd. Subsequently, the advisor, a second opinion advisor and an employee from Danish Pig Production visit the herd. During this visit, an action plan is made that is routinely subject to follow-ups and adjustments as the points in the plan are implemented.

At the beginning of the project, the farrowing rate in the herds ranged between 75-85%. This number has now increased in all the herds in the project. Below, some of the typical problems are described.

## Gilt management

To achieve top results, gilts must be



housed in light and pleasant pens with plenty of room. The gilts must have daily contact with humans as this makes them calm and trusting.

It is essential to heat check the gilts daily and to note gilt number and date. When heat is displayed, the gilt can be served three weeks later – in the next heat. Once these recordings are made, the producer will know

exactly how many gilts will be ready for service in each weekly batch. This improves the replacement strategy, so that excess sows can be delivered for slaughter immediately after weaning.

## Service

Many sows are served in each weekly batch. It is essential to perform a thorough heat check on all sows to make sure that the individual sow is in heat. Nurse sows will often have been in heat in the previous lactation period, and these sows must be subject to a thorough heat check. It may be an advantage to mark the nurse sows at weaning to enable the staff in the service facility to recognise them as nurse sows.

The boar should be placed in front of the sow during heat check. The boar's nose contact with the sow will often make her display heat easier. Before service, the sow must be stimulated to make her absorb the semen faster. It is important not to stimulate more sows to standing heat than can be served within 20 minutes. It is important that the staff works quietly and calmly and maintains concentration from the first service to the last. A good sign of calm work routines is when the sows lie down and do not get up until the staff or the boar approach her.

## Stimulation during service

Danish Pig Production recommends stimulation of sows according to a five-point plan. Not all producers decide to follow this plan as it is very time-consuming. Furthermore, several tools are used at service, such as Stimulus, Sofus, clips, etc. Many producers obtain satisfactory results with a low degree of stimulation, and good results are in these cases attributed to the abilities of the staff.

In 2009, Danish Pig Production will analyse the need for stimulation at service.

## Feeding

Gilts must be given extra feed doses from approx. two weeks before expected service. This is called flushing, and will make the gilts shed more

eggs resulting in a higher litter size. Sows must be fed according to approximate ad lib from weaning until service, which will make them reach heat faster.

## Advice

The advisors in the project agree that there is already sufficient know-how to be able to increase the farrowing rate to 90 in all herds. Each pig producer must be given individual advice to succeed. An ideal advisory process should follow the below points:

1. Before the first visit, a cost-benefit calculation is made to show how much can be made on increasing the farrowing rate and how much this will cost.
2. The herd owner and the staff must be 100% motivated to participate in an advisory process.
3. The advisor must motivate to make changes – not criticise.
4. At the first visit, three areas must be agreed upon, and they should be communicated personally to the sow producer and his staff to make them all feel part of the project.
5. Frequent follow-up – on the telephone and visits to ensure that owner and staff stay motivated.
6. Focal points are adjusted as progress is made in the herd.

## Authorised pig inseminator

Danish Pig Production is responsible for educating authorised pig inseminators, which is an education approved by the Danish Veterinary and Food Administration. Authorised pig inseminators possess thorough knowledge on fertility in pigs and the practical work in the service facility. They are therefore qualified in advising on reproduction.

Danish Pig Production expects to educate 14 authorised inseminators in 2008.



# Management of the gilt unit

## Enough gilts

Long-term planning in the gilt unit ensures that there are always enough gilts available for service. In a trial, five-months-old gilts were purchased; of these 95% reached first service. Gilts that were not served when they were 11 months old were never served.

## Correct conditions

The service facility should be functional in design for both animals and staff. It must be possible to feed the gilts heavily so that they can be flushed. There must be min. 100 lux in the activity area, and each gilt must have min. 1 m<sup>2</sup> available space (and more if the boar is brought into the pen). It must be easy for the staff to get in and out of the pens and let a boar in or a gilt out of the pens.

## Correct heat check

Producers should always be aware of whether the heat check in the gilt unit is optimal. The main problem is to motivate the staff to heat check the gilts thoroughly every day. In one herd, only 88% of the gilts were served. Examinations of the gilts' ovaries revealed that the majority of the gilts were culled cyclic.

## Heat check

Few gilts reach heat before they are six months old. From this age, there is great variation between herds when gilts become cyclic. Figure 1 shows the number of gilts cycling at increasing age in three herds.

## Managing the time of heat

Foreign studies demonstrate that it is possible to control the date for first heat by moving gilts to new pens, mixing them with new gilts and introducing boar contact. Danish studies show that to manage heat successfully, it is necessary to detect the optimum age of heat in the herd (see figure 1) and then work intensively with moving the gilts and introducing boar contact where boar and gilts meet in the same pen for min. ten minutes every day until heat sets in.

## Optimum heat for mating

A recent trial revealed that regardless of the age at first heat, the optimum litter size is achieved when the animals were served in the second heat (see

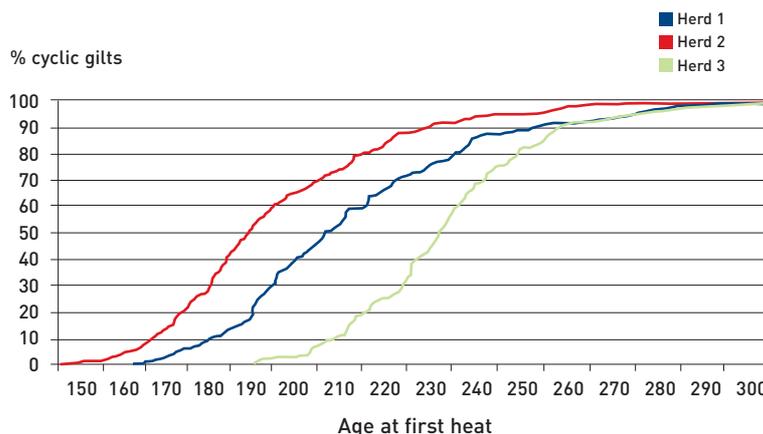


Figure 1. Percentage of gilts served at increasing age in three herds.

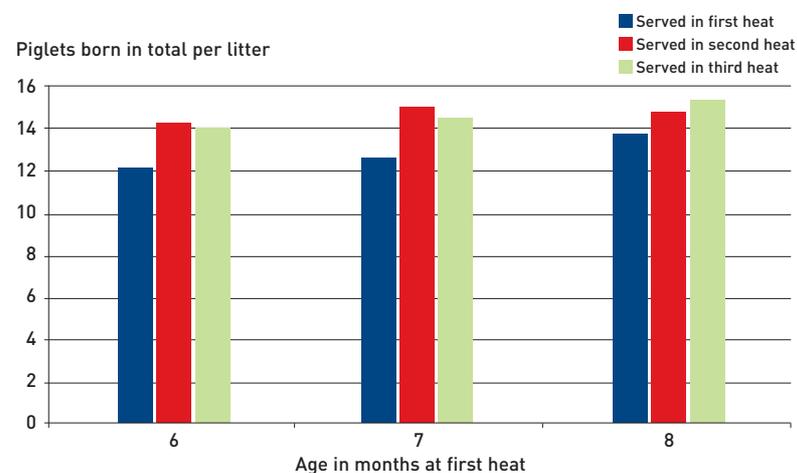


Figure 2. Effect of heat number at service for gilts displaying their first heat at 6, 7 or 8 months of age.

figure 2). Regardless of whether the gilts are young or old, nothing is gained by waiting until the third heat before serving the animals. Even when the age of the gilts is increased by three or six weeks by serving them in their second or third heat, this did not improve the maternal traits in the form of piglet survival or gain. It has yet to be established whether the increasing age and size during service in the second or third heat affect longevity of the gilts.

## Management of the gilt unit

Previously, it was recommended to serve the gilts at eight months. It was then easy to move the gilts to the service facility at seven months and serve them at the onset of heat. With the new strategy, where the gilts are served in their second heat, the gilts must daily be subjected to heat check from they are six months old, and be marked and served in the subsequent

heat. Thereby, the optimum litter size is obtained without having too many non-productive days. Furthermore, it leaves plenty of time to move the gilts to the service facility to feed them optimally up to service. Once you know the number of gilts ready for service in three weeks' time, you will know two weeks before weaning how many sows to cull, and replacement can thereby be planned optimally. Finally, it is possible to serve a gilt in her first heat if too few sows have been weaned and there are at the same time too few gilts for service in their second heat. Ultimately, more is made on the gross margin from a full farrowing pen than from the two extra pigs in the farrowing batch three weeks later. If the management of the gilt unit is inefficient and half the gilts are served in their first heat, the smaller litter size will cost 0.5 pig/sow/year.



# Feeding of highly prolific sows

## Nutrition is important

Nutrition and feeding are the most significant factors for a high level of productivity and longevity in Danish sow herds.

## Micro minerals

The micro minerals selenium, iron, zinc, copper and manganese are important to the function of the sow, and deficiencies in one or more of these micro minerals will reduce the sow's reproductive ability and longevity. In an investigation running in two sow herds, half of the sows are given organically bound micro minerals and the other half are given non-organically bound minerals. All sows get the same level of micro minerals, ie. the effect is attributed solely to differences in the sows' absorption of the micro minerals.

Samples are collected from the sows' milk, blood, liver and hooves. Furthermore, samples are collected from their piglets of liver, blood and tissue at birth and again at weaning. Analyses of these samples will reveal whether there is a better absorption of one type of micro mineral. Production results and culling causes are also recorded in this investigation. In each herd, 150 gilts are followed from their first service until departure from the herd. All samples are collected from these 150 pigs. Samples have now been collected from first and second parity sows. They demonstrate that both sows and piglets have a significantly higher selenium level when they were given organically bound micro minerals. No differences were found for the other micro minerals, nor did

we find significant differences in sow productivity and longevity.

An investigation made in 2000 revealed differences in the animals' levels of micro minerals, productivity and longevity after the third litter.

## Anaemia

A Danish analysis of 500 blood samples demonstrated that sows have an average haemoglobin level of 11.8 g per 100 ml, which is in the low end of the scale compared with current references (10.00-16.00 g per 100 ml). A low haemoglobin level may, for instance, increase the number of still-born piglets.

## Additional iron

In one herd, the sows were given 100 ppm additional iron in the lactation period. However, this did not increase the haemoglobin level at weaning, which means that additional supply of iron does not seem to affect the haemoglobin level.

## Vitamin B12

Vitamin B12 is important to the production of haemoglobin. A Canadian study demonstrated that a uniform haemoglobin level was obtained in weaners and finishers if extra vitamin B12 was added to the feed. In a Danish herd, half of the sows were injected with vitamin B12. Blood samples from these sows showed a drastic increase in vitamin B12 level after the injection. However, the effect quickly wore off, and the level dropped to that of the sows that were not injected. Analyses revealed no differences in haemoglobin level between the two groups, which means that injec-

tion with vitamin B12 did not have the expected effect on the production of haemoglobin.

## Protein during gestation

Experience shows that additional protein in the feed the last four weeks of gestation increases the birth weight of the piglets. In one herd, half of the gestating sows were given a diet until transfer to the farrowing facility that complied with the current amino acid standards for gestating sows. The other half of the sows were also given that same diet, but four weeks before expected farrowing they switched to a diet complying with the current amino acid standards for lactating sows. Both groups followed the same feeding strategy, ie. they received the same amount of energy. All piglets in approx. 200 litters per group were weighed. The results shows no differences in litter weight or spread in the piglets' weight within the litter. There were no differences between the groups in the sows' production results. It is therefore still recommended that gestation diets comply with the current amino acid standards. It is expensive to increase the protein level in gestation feed and this increase will influence the discharge of nitrogen from the sow unit.

## Feed enhancing satiety

In co-operation with the Faculty of Agricultural Sciences under Aarhus University and supported by the Danish Food Industry Agency, the third year of a project on satiety in sows has begun. In the first year, the water binding capacity and intumescence of various feedstuffs and their effect on gastric emptying were studied. Based on these preliminary analyses, pectin feed, sugar beet pulp and potato pulp were selected for inclusion in sow diets. In these studies, the sows' motivation to eat is being studied when they are given diets containing pectin, sugar beet pulp or potato pulp. The study will also analyse access vs no access to straw. When these analyses are finished, a practical trial will be conducted with the diet found to most enhance satiety. It will then be established whether this diet affects the sows' behaviour and longevity.

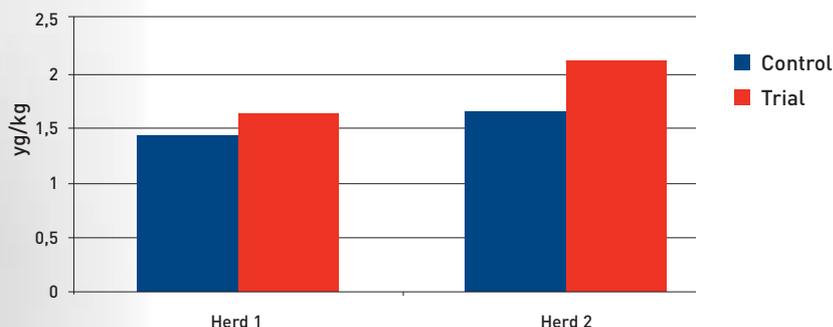


Figure 1. Level of selenium in livers from piglets.



# Feeding of weaners

## Horse beans for weaners

Horse beans are an alternative protein source that can be cultivated organically in Denmark, and it is therefore relevant for the organic production of pigs. Horse beans may contain tannins, which restrict the feed intake and growth of pigs. The maximum recommended dosage for weaners older than 5 weeks is 20%.

The variety Columbo, which has a low content of tannins, was studied for



The highest level of productivity was obtained with 15-25% horse beans.

weaners in increasing dosages from the pigs were 7 weeks old and until they weighed approx. 30 kg. Compared with control, an 8% higher production value was obtained with inclusion rates of 15, 20 and 25% horse beans in the feed (see figure 1 – trial report is out in December 2008). To conclude the study, the optimum inclusion rate will be tested on health and diarrhoea in an organic weaner diet for organic weaners. The study is financed by the

Table 1. Lysine requirement in weaners. Productivity and index of production value.

Group	1	2	3	4	5	6
Lysine, g dig./FUgp	8.4	9.2	9.8	10.4	11.0	11.0
Crude protein, g dig./FUgp	152	155	157	157	159	144
FUgp/day	0.93	0.96	0.97	0.96	0.97	0.99
Daily gain, g/day	453	492	514	524	534	533
FUgp/kg	2.07	1.95	1.90	1.84	1.83	1.86
Index, production value	79	93	100	107	108	106

Pig Levy Fund and The Fund for Organic Farming.

## Lysine requirement of weaners

The old lysine standard for weaners was determined on the basis of trials from 1991 involving few pigs in the growth interval 9-20 kg. Since, the genetic potential and the feed evaluation system have developed.

Five levels of digestible lysine in feed for weaners from 9 kg to 30 kg were investigated. The investigation comprised approx. 4,300 pigs. The level of the other essential amino acids and of calcium and phosphorus was min. 110% of the standard to make sure that differences in production results could be attributed solely to the content of lysine. Furthermore, the high level of lysine was studied as group 6 with a lower protein level, which represents a widely used practice (see table 1).

The maximum production value was obtained with the highest inclusion rate of lysine. The highest gross margin (including the feed prices) was found with the second highest lysine level: 10.4 g standardised lysine per FUgp. The gross margin per pig is

approx. DKK 1 lower under the old lysine standard in group 3 (see table 1).

Following the result of this study, the standard for lysine was raised in June 2008 from 9.8 to 10.4 g standardised digestible lysine per FUgp, and most of the other amino acid standards were proportionally increased (trial report is out in December 2008).

## Commercial diets

Danish Pig Production routinely studied some of the weaner diets available in 2008. The diets included in the study were selected by the local pig advisors in South-East Jutland (the production value index is shown in parenthesis):

1. Control (100)
2. ATR (104)
3. DLG (103)
4. Aller Mølle (98)
5. Danish Agro (118)
6. Hornshyld Købmandsgård (100)

The diets from Danish Agro resulted in the highest production value, which was 18% higher than that of the control group. This means that a producer can pay DKK 30 more per 100 kg and still obtain the same economic results. There was no difference in health between the groups (see trial report 818).

Production value, index

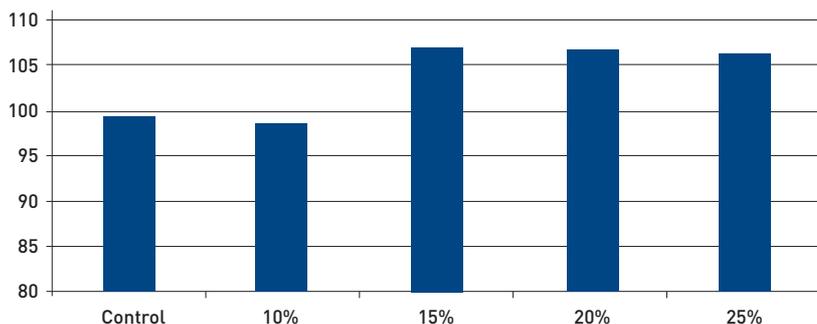


Figure 1. Production value, dosage of horse beans calculated with the same feed prices.



Weaner feed from Danish Agro resulted in the highest level of productivity.

# Feeding of finishers

## Carbo-hydrate splitting enzymes

Studies have demonstrated that Porzyme 9300 containing the enzyme xylanase can improve the feed conversion ratio by approx. 3% and daily gain by 1-2%.

However, other products are claimed to have the same – or a greater – effect, but these products have not been tested in Danish feed. One of these products is Bergazym P from the company Berg & Schmidt that primarily consists of xylanase. Bergazym P is used in dosages of 125-250 g per tonne finished feed.

The effect of adding Bergazym P to finisher feed was studied in a herd with feed mixed on-farm. 250 g Bergazym P was added per tonne finished feed, which was supposed to result in an enzyme activity of 1,500 EPU (Endo-Pentosanase Units). The feed for the control group did not contain Bergazym P.

The study revealed no benefits from adding Bergazym P to the feed as both the trial pigs and the control pigs had similar production values. There were no effects on gain, feed conversion ratio or lean meat percentage. An average difference in enzyme activity of 1,771 EPU was observed between the control diet and the trial diet, which was more than the desired difference in enzyme activity of 1,500 EPU between control and trial. However, enzyme activity varied greatly within the groups (control diet from 109 EPU to 1,623 EPU; trial diet from 1,096 EPU to 3,555 EPU). This



*The addition of Bergazym P to finisher feed mixed on-farm did not improve the production value compared with the control pigs.*

*Table 1. Productivity and production value index for finishers given CLA.*

	Control	0.5% CLA
Daily gain, g	936	959
FUgp/day	2.57	2.55
FUgp/kg gain	2.75	2.66
Lean meat %	60.4	61.0
Index PV	100	112

indicates that it is sufficient to analyse one sample to check the enzyme content in the feed (see trial report 826).

The effect of Ronozyme WX is now being studied in purchased finisher feed.

## Amino acid standards for heavy pigs

The current amino acid standards for heavy pigs from 65 to 110 kg are the same as for finishers from 75 to 100 kg. However, the standard is not based on practical studies.

The amino acid standards from approx. 75 kg to 120 kg in gender-based production are therefore currently being investigated. Three levels of nutrients are being studied, each with an amino acid content of 100, 92 and 84%, respectively, of the standard.

## CLA

Conjugated Linoleic Acid (CLA) is a group of isomers of linoleic acid with the following effects:

1. Reduction of fat deposits
2. Increase in growth and feed conversion ratio
3. Stimulation of the immune response.

The effect depends on the level of different isomers of linoleic acid.

Previous studies revealed a positive effect on lean meat percentage and fat quality of adding 0.5% and 1% CLA to finisher feed, but also a poorer economy because of a high product price. It was therefore decided to investigate the effect of 0.5% CLA given to finishers from approx. 60 kg.

The pigs were transferred to the finisher facility at an average weight of 29.6 kg and slaughtered at a live-



*The addition of CLA increases the lean meat percentage and makes the fat more saturated.*

weight of 107 kg for the control group and 109 kg for the trial group. The pigs were given the same feed until the trial pigs, at an average weight of 62.9 kg, switched to the diet containing 0.5% CLA.

The pigs given CLA had a 12% higher production value (PV) compared with the control pigs, which was significant. This was primarily attributed to an improvement in the feed conversion ratio of 0.1 FUgp/kg gain and a tendency to a higher lean meat percentage of 0.6 percentage units (see table 1). There was no difference in health between the groups.

Meat quality analyses showed a reduction of six units in the iodine number in loin fat, which indicates that the carcass of the pigs given CLA had more saturated fat. Surprisingly, the pigs given CLA had a higher content of intramuscular fat, while there were no differences in drip loss in the loin.

# Corn and sorghum

## New types of grain in pig feed

The feed season 07/08 was characterised by small wheat stocks and subsequent high prices on wheat. Corn and sorghum are rich in starch and low in fibre and are therefore nutritionally good alternatives to wheat, but there are maximum limits to the inclusion rate of both (see table 1).

## Corn

Corn is imported to Denmark from South and East Europe and from countries in South America that are able to guarantee that the product is GMO free. Three factors restrict the use of corn in pig feed:

- Fusarium toxins
- Effect on fat quality
- Inclusion rates in liquid feed

It is well-known that Fusarium toxins are a risk factor in corn. It is therefore recommended to analyse for Fusarium toxins to get an indication of the level. If Fusarium toxins are found in the corn, the inclusion rate must be adjusted to avoid exceeding the limiting values for finished feed.

The guiding maximum limit for finishers is 40% corn (see table 1) to take into account the fat quality as corn contains almost twice as much unsaturated fat than wheat. This is confirmed by analyses of fat quality in 50 finishers given 40-50% corn. A current dose-response study is investigating whether the recommendation needs revising.

Practical experience has shown that large amounts of dry, ground corn may block liquid feed systems. This is probably caused by the fact that corn contains less soluble fibre than wheat.

## Corn cultivated in Denmark

The increasing grain prices and a warmer climate have increased the interest in cultivating corn to ripeness. A significantly higher yield can in particular be expected in mild, sandy soil where corn replaces spring barley (see Brief 0743).

Corn cultivated in Denmark is typically harvested at water percentages of 35-45%. Drying to storage stability at 15%

Table 1. Guiding inclusion rates in pig feed.

% of kg	Wheat*	Sorghum	Corn
Sows	80 %	50 %	50 %
Weaners	70 %	0 %	70 %
Finishers	70 %	20-40 %	40 %

\* If this is the only type of grain, coarse grinding is recommended. If straw shortened, max. 30% is recommended for sows.



water is therefore expensive. For large quantities for use in the herd, liquid preservation is more relevant. The most common methods are ensiling in warehouse, silo bags or storage in an oxygen-free silo with a tapping device. These options are currently being studied by Danish Pig Production. The preliminary results show that a fine feed quality can be obtained at low pH (approx. 4) with both ensiling and oxygen-free storage.

However, it must be strongly deprecated to dry corn in a steel silo (American silo) – even if the corn is mixed with dry grain. The drying capacity is typically too small, and there is also a risk that the grain/corn is ruined by condensation along the walls of the silo.

## Sorghum

Sorghum is imported from the US and South America, in particular. A moderate inclusion rate of sorghum is recommended (see table 1). Sorghum has a natural content of tannins that protect the seed. Tannins are anti nutritional substances that reduce digestibility. It is recommended to request guarantees/analyses of a max. content of 0.4% tannins (see Brief 0803).

The digestibility of phosphorus from both corn and sorghum is very low due to the lack of natural phytase. It is therefore crucial to supplement with mineral phosphorus and to add phytase to the feed.



Liquid preservation of corn. Ensiling in silo bags or storage in oxygen-free silos with tapping device are the most common methods.



# Control of mineral feed

## Sampling

It is important that the correct procedures for sampling are followed to ensure that the analysis result is credible and can thereby form the basis of correct conclusions. Particularly sampling of mineral feed in big bags is difficult as there is a great risk that the product in the big bag is not completely uniform.

In co-operation with Rationel Kornservice, MHJ Agroteknik, and Aalborg University, Danish Pig Production has developed a set of sampling equipment that protects against the pitfalls of sampling. Samples will be collected according to the TOS principles (Theory Of Sampling) that ensure that the sample is representative.

The new equipment in action: (The equipment can be obtained through your local advisory office.)

## Test of the sampling equipment

The sampling equipment was investi-



A big bag containing mineral feed is lifted above the sampler.



The big bag is emptied through the sampler and into a clean big bag.



Approx. 50 cross-cut samples are taken from the big bag.



Many subsamples now form a representative sample of the content of the entire bag and are poured into a bucket.



The content of the bucket is split with a device for splitting samples.

gated in a trial where the same big bag was run through the system three times, and for each time, a sample was collected. The three samples were split into five samples and submitted for analysis.

The preliminary results reveal good agreement in analysis results between the three samplings. This supports

the observation that samples taken with the new equipment are representative. A few examples are shown in the tables below:

	Calcium, g/kg	Phosphorus, g/kg
Sample 1	204.8	61.8
Sample 2	202.2	60.4
Sample 3	204.6	60.1

The mineral diet had a declared calcium content of 193 g/kg and a declared phosphorus content of 62 g/kg. All samples lie within the latitudes of the Feedstuff Act.

	Free methionine, g/kg	Free lysine g/kg
Sample 1	17.3	37.5
Sample 2	17.2	36.0
Sample 3	17.1	36.8

The declared total methionine content was 23 g/kg and the total lysine content was 46 g/kg. The total content of these amino acids in this diet corresponded largely to the free content. All samples revealed that this mineral diet contained approx. 25% less methionine than declared and approx. 20% less lysine than declared. The samples used for analysing the content of free lysine were ground before splitting as a previous trial found that, when the lysine source is Biolysine (lysine 65), the lysine content is more accurately determined when the samples are ground before splitting.

## Test of mineral feed

Danish Pig Production has collected samples of mineral diets from 59 herds. The samples were analysed for content of calcium, phosphorus, zinc, copper and free amino acids (lysine, methionine and threonine). The samples were also analysed for phytase. The aim is to investigate whether the different suppliers of mineral diets meet their own guarantees.

The final results are not yet available, but will be published at [www.dansksvineproduktion.dk](http://www.dansksvineproduktion.dk).

# Phosphorus and phytase

## Phosphorus for finishers

In two finisher trials, the minimum requirement for phosphorus in feed with a high inclusion of phytase was studied. In one trial, the diet was based on barley, wheat and soybean meal, which gives in the lowest possible content of plant phosphorus (see table 1). In the other trial, the feed contained 8% sunflower meal and 6% rapeseed meal (see table 2). The trials revealed that with a high inclusion of phytase, it is possible to make do with approx. 3.9 g total phosphorus per FUgp in the diet based on barley, wheat and soybean meal, while approx. 0.5 g more is needed in the diet based on rapeseed meal and sunflower meal, because the digestibility of phosphorus is lower when the diet contains a large amount of rapeseed meal and sunflower meal.

## Digestibility of phosphorus

Simultaneously with these trials, trials were conducted at The Faculty of Agricultural Sciences to determine the digestibility of phosphorus in the most important feedstuffs, when a high dosis of phytase is added to the feedstuff. As a result, the digestibility of phosphorus was adjusted in a number of feedstuffs.

## Sows and weaners

The minimum requirement for sows with a high inclusion of phytase was also studied - just as it was for weaners a couple of years back.



12 kg less phosphorus was spread per ha/pig farm in 2007 compared with 2000.

Table 1. Phosphorus for finishers in diets with a low content of plant phosphorus.

Total P, g/FUgp, analysis	3.4	3.9	4.4	4.9
Phytase added (Ronozyme P), FYT	1500	1500	750	750
Dig. P, g/FUgp, calculated	2.0	2.4	2.5	2.8
<b>Production results, 30-105 kg</b>				
Daily gain, g	883	898	909	902
FUgp/kg gain	2.87	2.81	2.81	2.81
Lean meat %	59.5	59.9	59.7	59.9
Production value, index	92	100	100	100

Table 2. Phosphorus for finishers in diets with a high content of plant phosphorus.

Total P, g/FUgp, analysis	4.0	4.0	4.0	4.4	4.5	4.9
Phytase added (Ronozyme P), FYT	0	750	1500	750	1500	750
Dig. P, g/FUgp, calculated	1.5	2.0	2.2	2.3	2.6	2.6
<b>Production results, 30-105 kg</b>						
Daily gain, g	940	950	972	975	982	987
FUgp/kg gain	2.78	2.74	2.73	2.71	2.70	2.68
Lean meat %	60.1	60.2	60.3	60.3	60.2	60.4
Production value, index	91	95	98	99	100	103

## New phosphorus standards

Based on recent trials and digestibility studies, the standards for digestible phosphorus were adjusted for all animal categories, and guiding minimum recommendations were published for content of total phosphorus depending on the inclusion of phytase. The new recommendations are shown in table 3.

## Large environmental impact

The increasing use of phytase has significantly reduced the phosphorus content in pig manure, which means that in 2007 the spread of phosphorus measured as an average per ha/pig

farm dropped by 12 kg compared with 2000. This reduction was calculated at 1.4 livestock units per ha for an integrated pig farm with sows, weaners and finishers. The current phosphorus situation means that the pig industry meets the objective for phosphorus put forward in the Aquatic Environment Scheme III, and it is expected that the phosphorus content in manure will drop again next year as the feedstuff industry now typically adds double doses of phytase due to the high prices on phosphorus.

Table 3. Standards for digestible phosphorus and minimum level of total phosphorus at normal and double doses of phytase.

Dosis of phytase		Normal dosis, 500 FTU/750 FYT		Double dosis 1000 FTU/1500 FYT	
Diet	All	Meal	Pellets	Meal	Pellets
	Dig. P	Total P	Total P	Total P	Total P
Gestating sows, g/FUsow	2.0	3.6	3.8	3.4	3.4
Lactating sows, g/FUsow	2.7	4.6	4.7	4.3	4.3
Weaners, 9-30 kg, g/FUgp	3.1	5.1	5.2	4.9	4.9
Finishers, 30-105 kg, g/FUgp	2.4	4.1	4.3	3.9	3.9



# Feed – ammonia and odour

## Trial in climate chambers

A study of 14% and 17% crude protein in finisher feed was conducted in the climate chamber at Experimental Station Grønhøj. Both levels of protein were tested with and without the addition of 1% benzoic acid to the feed.

## Ammonia

Benzoic acid is approved in doses of up to 1% for reduction of ammonia emission from finishers. Generally, the ammonia emission from a pig facility drops by 1% per gram benzoic acid added per feed unit. Because of the energy level in finisher feed, the addition of 1% benzoic acid to the feed (10 g per kg feed) will typically correspond to 9 g benzoic acid per feed unit and will thereby reduce the ammonia emission by 9%.

The expected effect of benzoic acid on ammonia emissions is partly an antimicrobial effect and partly acidification of the urine. The antimicrobial effect is expected to have a positive effect on daily gain and the feed conversion ratio as benzoic acid restricts the micro organisms of the intestines, which reduces the loss of nutrients in the intestines. Urine is acidified when benzoic acid is absorbed in the small intestines and is discharged with the urine as hippuric acid. This will reduce the acidity of the urine, which may cause a drop in pH in the slurry.

The preliminary results from the trial show an average reduction in ammonia emission of 8.5% when benzoic acid is added to the feed, which corresponds with the expected effect of 9%.

The effect of benzoic acid was unaffected by the protein content of the feed (17% or 14%).

Daily gain and feed conversion ratio were recorded in the trial, but the trial was not designed to conclude on these production parameters. The effect on the production of adding 1% benzoic acid to finisher feed is currently being studied in a production herd.

As shown in figure 1, pH in the pigs'

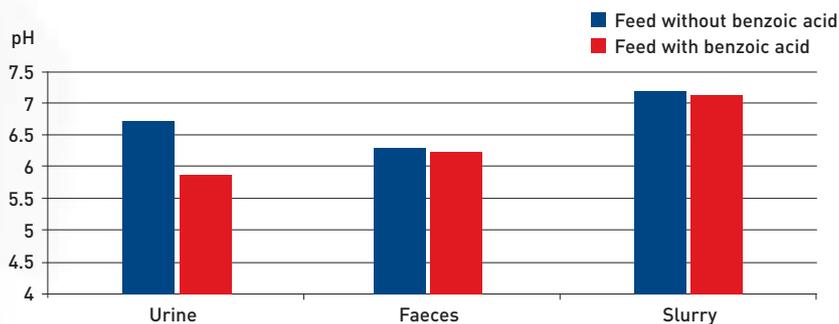


Figure 1. pH in urine, faecal samples and slurry samples.

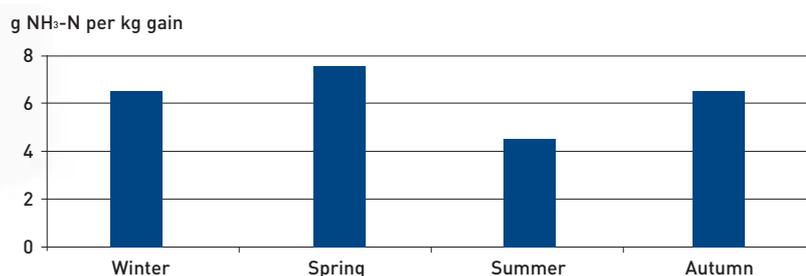


Figure 2. Ammonia emissions per kg gain in different seasons of the year.

urine dropped as expected, but a significant drop in pH in slurry was not observed. The trial was conducted in a section with fully drained floor and was repeated four times over a year. As shown in figure 2, the ammonia emission per kg gain was somewhat lower during the summer. The figure shows the ammonia emission per kg gain for the pigs given 17% crude protein without benzoic acid.

The seasonal influence on the ammonia emission was caused by the temperature and thereby the consumption of water, sprinkling and the amount of slurry, which affect the concentration of ammonium nitrogen and pH in the slurry.

## Odour

The aim of the trial was also to investigate whether the odour emission is affected by the reduced protein content or by the addition of benzoic acid.

The trial demonstrated, as did previous trials, that the odour emission is unaffected by a low protein level.

Benzoic acid is expected to affect odour emission because of the above-mentioned antimicrobial effect in the intestines. The antimicrobial effect is expected to reduce the production of

volatile odorants in the intestines and in the slurry.

The trial did not reveal a significant reduction in odour emission in the groups where 1% benzoic acid was added to the feed. Numerically, there was a small reduction, but it could not be documented that this difference was significant.

The trial in the climate chambers demonstrated that the addition of 1% benzoic acid had the expected effect on the ammonia emission from the chambers. However, it was not possible to demonstrate a significant reduction of the odour emission from the pigs given 1% benzoic acid in the feed.



Climate chambers at Grønhøj.

# Environmental approvals

## Environmental regulation

On January 1, 2007, the new environmental regulation of livestock farms commenced. All producers with livestock farms larger than 75 livestock units (LU) must obtain environmental approval if they wish to extend or modify their production.

For producers with livestock farms between 15 and 75 LU, a local approval will suffice.

## Status of environmental approvals

In 1 1/2 years, many municipalities have only managed to close 1-2 applications for environmental approvals, which is clearly unacceptable.

Below, the progress of the review process conducted by the municipalities is described:

- In 2007, 147 applications for environmental approvals were completed (approx. 2,000 applications were submitted).
- In the first six months of 2008, approx. 300 applications were completed, while approx. 2,200 are still in waiting, of which 1,200 have not even been looked at yet.
- Politically, it has been stated that min. 1,200 applications must be completed in 2008.

The long review process is attributed to several conditions:

1. The reform of the municipalities in which the entire responsibility was handed over from the counties to the municipalities.
2. It took approx. six months before the electronic application system was up and running.
3. Uncertainties in the interpretation of the guidelines sent to the municipalities. Many municipalities have chosen to draw up a supplementary administrative basis.
4. Many municipalities have allocated too few resources to handle the many applications.

Several political initiatives have been introduced to reduce the long review process. For instance, the trifle list of when to apply for environmental approval is expected to be extended. Furthermore, it is planned to collect part of the supplementary guidelines in an order.

## Many complaints

Many complaints have been submitted, particularly the Ecological Council and the Danish Society for Nature Conservation, as a result of uncertainties in the interpretation of the guidelines forwarded to the municipalities. By June 2008, the environmental complaints board had received 245 complaints. Of these, 130 were filed under the old scheme, while 115 were filed under the new Livestock Act. This means that complaints have been filed in 25% of the completed cases under the new Livestock Act. The many complaints further prolong the review process.

## Revised basis of livestock units

It was demonstrated that pigs excrete less nitrogen than assumed so far. As a result, the standard for livestock manure was slightly revised in 2007/08.

Consequently, the basis for calculating livestock units will also have to be revised.

This result is expected to be approx. 10% more finishers and close to 20% more weaners per livestock unit. Sow units will remain unchanged. One

### Facts: Livestock unit (LU)

One livestock unit equals 100 kg nitrogen from slurry tank or dung hill.

For pigs, the maximum limit per hectare is 1.4 LU, ie. a maximum spread of 140 kg nitrogen per hectare annually.

### Old calculation

For pigs, one livestock unit equals:

- 4.3 sows including weaners up to 7.2 kg
- 175 weaners from 7.2 kg to 30 kg
- 35 finishers from 30 to 102 kg.

### New calculation (estimated<sup>1</sup>)

For pigs, one livestock unit equals:

- 4.3 sows including weaners up to 7.3 kg
- Approx. 200 weaners from 7.3 kg to 32 kg
- Approx. 36 finishers from 32 to 107 kg.

<sup>1</sup> Note the revised weight limits.

problem that remains to be solved is how to handle the relatively larger phosphorus load from weaners, in particular, when spreading 1.4 livestock units per ha.

Throughout the autumn 2008, various solutions will be analysed, and revisions are expected to be effective from the manure season 2009/2010.

## BAT – a challenge

The definition of BAT (Best Available Technique) in the Livestock Act is found in the EU IPPC directive.

### Requirement for BAT documentation

The requirements for BAT documentation vary according to the size of the production unit.

### Livestock farms 15-75 livestock units

- No requirements for BAT documentation.

### Livestock farms 75-250 livestock units

- Documentation of the housing systems and environmental technologies described in BAT sheets.
- Documentation of the use of BAT in new as well as in existing facilities.
- Guarantee of compliance with general environmental requirements, for instance in relation to ammonia. Generally, reference to techniques will not suffice.
- Documentation of when renovation of the facility is expected so that the BAT requirements will be met if existing facilities do not comply with BAT.

### Livestock farms > 250 livestock units

Full BAT documentation includes minimum:

#### Management

- Description of management and control routines used for checking the environmental conditions of the production including the techniques used.

And BAT documentation of:

- Feed
- Design of facilities
- Consumption of water and energy
- Storage/treatment
- Spreading.

The BAT principle is based on the use of the most efficient technology within environment, working environment, energy consumption, economy, etc.



# Environmental approvals

However, BAT conditions do not imply the use of a specific technology environmental approval.

## Basis of BAT:

- **Best** = the technique that most efficiently protects the environment as a whole
- **Available** = balancing economic costs and advantages it must be possible to use it in the industrial sector
- **Technique** = evaluated from implementation to scrap.

The Danish Environmental Protection Agency has pointed out that the municipalities, as approval authority, decide on "minimum" and "maximum" for levels of, for instance, ammonia emissions.

## Interpretation of the Danish Environmental Protection Agency

*"If an applicant uses a technique that generates more pollution than "the best available technique", the local authority should make requirements for an emission that is level with "the best available technique" even if the technique used complies with the general level of protection."*

*"However, there must at all times be proportionality between the environmental effect and the costs of a BAT*

*requirement. The proportionality also applies to the size of the livestock farm as the costs for implementing the various technologies depend on the size of the farm."*

According to the published guidelines, the municipalities decide which technologies can be classified as BAT, and which cannot, based on individual evaluation of each application. The evaluation of whether a technology can be classified as BAT must also be based on an evaluation of the proportionality between the environmental impact and the costs.

The industry finds it unacceptable that the municipalities decide what is classified as BAT. This results in a highly uneven administration of the BAT requirements and it is, technically, very difficult for the individual authorities to evaluate what can be classified as BAT.

It is vital that:

- National standards for BAT be drawn up centrally (for instance in the form of BAT sheets).
- The evaluation of proportionality (economic availability) for when a technique can be classified as BAT takes place in a central body consisting of representatives from the authorities and the industry, and that this evaluation be incorporated in the BAT sheets.
- The evaluation of proportionality be built on an analyses of the economic sustainability and competitive situation of the individual branches.

In the autumn of 2008, the Ministry for the Environment initiated a pilot project on standardised BAT terms. Danish Agriculture participates in this work.

## Identical conditions

It is essential that a market for environmental technology be created outside Denmark if the increased requirements for, for instance, odour and ammonia loss are to drive the technology.

This market will only develop if other pig producing countries in the EU are subject to the same requirements as in Denmark for odour and ammonia. Otherwise, there will be no basis for export of environmental technologies. Instead, companies will lose interest in further developing cost-effective environmental technologies.

If the environmental requirements impose costs on the Danish pig industry that are significantly higher than those of our competitors, the result will be an increasing outsourcing of livestock production to other countries. This is seen in other industries as well.

Generally, Danish Pig Production does not see anything wrong with increased environmental requirements as long as they apply to our competitors as well.

It is therefore extremely important that the Danish authorities and politicians work for identical conditions in the EU.



*It is possible for modern pig production to blend in with nature.*

# Environmental technology

## Development is paramount

Danish Pig Production investigates and develops environmental technologies for reduction of ammonia and odour from livestock production. This takes place in close co-operation with companies, research institutes and pig producers, and is financially supported by EU funds and funds obtained via the Innovation Act under The Danish Food Industry Agency.

The following pages summarise the results of investigations of environmental technologies conducted in the last year. Please see the Annual Report 2007 for a general outline of the technologies available. The operating costs mentioned in this section concern the recorded consumption of water, electricity, and for some, acid, for running the technologies. Costs for service, replacement of filters, cleaning, interest and depreciation of the systems must therefore be added to the overall costs as it was not possible to determine these costs in the trials.

## BIO-REX Hartmann biofilter

BIO-REX Hartmann Technology stocks the German Hartmann biofilter, which is a horizontal surface filter consisting of modules. In Denmark, the product is called BIO-REX Hartmann. The filter material is approx. 90 cm thick and consists of approx. 60 cm wood slabs laid out crisscross. On top of these are approx. 30 cm of wood chips. The bottom 10 cm wood chips are impregnated with a patented mixture of enzymes and bacteria. On top of the biofilter, a sprinkling system is installed that is regulated by moisture sensors placed in the layer of wood chips.



The BIO-REX Hartmann biofilter.

Danish Pig Production tested the biofilter during the summer.

Measurements on the biofilter in a finisher facility revealed a reduction in odour and ammonia concentrations in the exhaust air. In the air before the biofilter, the odour concentration averaged 2,860 OU<sub>E</sub>/m<sup>3</sup> and was reduced to 575 OU<sub>E</sub>/m<sup>3</sup> after the biofilter. This is a 77% reduction in odour concentration through the biofilter. The ammonia concentration was reduced from 7.2 ppm before the biofilter to 2.6 ppm after the biofilter.

However, operating costs were high. Vast amounts of water for moistening of the biofilter and large variations in water consumption were recorded. The daily consumption of water averaged 2.41 m<sup>3</sup>, which was more than the expected 1 m<sup>3</sup>/day. The moisture control caused problems as the sensors in the biofilter were at times incapable of recording the actual moistness in the filter material. The pressure loss above the biofilter ranged from 180 to 260 Pa, which, combined with a high pressure loss in the duct leading to the filter, resulted in a large consumption of electricity. The consumption of electricity for ventilation in this trial amounted to 32.5 kWh per pig. In comparison, the annual amount of electricity used for ventilating a finisher facility without air purification averages 6 kWh per pig. As a result of the consumption of water and electricity, the total operating costs during the summer amounted to DKK 23.00 per produced pig. However, the electricity costs are likely to drop significantly if the air is led to the filter without significant pressure losses.

BIO-REX Technology ApS has continued optimising the control of the moistening system and the setup of the biofilter to reduce the pressure loss. Danish Pig Production has not yet tested the optimised setup, but will complete measurements once the company has demonstrated that the biofilter can run reliably over a long period of time.

## Bovema S-air

Danish Pig Production tested the Bovema S-air two-step air purifier in

a finisher facility for a year and in a weaner facility during the summer. The air purifiers are constructed as two-step systems: it is expected that one filter step reduces the odour concentration and the other reduces the ammonia concentration in the air. The test demonstrated that the Bovema S-air two-step purifier reduced the ammonia concentration by 96.9% in the finisher facility all year and by 98.7% in the weaner facility in the summer in the part of the air that was led through the air purifiers. However, neither of the studies revealed a significant effect on the reduction of odour in the air from the facilities. As a result, Farmtech A/S will only market the Bovema S-air as a one-step purifier, i.e. the Bovema S-air will only contain one filter element with sprinkling with a sulphuric acid solution.

Danish Pig Production has just completed a one-year trial of the Bovema S-air one-step purifier in a weaner



The Bovema S-air air purifier.

facility. The exhaust air from nine sections was collected in one joint air duct in the ceiling of the facility where the Dutch Bovema S-air was installed. The system was constructed as partial purification as the air purifier was dimensioned to purify approx. one third of the maximum ventilation capacity in the facility corresponding to approx. 60% of the air that was ventilated in the facility annually. If the ventilation need was greater than one third of the maximum ventilation capacity, which is often the case during warm periods, extra exhaust

# Environmental technology

units were switched on and the outlet air was thereby not purified.

Over the year, the ammonia concentration in the air from the weaner facility averaged 4.0 ppm. More than 99% of the ammonia was eliminated from the part of the air that purified. The filter element was blocked by dust in the air from the facility. The filter element was therefore disinfected with a high-pressure cleaner once a month to ensure optimum passage through the air purifier. This took 10-20 minutes. pH was read on the control board of the purifier and was compared with pH measured directly in the sump with an external pH meter, and the measurements showed that pH in the sump varied from the pH read on the control board. The pH meter of the air purifier was replaced twice during the trial due to defects. The addition of acid to the air purifier was regulated according to the pH value recorded in the sump. In this connection, and thereby in relation to the operating costs, it is crucial that the pH meter in the air purifier is calibrated and that the calibration is checked regularly with an external pH meter.

The Bovema S-air uses sulphuric acid, water and electricity. The operating costs amounted to DKK 3 per produced weaner provided that electricity costs DKK 0.75 per kWh, acid DKK 5.80 per litre and water DKK 3.50 per m<sup>3</sup>. In a weaner facility without air purification, an average of 2 kWh is required per produced pig to ventilate the facility. The actual operating costs of the air purifier are found by deducting the average costs for ventilating a weaner facility without air purification; in the current trial the actual costs amounted to DKK 1.50 per produced weaner. To this, interest and depreciation of the air purifier must be added as must costs for regular washing of the filter element, service and maintenance. In comparison, the operating costs of the Bovema S-air two-step purifier in the finisher facility amounted to DKK 6 per produced pig.

## ScanAirclean central air purifier

ScanAirclean A/S central air purifier from the Dutch company INNO+ was

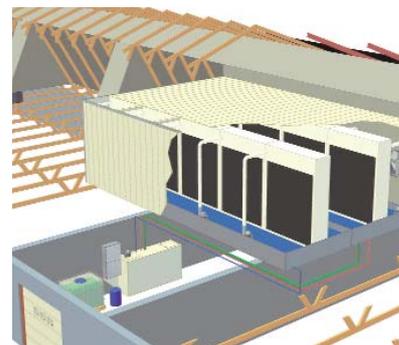
studied in a facility with weaners, gilts and boars. The air purifier consists of two steps with plastic elements as filter materials. In the first step, sulphuric acid mixed at pH 2.2 is recirculated to reduce the ammonia concentration in the air from the facility. In the second step, a cleaning fluid is recirculated primarily to reduce the odour concentration. Measurements revealed a 97.3% reduction in ammonia concentration in the air in the summer. However, no odour reduction was recorded in the summer from leading the air through the purifier. The annual ammonia reduction and operating costs are now being measured under this air purifier.

## Heating/cooling the ventilation air

An earth cooling/heating system was established in a farrowing facility to temperate the ventilation air. The ventilation air is cooled in the summer to reduce the ventilation output, which is also expected to reduce the odour emission. The system heats the ventilation air in the winter, which facilitates ventilation at a higher air speed and thereby improves the air quality in the facility.

The cooling/heating system is established in three out of six sections in a farrowing facility with diffuse ventilation and insulated roof. The three remaining sections function as control sections and are traditionally ventilated. In the three trial sections, the opening to the eaves is closed, which means that all inlet air passes a heat exchanger established at the end wall of the facility. The cooling/heating exchanger is connected with 8 km of plastic hoses placed 4 m underground in an adjacent field. There are four parallel tubes in the ground, i.e. the total length is 2 km. In the summer, the cooled water in the hoses releases heat to the ground, and in the winter heat is absorbed. The temperature in the air intake to the facility is expected to vary between +8° and +18° all year as opposed to between -10° and +27° in a traditionally ventilated facility.

The system is expensive to establish, but the costs for ventilation and heating are expected to be signifi-



ScanAirclean central air purifier from the Dutch company INNO+.

cantly reduced. Danish Pig Production is now clarifying the technical abilities of the system – also in relation to reduction of odour emissions.

## Treatment of slurry with ozone

In co-operation with the company BioAqua A/S, Danish Pig Production studied a trial system for treatment of slurry with ozone. The trial was conducted in two climate chambers at Experimental Station Grønhøj. The climate chambers were identically designed with two traditional finisher pens and 32 finishers in each chamber. The slurry from one chamber was manually emptied into a tank once a week where the heavy fraction sedimented. The thin fraction was subsequently emptied into a container and treated with ozone. During this treatment, the slurry fractionated further, and the thin, relatively clear and odour-free fraction was returned to the facility while the rest was transferred to manure storage. The treated slurry was returned to the facility to dilute the slurry produced until the next treatment and thereby reduce the odour from the slurry. Furthermore, it was ensured that a sufficient amount of slurry was available in the facility to properly empty the facility during the subsequent treatment.

To compare the effect of slurry treatment with traditional slurry handling, the slurry from the other climate chamber was emptied manually 1-2 times during the production process (approx. 30-100 kg) depending on sea-

son and the consumption of water, and when the pigs had been delivered for slaughter.

Odour and ammonia emissions from the two climate chambers were recorded the day after the slurry was treated with ozone in one chamber. Analyses made during two batches of finishers in the spring and summer 2007 demonstrated that the average odour emission dropped from 490 OUE/sec. per 1,000 kg animal from the control chamber to 240 OUE/sec. per 1,000 kg animal from the climate chamber with treated slurry. The slurry treatment did not increase the ammonia emission from the facility despite a slight increase in pH in the treated slurry.

**Treatment of slurry with ozone and polymer**

Parallel with the above investigation, lab trials revealed that the thin fraction split into further fractions when a polymer known from waste water treatment was added to the slurry treated with ozone. An identical trial was therefore conducted in the two climate chambers at Grønhøj where poly-

mer is added during treatment of the slurry in the trial system.

Measurements made of the last batch 1-4 days after treatment in the winter 2008 revealed a drop in the average odour emission from 320 OUE/sec. per 1,000 kg animal from the control chamber to 180 OUE/sec. per 1,000 kg animal from the climate chamber with treated slurry. pH increased slightly in the slurry during the treatment. Nevertheless, the ammonia emission from the facility was reduced from 0.334 g NH<sub>3</sub>-N/hour per pig from the control chamber to 0.198 g NH<sub>3</sub>-N/hour per pig from the trial chamber measured over two batches of finishers in the period October 2007-March 2008.

**The SmellFIGHTER**

In co-operation with BioAqua, the company Infarm A/S, also known for the slurry acidification system "NH4+", has developed a system that combines odour reduction from treatment of slurry with ozone and polymer with ammonia reduction via acidification of slurry with sulphuric acid. This is called the "SmellFIGHTER".

Since April 2008, Danish Pig Production has been running a small-scale test of this system in the climate chambers at Grønhøj. In the summer 2008, a full-scale investigation was initiated of the SmellFIGHTER in a finisher herd.

Measurements of the summer 2008 were not finished at the time of writing, but experience from the commercial herd revealed that detailed knowledge of the slurry system in a facility is absolutely essential when installing a slurry treatment system in an existing facility.



The SmellFIGHTER from Infarm A/S.

**Ammonia and odour reductions and operating costs related to air purification systems.**

	SKOV A/S Farm Air Clean DA		BIO-REX Hartmann biofilter	Bovema S-air one-step purifier	Bovema S-air two-step purifier	ScanAirclean central air purifier	
Facility	Finishers	Weaners	Finishers	Weaners	Weaners	Finishers	Finishers
% of facility exhaust air purified over the year	100 %	60 %	100 %	60 %	60 %	60 %	100 %
Period of measurement	1 year	Summer	Summer	1 year	Summer	1 year	Summer
Ammonia reduction through purifier	Summer: 50-60 pct. Winter: 75-85 pct.	65 %	65 %	99.4 %	98.7 %	96.9 %	97.3 %
Concentration before	4.1-9.0 ppm (1.2-2.4 ppm after filter)	2.6 ppm	7.2 ppm	4.0 ppm	2.1 ppm	10.2 ppm	7.5 ppm
Odour reduction through purifier	Summer: 30 % Winter: 50 %	30 %	77 %	No odour reduction	No odour reduction	No odour reduction	No odour reduction
Concentration before	600 OUE/m <sup>3</sup>	1.280 OUE/m <sup>3</sup>	2.860 OUE/m <sup>3</sup>				
Operating costs (water, electricity, acid)	DKK 6.00 /prod. pig	Not calculated	DKK 23.00/prod. pig	DKK 1.50 /prod. weaner	Not calculated	DKK 6.00 /prod. pig	Not calculated



## Pig facility with source separation

In co-operation with Aarhus University, the Faculty of Life Sciences, a newly developed floor with source separation was studied where the manure is separated into a solid fraction and a liquid fraction. The concrete element was developed by Perstrup Betonindustri A/S and was combined with a wire cleaner with a special scraper from Skiold Mullerup.

The aim was to evaluate the efficiency of the separation of manure and urine and to evaluate the efficiency of the under-floor air evacuation.

The trial was conducted in a new pig facility with approx. 800 place units divided between a control facility and a trial facility with source separation. Under-floor air evacuation was established in both control and trial sections.

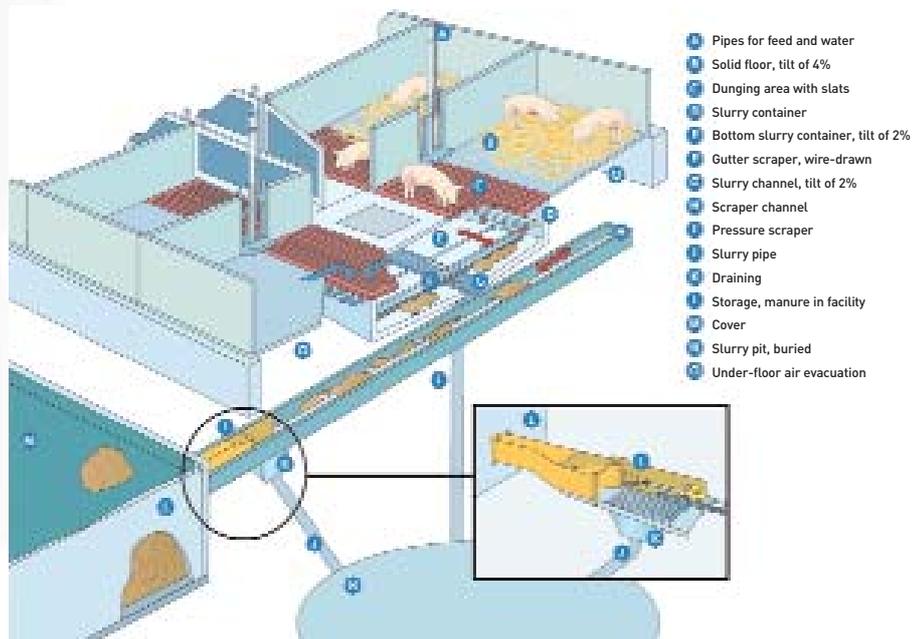
## Results of the separation

A high separation efficiency was obtained of 69% total nitrogen and 95% phosphorus in the solid fraction, respectively. However, the separation was not satisfactory as more than half of the manure followed the solid fraction. A significant reduction in the amount of the solid fraction is required for source separation to be practical and economically realistic.

No differences were measured in ammonia concentration and emission between the control facility and the trial facility. There were no differences in odour concentration in the facility between the two systems. However, the odour concentration was significantly higher in the under-floor air evacuation than from the control facility ( $P=0.011$ ). As a result, the overall odour emission was 16% higher from the facility with source separation than from the control facility ( $P<0.05$ ).

## Results of under-floor air evacuation

In both the control facility and the trial facility, the level of particularly ammonia and partly also odour inside the facility was very low due to a highly efficient under-floor air evacuation. The ammonia concentration in the

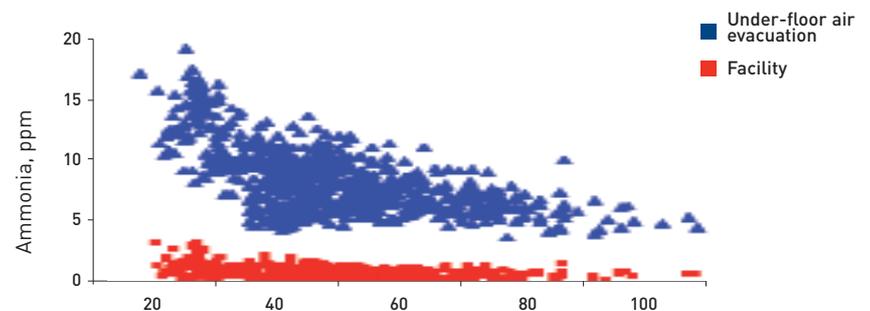


*Drawing of a facility with source separation designed with two-thirds solid floor, diffuse air intake and exhaust through under-floor air evacuation and ceiling exhaust, approx. 65% and 35%, respectively, of max. ventilation capacity.*

under-floor air evacuation was more than a factor 10 higher than in the room, while the odour concentration was a factor 1.5 and 1.9 higher, respectively, in the control facility and the source separation facility ( $P<0.001$ ). The ammonia concentration in the facility averaged less than 0.5 ppm in both the control facility and the source separation facility, which is very low.

Under-floor air evacuation holds some interesting possibilities in relation to partial purification of ventila-

tion air. Varying degrees of under-floor air evacuation combined with different floor types are currently being studied.



*The under-floor air evacuation efficiently eliminated ammonia through the under-floor duct and maintained a very low concentration in the facility – also during the winter where ventilation rate is low.*



# Partial purification and central exhaust ducts

## Partial purification may be a good idea

It is expensive to establish air purification if the intention is to lead all the air in a facility through an air purifier. When a producer applies for an environmental authorisation, he can decide to purify the part of the air that is extracted to reduce ammonia emissions. This may be a good idea to get the most air purification for his money.

## 60% of the air is purified

The ventilation output depends on the temperature outside. The maximum exhaust capacity is dimensioned to summer conditions. In a finisher facility, 100-120 m<sup>3</sup> air/hour is normally available per animal. This corresponds to a temperature in the facility of 24-25°C during outdoor temperatures of 20°C. During nights and cold weather when outdoor temperatures drop, the need for ventilation is much lower. In the winter, the ventilation need is often below 15 m<sup>3</sup>/hour per finisher, and the ventilation system only works at 100% performance in 15% of the time during the year. In the magazine "Grøn Viden", published by the Faculty of Life Sciences, it was calculated that if 15% of the maximum exhaust capacity is purified with an air purifier that eliminates 95% of the ammonia, the annual ammonia emissions will drop by approx. 60%.

## Correct operation

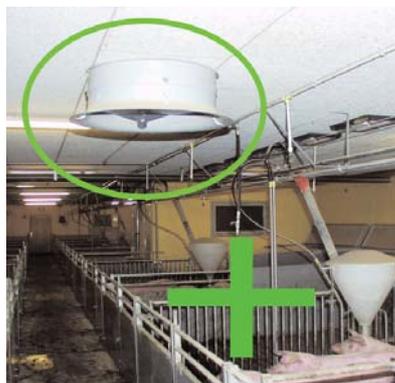
When the first air purification systems were established, the air ducts were dimensioned to lead all the air from the facility through the ducts.



Partial purification established incorrectly.

The air was firstly led through the air purifier. When the ventilation requirement exceeded the capacity of the purifier, the excess air was led from the air duct around the air purifier. Measurements have demonstrated that these systems are very difficult to operate.

The size of the air ducts is therefore now reduced under partial purification to match the amount of air to be purified. Extra exhaust capacity is established directly from the individual housing sections. Experience with these types of systems has demonstrated that they are easy to operate, and that the operating principle largely corresponds to the principle



Good solution for partial purification.

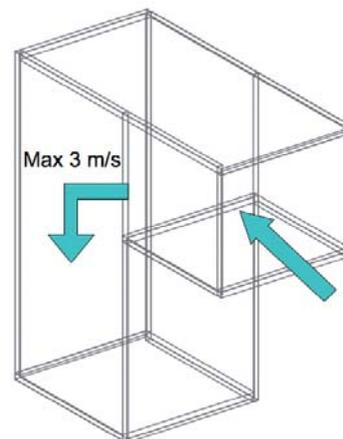
principles used in facilities without air purification.

## Smaller ducts

If 15% of the maximum exhaust capacity is purified, the air ducts can be reduced in size accordingly. This makes it easier to integrate both the duct system and the air purification system into the facility without negatively affecting the air quality down in the pens. The requirement for smaller ducts also makes it possible to establish the air ducts as under-floor air evacuation ducts without significant building costs. Experience has shown that the most reliable air purification system is achieved by constructing the systems in such a way that the air to be purified is collected and then led to the air purifier. The remaining air is extracted directly from the individual sections.

## Three meters/second

The pressure loss in the air ducts increases when the air speed in the ducts increases, and the energy consumption for the ventilators is increased if they must work hard to get the air through the ducts. The output of



Duct with max. speed.

the ventilators is reduced when the pressure loss increases.

To limit the overall pressure loss, the cross-sectional area of the air ducts must be large enough in all passages to prevent the air speed from exceeding 3 m/second. Measurements from active systems revealed that when the air speed is kept below approx. 3 m/second, an overall pressure loss of 45-50 Pa is expected through a normally dimensioned diffuse air intake and a duct system with under-floor air evacuation. This fairly modest pressure loss in the duct system makes it possible to attach an air purifier with a corresponding pressure loss without jeopardizing the overall capacity of the system and without having an unrealistically high consumption of energy.

## Alarms and emergency ventilation

Alarm systems and emergency ventilation are extremely important when duct systems and air purification systems are established. It is therefore essential to incorporate routines to regularly check the alarm systems.



# Lactating sows

## Farrowing pens are changing

The increasing litter size has made it even more necessary to make the most of the potential of sows and piglets for productivity, and this must go hand in hand with good welfare and safe working conditions for sow, piglets and staff. Danish Pig Production is therefore engaged in the development of farrowing pens where the sow is housed in a crate and farrowing pens for loose sows.

## Sow in crate

The traditional farrowing pen where the sow is housed in a crate has become bigger over the years as the sows have grown bigger and litter size has increased. This is also the case for the crate and the creep area. However, the farrowing pen still needs to be improved in a number of ways. The only way for efficiency to keep up with the current potential for number of weaned pigs and weaning weight is to continuously improve the farrowing pen. The high level of productivity must not jeopardise the welfare of the sow. Future development must therefore result in the best possible conditions for the sow in the crate.

As part of the development activities of farrowing pens, research and development activities have been initiated on floor design. One of the primary aims is the prevention of shoulder ulcers. Most activities related to flooring are presented in the section concerning shoulder ulcers in this report.

The work takes place in close dialogue with producers of farrowing pens and producers of equipment for farrowing pens. The aim is to ensure further development of the pens and that this development is based on the latest know-how. New ideas for pen concept are also brought into the work, such as:

- Two-piece (or two) covered creep area(s)
- "Solid wall" in part of the crate, which may be completely different from the design we know today
- More room for nursing
- Different design of the pen.

"Lactation width" is an important pen measurement that was not previously



*New floor profiles must be developed for farrowing pens to combine hygiene and solid floor under sow and piglets. This picture from a trial shows a pen with partially slatted floor with drain in the pen side opposite the creep area.*



*To utilise the growth potential of the pigs, there must be plenty of room for nursing. As in this picture, the pen should measure min. 127 cm from the sow's back to the pen side opposite the creep area.*

included in the recommendations. This is the space occupied by the sow when she lies down and the piglets when they nurse, which is min. 127 cm.

Both sow and piglets need to have solid floor beneath them. Many pig producers decide not to use traditional pens with partially slatted floor due to the risk of a low level of hygiene on the solid floor. The development of solid flooring is based on, among other things, the desire for obtaining a good level of pen hygiene.

## Nesting material

Two different amounts of straw used as nesting material were studied in farrowing pens with partially slatted floor and the sows housed in crates. The aim was to establish whether the amount of material affected the percentage of stillborn piglets and complicated and prolonged farrowing courses. This was studied in two herds and comprised 663 farrowings.

## The study comprised two groups

Group 1: 100 g straw a day from transfer to farrowing pen until end of farrowing.

Group 2: 100 g straw a day from transfer to farrowing pen until day 114 of gestation. From day 115 until end of farrowing, 1,000 g straw was given a day.

The percentage of stillborn and LP5 – live piglets on day 5 – was not significantly different between the groups in either of the herds. Nor were there any differences between the groups in duration of farrowing, obstetric aid or treatments for M.M.A. A correlation was observed between the use of obstetric aid and treatments for M.M.A.

It is recommended to supply min. 100 g nesting material a day from the animals are transferred to the farrowing facility. Nesting primarily takes place the last day before farrowing, and the amount given should therefore be adjusted to the sows' need to ensure that material is available. Particularly the day before expected farrowing and until the end of farrowing, the amount should be increased to ensure that material is available at all times.

### Pens for loose lactating sows

How should farrowing pens for loose lactating sows be designed? The easy answer is: according to the users of the pen, ie. sows, piglets and staff. However, it is not quite that simple as sows, piglets and staff have many, very different, requirements.

In a project made in co-operation with Aarhus University and Copenhagen University and the Danish Animal Welfare Society, the function of different types of pens for loose farrowing and lactating sows was studied at Research Centre Foulum. The project established the following requirements for the pen design:

The sows must always have minimum one pen wall to lie against as that reduces the risk of crushing the piglets.



*Sow in farrowing pen with tilted lying walls and floor heating under the place of farrowing.*

Sows measure up to 2 m, and the pen side must therefore be minimum 2 m long plus have room for movement.

The piglets stay close to the sow in the first days after farrowing and are thereby at risk of being crushed if the sow is agitated. It may be an advantage to have a "crate" that restricts the movements of the sow in the period around farrowing, for instance. However, no studies have documented that this reduces piglet mortality.

It is essential to meet the piglets' requirements to the immediate environment - and in Danish legislation - that all piglets be able to lie down at



*Pen in which the sow can divide the area into zones.*

the same time on the solid floor also towards the end of nursing. It must be expected that the sows will have litters of 14-16 piglets and a lactation period of 26/33 days in the future. The pen must have solid floor to enable all piglets as a minimum to lie on the solid floor at the same time.

The solid floor must also ensure that the nesting material stays in the pen and that the sow can lie on an even floor - and at the same have a high level of hygiene.

Age, weeks	2	3	4
	Area m <sup>2</sup>		
Prone position	0.7	0.8	1.0
Lateral position	1.1	1.3	1.5

*Space taken up by 14 piglets depending of age. The pigs must be able to lie on the solid floor at the same time.*

Safety in the daily tasks, easy handling of sows and piglets, and tasks such as adjusting feed dose etc. are essential for the staff. The pens must be easy to clean with minimum amount of labour involved, and in general, it must be possible to rationally and quickly perform the necessary work routines.

### Development in production herd

On the basis of the results from the above research and experience from practice, DPP together with producers of pen equipment and a series of pig producers have designed a number of farrowing pens for loose sows and are testing these in several herds. The primary areas of interest are pens divided into zones, pens with reduced space, and pens where a crate is used for a limited period of time.

The point of departure is that the sows are housed loose from transfer until weaning as a crate - even for a limited time - will restrict the sows' movement and result in extra labour for the staff.

### Division into zones in pens for loose sows

Experiences are analysed in 3-4 herds with pens in which the sows are loose from transfer until weaning. The pen design allows the sows to divide the pen into zones for resting, activity and dunging. This results in a space requirement of 6-7 m<sup>2</sup> or more per pen.

The advantage of dividing a pen into zones with solid floor and with slatted/drained floor is that floor heating can be installed at the expected place of farrowing, which has been demon-



# Lactating sows

strated to increase the survival of the piglets. It is also a good idea to establish more tilted lying walls as it has been shown that if the sows are supported when they lie down, piglet mortality drops.

It is quite a challenge to maintain a high level of hygiene on the solid floor when the pens have zones with solid floor and slatted floor – and the sows are loose.

In pens of this size, the staff is unable to reach into the entire pen from the inspection alley, and it would therefore be an advantage if the equipment could restrict the area available for the sow to enable the staff to work safely in the remaining part of the pen.

### Pens with reduced space

Experiences are also analysed from 3-4 herds with pens in which the sows are housed loose from transfer to weaning, but in which the available area does not differ significantly from that of farrowing pens with sows in crates.

Compared with, for instance, pens with crates, this concept has the advantage that the sows are loose before, during and after farrowing,

which allows them to turn around and decide where to lie down. However, the fairly limited space available makes it difficult for the sow to divide the pen into zones for, for instance, resting, activity and dunging due to her size.

If the pens measure, for instance, 2 m x 3 m and the sows are approx. 2 m long and are able to turn around in the pen as they desire, a large percentage slatted/drain floor is required to have a high level of hygiene. As a result, the area with solid floor will be reduced and this will reduce the possibilities for floor heating in the place of farrowing, which has been shown to reduce piglet mortality.

A significant percentage slatted/drain floor also makes it more difficult to supply nesting material, which has also been known to reduce piglet mortality in farrowing pens with loose sows. The supply of rooting and enrichment materials is also made more difficult.

### Pens with crate and loose housing

Many pig producers acknowledge the great potential of loose sows in the farrowing facility, but they would like



*Farrowing pen in which the sow's movement can be restricted with a crate.*

to be able to keep the sows in crates around farrowing when the risk of crushing the piglets is greatest. It is then important to know for how long to house the sows in crates before it reduces piglet mortality.

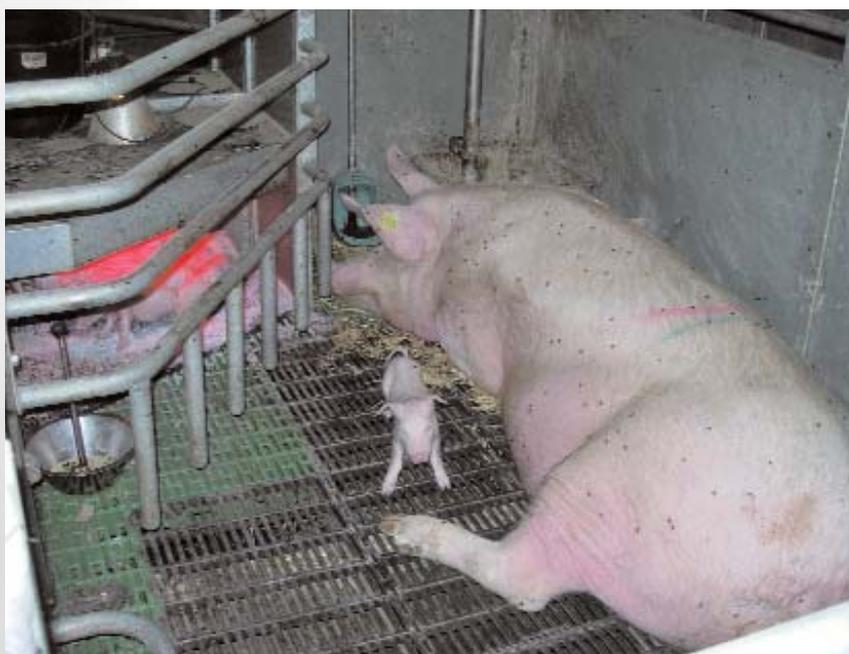
Danish Pig Production is therefore studying the use of crates before or after farrowing and the use of crates until day 4 or 7 after farrowing.

### Co-operation on development

The development of farrowing pens for loose sows takes place in close co-operation with both national and foreign research institutes, the Danish Animal Welfare Society, the equipment industry and pig producers.

For instance, Danish Pig Production is participating in a project under the Innovation Act on development of farrowing facilities for loose sows. Danish Pig Production is also participating in a project under the Danish National Advanced Technology Foundation concerning the Intelligent Farrowing Pen.

Inspiration and experiences are also obtained abroad. Aarhus University and Danish Pig Production held a seminar with participation of scientists from Switzerland, Austria, UK, Norway and Sweden. These are all countries with widespread use of farrowing pens for loose sows, but where herd structures and cost levels cannot be compared with those in Denmark. Countries with a pig production corresponding to the Danish do not have focus on design of farrowing pens for loose sows.



*Sow in farrowing pen measuring approx. 1.8 m x 2.8 m.*

# Solid floor with no mess

## Clean pens all year

Ammonia and odour emissions are lower from finisher pens with solid floor than from pens with slurry channels under the entire pen - provided that the solid floor is kept clean all year. In a current project, researchers are looking for ways to reduce mess on solid floors.

## Cause of mess

Weaners and finishers in growth need to get rid of a lot of heat due to a feed intake that is typically three times as high as pigs' maintenance requirement. However, pigs are unable to perspire and will instead wallow to get rid of the heat. For weaners up to 30 kg, wallowing behaviour begins when housing temperatures reach 24-26 °C, and it will usually be possible to keep the solid floor clean. However, large finishers start wallowing at 20 °C, and it requires more work of the climate control to keep solid floors clean.

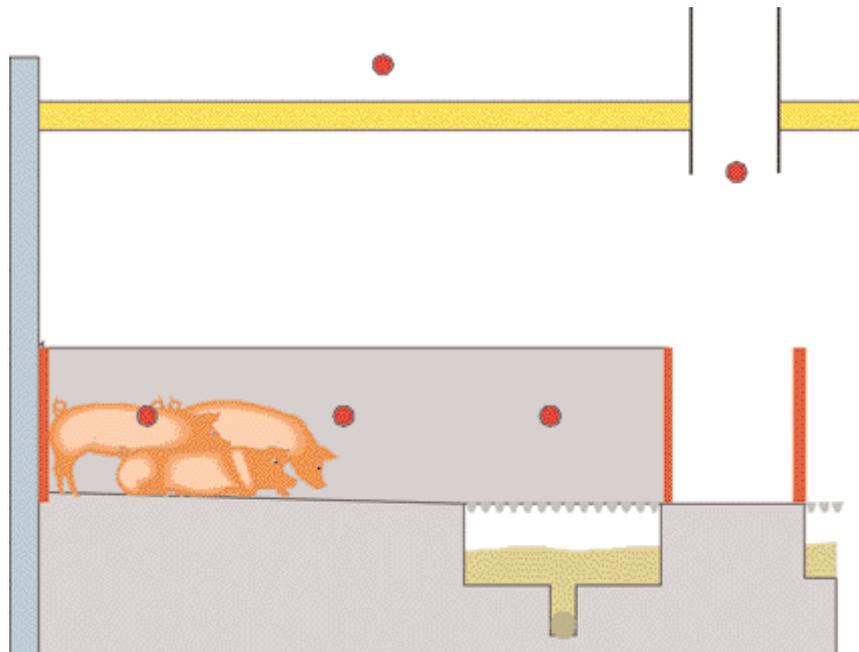
## Reduction of mess

Previous trials and climate studies have demonstrated that there are several ways to prevent mess in the daily climate control. This is also confirmed by the large variations between herd where the same types of pens are clean in one herd and dirty in another.

The temperature strategy is an essential factor. The temperature must be lowered if the pigs seem too warm and start moving away from the solid floor. The temperature can be reduced until max. ventilation capacity is obtained. It is important to ensure that the ventilation capacity is correct, ie. the housing temperature must not exceed the outdoor temperature by more than four degrees at an outdoor temperature of 20°C. Subsequently, sprinkling frequency must be increased. Furthermore, the air speed should be increased if possible with the ventilation system.

## Ventilation efficiency

Measurements have shown that there is often a low air change rate in the pigs' activity zone, which results in a warmer and more humid air than the air that leaves the facility via the



To analyse the efficiency of air exchange in the pigs' activity area, the carbon dioxide concentration in the activity area is compared with the concentration in the exhaust air. Supplementary air intake, ceiling fans, under-floor air evacuation, open pen partitions etc. may improve the air exchange. The red dots denote the points of measurements.

exhaust units. In such cases, the ventilation efficiency is inadequate as the ventilation inefficiently eliminates the heat production of the pigs.

The ventilation efficiency is analysed by measuring the carbon dioxide concentration because the pigs' excretion of carbon dioxide is a direct expression of their heat production.

The ventilation efficiency in the pigs' activity area was measured with a new instrument, with which the carbon dioxide concentration is measured in three places in the pen (lying area, activity area and dunging area), and the measurements are then compared with the concentration in the exhaust air and the air outside.

Measurements made in finisher facilities with diffuse air intake have shown a very clear gradient: the concentration in the lying area is twice as high - relatively seen - compared with the concentration in the dunging area.

Several methods for improving the ventilation efficiency in the pigs' activity area are being studied; supple-

ppm	Without	With
Exhaust	199	189
Dunging area	286	267
Activity area	387	211
Lying area	530	360

Measurements of the carbon dioxide concentration adjusted for outdoor concentration made in July-August 2008 in a diffusely ventilated finisher facility with and without supplementary air intake. Housing temperature was above 22 °C.

mentary air intake via ceiling inlets, mixing the air with ceiling fans and air directly into the pen. As expected, supplementary air intake via ceiling inlets improved the air change in the activity area compared with a control section.

The temperature strategy in the trial herd ranged between 16 °C and 19 °C and the supplementary air intake was activated at an excess temperature of +4 °C.



# Weaner and finisher facilities

## Surface treatment of floors

For the last three years, Danish Pig Production and Danish Agricultural Service have studied the durability of the floors in a WTF facility after the floors were treated with three different surface treatment products:

- Sealing products such as epoxy coating and wearing surface mortar
- Fluolate products that react chemically with the free chalk in the concrete
- Impregnation products based on epoxy and acrylic mixed with a solvent

The best protection of the floor was obtained with epoxy-based sealing products. The products must be mixed with arenaceous quartz or Dynagrip to make the floor sufficiently non-skid. Dynagrip is a hard rock crystal that is probably more hard-wearing than arenaceous quartz. The combination with Dynagrip enhances the durability and keeps the floor non-skid for a longer period of time than arenaceous quartz, which wears faster.

To reduce feed waste and corrosion of the floor, a plate is placed on the floor off the feeder. Corrosion was primarily observed along the edges of this plate and around base fittings and nipple drinkers.

The pigs' leg health was recorded when the trial started and when they weighed 25-30 kg. The leg health was good and differences in leg health were not observed regardless of the product used for surface treatment.

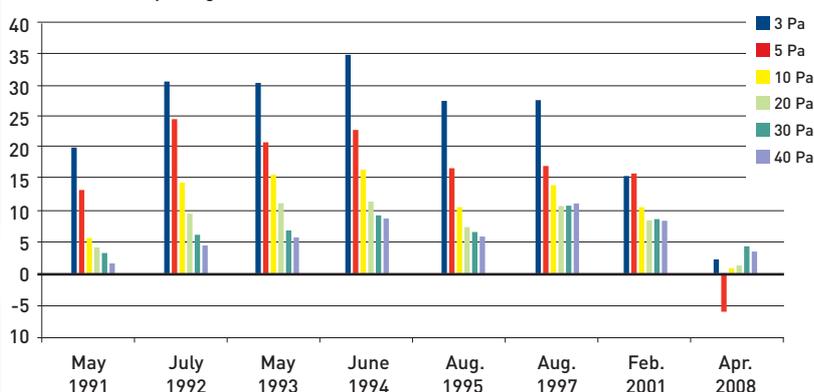
### FT-30

For the last year, Danish Pig Production has followed a herd where



*Corrosion of slatted floor in a pen floor treated with an impregnation product.*

Reduction in air passage, %



*Percentage reduction of air passage compared with new insulant measured over 18 years.*

the pigs are weaned in litters in the farrowing pen. The production results were compared with the production results of a traditional weaner pen where the pigs were mixed and randomly accommodated in pens. Contrary to expectation, no positive effect was observed of housing the pigs in litters. One reason for this may be that the trial was conducted in a herd with SPF health status.

It was also expected that this type of accommodation would save labour as the pigs were not moved in connection with weaning nor was it necessary to wash the pen when it was changed from farrowing pen into weaner pen. However, this was not the case as the time spent on cleaning the pen and the work related to changing the pen from farrowing pen to weaner pen was longer than what was saved by not having to move the pigs.

Despite 70 cm high pen sides, several pigs jumped over the pen partitions using the horizontal pipes as "lad-



*Quite a lot of work is involved in changing a pen from farrowing pen into weaner pen.*

ders". Accommodating weaners in the farrowing pen furthermore wears the equipment. Particularly the covered creep areas are vulnerable when pigs jump on top of them, and they are not expected to last as long as when the pen is only used as farrowing pen.

### Passage of air

To ensure optimum ventilation and to avoid an unnecessarily high consumption of energy, it is important that the air can still pass through the mineral wool used as insulant in facilities with diffuse ventilation. For 18 years, Danish Pig Production has therefore routinely studied the passage of air when glass wool is used as insulant in a finisher facility.

The first years, the penetration was gradually reduced and then it stabilised. Pressure-stable ventilators are capable of compensating for this by working at a higher negative pressure.

Based on these results, it must be expected that glass wool can last for many years as insulant in facilities with diffuse ventilation. The durability depends on the amount of dust in the inlet air, on the risk of contamination with feed or feed dust and on whether the material is form-stable.

# Animal welfare

## Welfare audits

Welfare standards on Danish pig farms are definitely moving in the right direction according to reports of the welfare inspections carried out in 2006 and 2007 under the control of the Danish Veterinary and Food Administration. The authorities carried out 611 audits during 2006 and a further 596 in 2007. The inspections are carried out in 5% of all pig farms in Denmark with more than ten animals.

The total of all non-compliances fell from 996 in 2006 to 537 in 2007, and the number of reports made to the local police fell from 129 in 2006 to 37 in 2007. The main reasons were fewer sows found with shoulder ulcers, fewer cases of insufficient soft bedding in hospital pens and inadequate supply of rooting and enrichment materials. However, these matters are still an issue on a significant number of farms and will continue to receive focus in the coming year.

In 2006, 270 producers demonstrated full compliance with the required standards, representing 44% of all audits. In 2007, 328 producers demonstrated full compliance, representing 57% of all audits carried out.

## Evaluation of the current legislation

Danish Pig Production participates in a working group under the Danish Ministry of Justice, reviewing all aspects of pig husbandry.

The first task of the group was to evaluate the current legislation on rooting and enrichment material. As a result of this work, basic studies will be initiated at the Faculty of

Agricultural Sciences, Aarhus University, to establish how much straw is necessary to enable finishers to satisfy their requirement for rooting and foraging. This will be measured on the basis of the observed frequency of abnormal behaviour directed towards pen mates with differing amounts of straw.

The group is also reviewing a number of other issues:

- Weaning age
- Loose lactating sows
- Pen dimensions

## Self-Auditing

The formal notification from the Danish Veterinary and Food Administration regarding the implementation of the self-audit programme has not yet been published. Self-auditing procedures for animal welfare are therefore expected to be implemented in Danish herds during 2009.

## Large production units

It will be possible to establish pig production up to 950 livestock units (LUs) providing a series of stricter requirements are met, including those applying to the welfare of the pigs.

Sow producers wishing to extend their production up to 950 LUs must comply with "The Act for Indoor Housing of Gestating Sows and Gilts" from January 1, 2010, including all requirements for loose housing. Finisher producers must comply with "The Act for Indoor Housing of Weaners, Breeding Stock and Finishers" from the same date, including all the requirements for solid and drained flooring.

## DANISH Product Standard

A new DANISH Product Standard was introduced more than a year ago. Currently, more than 2,500 pig producers have received an independent audit. At least 30% of all Danish pig herds will receive an inspection every year.

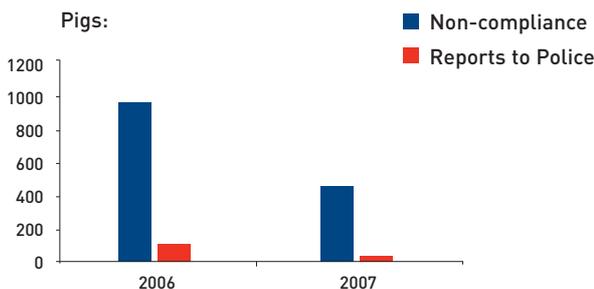
The results from the audits already undertaken reveal that conditions in the herds are generally good, but there is still room for improvement in a number of key areas. This particularly applies to the use of traceable needles, the correct recording of pig supply contracts, the provision of rooting and enrichment materials and design of hospital pens.

It is therefore essential that all areas of the production are inspected routinely to ensure that statutory requirements are being met.

## Advantage of DANISH certification

DANISH certification is proof that the Product Standard is being met as well as providing a guarantee for the future export of DANISH pork or supply of live pigs to the large German market. DANISH certification also provides a secure basis for upholding the reputation of the Danish pig industry.

The audit also provides valuable preparation for other welfare inspections carried out by the regional authorities. The DANISH certification audit also includes 26 standards necessary to fulfil the requirements for official cross-compliance. However, a successful DANISH certification does not in itself provide a guarantee of full compliance with an audit subsequently carried out by the regional authority.



A significant reduction in non-compliances and reports made to the local police occurred in the official inspection programme carried out in 2007.



# Suitability for transport

## Focus

Over the last years, focus has increased on the transport of live animal including on evaluations of whether an animal is suitable for transport. Evaluation of whether an animal is suitable for transport is regulated in several pieces of legislation. Primarily in the Animal Protection Act §1 stipulating that animals must be treated responsibly and be given the best protection possible against pain, suffering, fear, permanent injury and significant discomfort. Suitability for transport is also regulated by Council regulation (1/2005) on protection of animals during transport and an adjoining Danish order on protection of animals during transport (1728/2006). Furthermore, the Veterinary Health Council has put forward views on evaluation of animals before transport.

If the statutory guidelines are violated, pig producer, carrier and driver may be fined. In July 2007, the Danish Parliament introduced a penalty point system under which the driver risks being penalised in his right to transport animals if he fails to meet these statutory guidelines.

The controlling authorities (police and the veterinary inspectors at the slaughterhouses), transporters, pig producers and their advisors (practising vets) are all involved in the evaluation of whether an animal is suitable for transport. In an attempt to form a uniform basis for what is acceptable and what is not, Danish Pig Production issued a series of fact sheets in 2008 illustrating how to evaluate various disabilities. The fact sheets were made in co-operation with the industry and the Danish Veterinary and Food Administration.



*Veterinary inspection during unloading at the slaughterhouse.*

## Evaluation of suitability for transport

As a general rule, animals must be transported under such conditions that they are not injured or suffer unnecessarily.

Injured animals and animals with physiological disabilities are considered unsuitable for transport, especially if they:

- Are unable to move around without pain or without support
- Have severe, open cuts or prolapse
- Have torn hooves or fresh fractures
- Are generally weakened, including if they are stressed or have a fever.

Furthermore, the following animals are not suitable for transport:

- Sows in the final 11 days of gestation, or sows that have farrowed within the last week
- Newborn piglets whose navel has not fully healed and piglets younger than 3 weeks, unless the transport distance is less than 100 km.

Pigs weighing less than 10 kg must not be transported for more than 8 hours.

## Evaluation of hernia

Pigs with hernia are suitable for

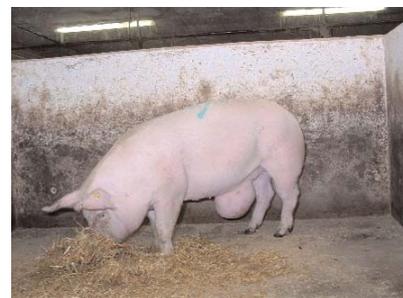


*Sow weakened by luxation. The wellbeing of the animal is clearly affected. Evaluation: Not suitable for transport.*

transport if their walk and overall wellbeing are normal. The length, width and depth of the hernia must not exceed 15 cm on a finisher; 7 cm on a 30 kg pig; and 5 cm on a 7 kg pig. Furthermore, the hernia must not have cuts/lesions, and the hernial opening must be large enough for the intestines not to be squeezed.

If a hernia measures more than 15 cm, there are no cuts and the animal's

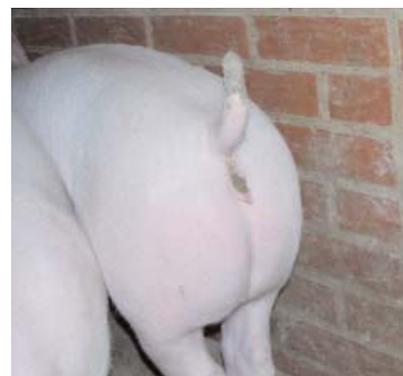
wellbeing is normal, the pig must be transported separately from other animals and must have extra space and bedding (contingent transport). However, up to five pigs with hernia can be transported in one confinement if a vet has identified them and declared them suitable for transport (veterinary declaration) within the last week. Pigs with a veterinary declaration must be loaded from a separate confinement and the carrier must be notified when the transport is ordered.



*Umbilical hernia exceeding 15 cm with no cuts/lesions, the overall wellbeing of the animal is unaffected. Evaluation: Suitable for contingent transport.*

## Evaluation of tail bites

Pigs with bleeding or infected tail bites are not suitable for transport. Pigs with fresh tail bites and pigs with crusts or tail bites that are at risk of breaking up during transport must be transported in separate confinements from other animals (contingent transport). The walk and overall wellbeing of the animal must be normal and unaffected by the tail bite in all situations.



*Healed tail bite with dry crust and no inflammation. Evaluation: Suitable for transport.*

# Sow Life

## Demonstration project

For years, sow mortality has been increasing. Figures from 2007 show that approx. 15% of all sows never make it to slaughter, but are destroyed or die in the herds. That figure is too high.

Supported by the rural district programme under the Ministry of Food, Agriculture and Fisheries, Danish Pig Production has initiated a comprehensive demonstration project that, in combination with a nation-wide campaign, is aimed at turning this development around and reducing sow mortality by 25% before 2013.

Fifteen sow producers participate in the demonstration project "Sow Life" and the aim is to reduce sow mortality in their herds by engaging in an extensive advisory process. This takes place in close co-operation between Danish Pig Production, the herd owners, the advisor and practising vet of the herds. For each herd, a strategy is drawn up to reduce mortality, and this strategy is closely followed during frequent visits from the advisors over 18 months.

As a novelty, all project data are published on the web in a log that can only be accessed the parties in the project. The log functions as a joint communication platform for the parties and will ensure that all relevant information is quickly made available and implemented.



The 15 sow producers were nominated to the project by their local advisor and are located across the country. Five of them have agreed to function as demonstration herds, which means that other advisors and vets will be allowed to visit on appointed demo days and be given a status of the results and experiences.

The aim is to communicate these experiences and results to as many pig producers as possible through a nation-wide advisory campaign.

Initiatives implemented in several of the demonstration herds:

- Production-technical optimisation
- Feed hygiene
- Training facilities for gilts
- Active selection of gilts
- Transfer strategy when sows are housed loose
- Management of body condition – feed curves
- Daily supervision
- Consistent use of hospital pens
- 3-5 daily feedings in the farrowing facility
- Gastric examinations on slaughter sows
- Recording codes – codes for departure.

It was demonstrated that increased attention to specific problems makes it interesting for all parties involved and increases the motivation to follow up on the initiatives made in the herd.

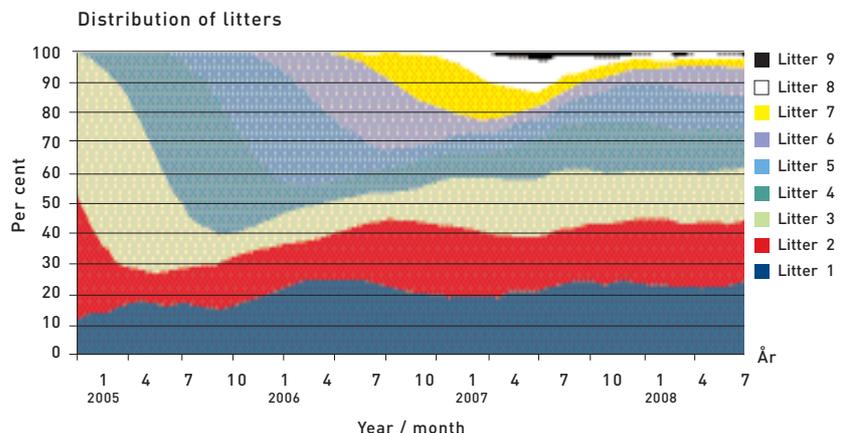
Joint visits where all parties contribu-

te with their know-how have created the basis for success in the demonstration herds. It is agreed to have quarterly joint visits where follow-up is made on the herd strategy. It is easy to follow up on the strategy if the initiatives that are agreed and implemented are made visible.

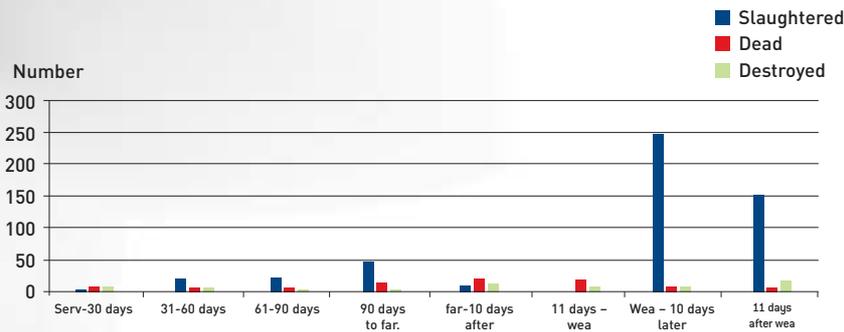
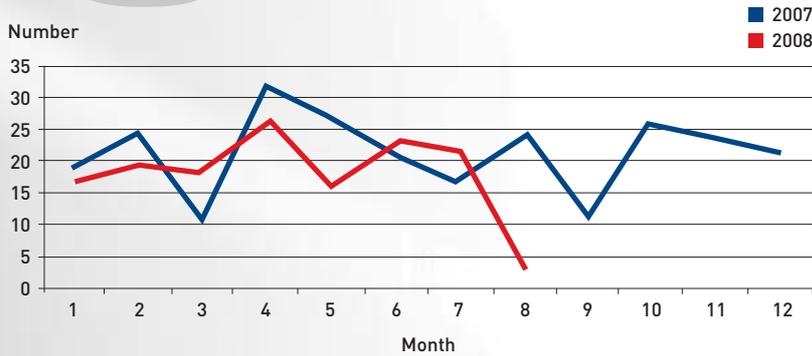
## Codes and curves

Routine recording is an essential prerequisite for providing specific advice on sow life. Not just of production data, but also of codes denoting departure/cause for the sows that are slaughtered, destroyed or dead. The codes are already an integral part of the data systems used in the herds across the country.

These recordings made it possible to draw curves that visualise the development within specific areas in the herd over time, such as the distribution of sows on parity number from 2005 to 2008, the number of sows for DAKA per month in 2007 and 2008, or



# Sow Life

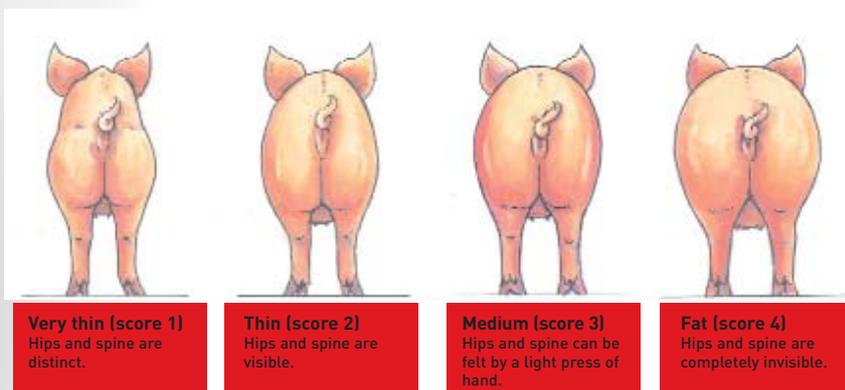


sows culled in the reproduction cycle in the first 7 months of 2008.

### Management of body condition

Correct management of body condition is one of the most important factors for good longevity, a high level of productivity, and a low feed conversion ratio, and is one of the main tools in the prevention of shoulder ulcers.

Visual evaluation of body condition is a good method for assessing the feed condition of the sows. However, the eye measure needs routine calibration, and one should therefore also palpate a section of the sows. This method is easy and is described in the text below each drawing.



Body condition should be evaluated through the sow's entire cycle, and preferably at farrowing, at weaning, at the first gestation check, approx. 60 days into gestation and approx. 90 days into gestation. This is necessary to find and treat sows that are either too fat or too thin. This means that besides evaluating body condition, the producer must also act on it – by increasing or reducing the feed dose of the individual sow.

At [www.soliv.dk](http://www.soliv.dk) at video can be downloaded of how to assess the body condition of a sow.

### Gastric changes

Gastric changes in gilts and sows are



The inside of a normal sow stomach. The white part is smooth and nacreous. Gastric index is 0.

found almost exclusively in the white part of the stomach, immediately after the mouth of the oesophagus.

In theory, gastric changes in this part occur when acid and enzymes produced in the lower part of the stomach "flush" onto the white part where the mucosa is unprotected. To prevent this, it is necessary to maintain the "acid" environment in the lower part of the stomach. This can be done by enhancing the texture of the gastric content.

### Feed composition

Several trials have studied how to formulate the feed to make the gastric content more porridge-like. Overall, it was concluded that various types of fibre did not have the desired positive effect on the gastric health, but that an increase in particle size in the feed had a positive effect. It is therefore recommended to use grain that is ground medium-coarse to coarse.

Currently, meal versus pellets is being studied in four sow herds where the effect on gastric health is being analysed. In two of the herds, the study comprises a control group and a trial group in the herd, whereas in the two other herds, meal versus pellets is studied in a before and after period.

In all four herds, the trial is conducted in both the gestation period and the lactation period.





Bygholm sieve with medium-coarse grain.

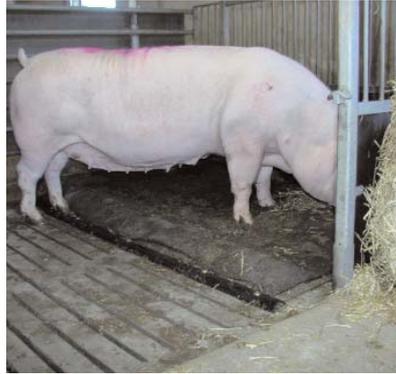
The preliminary results demonstrate a significant effect on the gastric health of using medium-coarse feed. The calculated gastric index in the white part of the stomach drops when meal feed is used. Results also show that the sows can eat approx. 1 kg feed more a day during lactation when the feed is served as meal feed. Litter size and weaning weight were slightly higher in the "meal group" and fewer sows were culled in this group.

### Hospital pens with soft lying area – a good tool

Studies demonstrate that a positive effect on the sows' health and on the economy is obtained when sows are moved to a hospital pen early in the disease course. Eighty per cent of the sows that were transferred to a hospital pen returned to the gestation pen or the farrowing facility after treatment/relief. The sows stayed in the hospital pen for approx. three weeks. To ensure a good immediate environment and to comply with legislation, min. 2/3 of the hospital pen must have soft bedding.

In an on-going pilot study, positive results were achieved with soft mats in the lying area. The mats are normally used in cubicles for cattle and were obtained from the company Erri-Comfort A/S.

The hospital pens have fully slatted/fully drained floor. The mat in the lying area is permeable, i.e. urine and wash water "disappear" through the mat. The mat consists of two parts – a canalized mattress with rubber granulate and a coarsely woven cover. The mat is kept in place by slides. The durability of the mats seems good.



### Treatment strategy

It is recommended to have a treatment strategy to ensure uniform handling in due time of sick and injured sows. The strategy is made by the herd vet in co-operation with the staff, and describes injuries, medication and time of treatment. It is important that the plan includes a description of when to decide whether the sow should continue with treatment or should be destroyed.

Experiences from the herds show that the earlier a sow is moved to a hospital pen and treated, the sooner she returns to the gestation pen. The staff must therefore daily be aware of sows with abnormal behaviour – for instan-

ce, sows with no appetite or lame sows.

### Nation-wide advisory campaign

To raise the awareness of the problems concerning sow mortality, Danish Pig Production in co-operation with DAKA sent out letters in the spring 2008 to the sow producers who in 2007 had delivered sows for destruction. The letter included an economic calculation so that each producer could calculate the value loss. At the same time, www.soliv.dk came online, which is a website containing material and information supporting an active effort to reduce mortality at herd level. Besides a description of goals and measures, the website contains various material including relevant fact sheets in Danish, English and Russian and lists of images and data of the pig advisors participating in the advisory campaign.

Sow Id. and litter no.	Date for transfer (resp.)	Transferred to pen no. x Diagnosis	Preparate (treatment 3 days in a row)	Date for cured /destruction (stay in days)
ld.	Date		1.	Date
Litter no.	Employee		2.	Days:
ld.	Date		1.	Date
Litter no.	Employee		2.	Days:
ld.	Date		1.	Date
Litter no.	Employee		2.	Days:

$$\% \text{ dead sows/destroyed sows} = \frac{\text{Dead sows for DAKA} \times 100}{\text{number of sows per year.}}$$

	Sow mortality in % of sows/year	Effort	Loss per sow/year
Red	15-30%	Needs improvement	> DKK 500
Yellow	10-15%	Could be better	> DKK 350-500
Green	0-10%	Needs improvement	< DKK 350

Place a board by each hospital pen to note various information, such as when the sow was transferred, type of injury, treatment course, responsible staff member etc.



# Shoulder ulcers

## Drop in reports

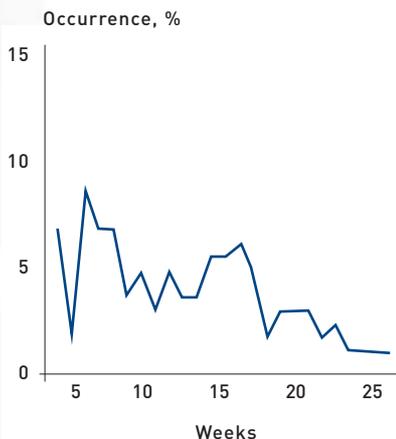
The number of reports of severe shoulder ulcers has dropped significantly from 2006 to 2007 – and this tendency continues in 2008. The prevalence of shoulder ulcers and the severity (of the ulcers) also decrease. The aim of Danish Pig Production is minimal prevalence of shoulder ulcers among Danish sows.

## “Healthy Shoulders”

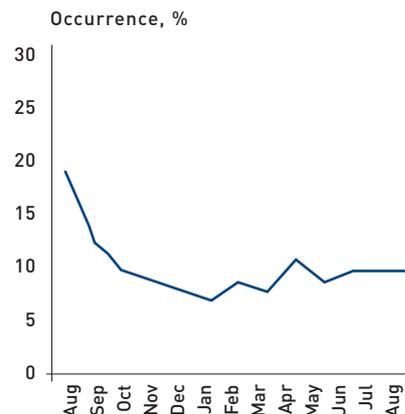
To achieve this quickly and efficiently, pig producers must be capable of prioritising their efforts. The project “Healthy Shoulders” helps them do this. In this project, a team of experts from Danish Pig Production visited 11 pig producers who, despite a determined effort, still struggle with problems with shoulder ulcers.

The producers received an action plan with particular focus on shoulder ulcers. Though the action plans were individual, two recurrent themes were seen in all herds: inadequate feeding and incorrect management of body condition of the sows in both the gestation facility and farrowing facility.

The preliminary results of the project demonstrate that it is possible to further reduce shoulder ulcers, but it requires perseverance. This project therefore provides a detailed outline of the challenges faced by the producers. Part of the solution may be fairly easy; for instance, adding fat to the lactation diet or changing feed curves in the gestation facility. However, the problems are often highly complex and require detailed knowledge of and interest in feed and feeding. The producers must also make time for imp-



Development in % sows with shoulder ulcers in farrowing facilities from August 2007 to August 2008. The graph is based on recordings made by practising vets at routine visits.



plementing the action plan on a daily basis.

Fortunately, the results of the project indicate that a determined effort against shoulder ulcers will have a positive effect on the production as such. An effort against shoulder ulcers should therefore be considered a positive work investment rather than a necessary evil.

In Danish Pig Production, a series of activities are aimed at increasing the knowledge on occurrence and prevention of shoulder ulcers. These centre on the following areas:

- Heredity in relation to the risk of developing shoulder ulcers
- Feeding strategy in the lactation period
- Flooring and thermic immediate environment in the farrowing pen
- Development of shoulder ulcers and evaluation of suitability for slaughter.

The projects are supported by funds from the Rural Development Programme.

## Heredity of shoulder ulcers

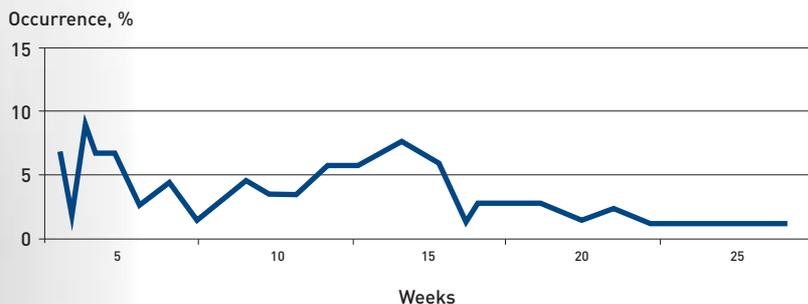
A comprehensive project has been initiated to establish the genetic possibilities for preventing shoulder ulcers. In this project, the occurrence of shoulder ulcers in sows is recorded in five commercial herds. The sows are of known origin to be able to trace their origin back to their parents and grand parents. Recordings are correlated with information on origin from Danish Pig Production’s databank and with production data from the production records of the herds.

To be able to detect heredity, recordings must be made of minimum 10,000 sows, and these sows must be followed through all lactation periods. The project will be finished in 2010.

## Feeding during lactation

It is important to feed the sows according to their condition in the gestation period as was made clear from the project “Sow Life” described in the previous pages in this report.

However, correct feeding during lactation is also extremely important. The feed dose must be increased with the milk production of the sow. The feed dose should be 2-3 FUsow a day at farrowing and increase to 5-6 FUsow after the first week of lactation. After this, the sow should be fed



Occurrence of shoulder ulcers in a sow herd (% of sows in the farrowing facility) before and after an action plan was implemented in week 42.



according to approximate ad lib. The aim is for the sow to have a feed intake of approx. 180 FU/sow in four weeks of lactation.

In many herds, it is difficult to achieve this feed intake, particularly among young sows. As a result, the sows lose too much weight and are at greater risk of developing shoulder ulcers. Normally, sows are fed three times a day in the farrowing facility. The preliminary results of a current trial on frequent feeding in the lactation period showed that sows can be fed up to eight times a day with dry feed. When the sows are fed more than three times a day, the feed intake increases and weight loss drops. The prevalence of shoulder ulcers also dropped.

Several of the producers who participate in the projects "Healthy shoulders" and "Sow life" have increased the number of daily feedings in their herd and have obtained positive results from introducing four or five daily feedings.

Furthermore, activities on Vitamin B12 and objective assessment of body conditions are planned.

### Flooring in farrowing pens

Slatted floor under the sow in the farrowing pen increases the risk of shoulder ulcers or makes a shoulder ulcer worse. This was demonstrated in Danish and foreign studies. It is therefore recommended to use rubber mats in pens with fully slatted floors and for sows that, due to poor condition or a history of shoulder ulcers, are at increased risk of developing shoulder ulcers.

In four herds, four different brands of rubber mats were studied: Kraiburg: "Atlas", AAG: "staldmåtte", ErgoFloor: "GSM", and P. Lindberg: "somåtte med huller".

The mats were investigated for four consecutive lactation periods, i.e. each mat was used for approx. 120 days. Two of the mats had to be taken out of the study due to poor durability ("GSM" and "somåtte med huller"). These were replaced by two other types of mats from the same producer/importer ("HSM" and "somåtte,

massiv"). The pigs had bitten and scratched the mats from Kraiburg and AAG, and only few mats were discarded during the study.

A good level of hygiene was found in the pens with fully slatted floor and mats. In many of the pens with partially slatted floor, the hygiene was poor. In the pens with partially slatted floor, mats often slid backwards unless they were carefully fastened to the slatted floor. The mats were stable in the pens with fully slatted floor as they had been fastened in all four corners.

Various types of flooring in farrowing pens will now be investigated in relation to the prevention of shoulder ulcers. They will be studied in herds with partially slatted floor and the groups will include different types of non-skid flooring/floors that can relieve pressure.

Besides the drawbacks of low levels of hygiene and durability, there is another significant drawback to rubber mats: they are warmer to lie on than concrete and this is assumed to have a negative effect on the sow's wellbeing.

Danish Pig Production is therefore involved in the development of a floor type that both relieves pressure and is



*In co-operation with a company outside the pig industry, DPP is working on developing durable floors for farrowing pens that also relieve pressure.*

durable. On-going trial activities are also investigating non-skid surfaces on farrowing pen floors.

Sows have a large production of heat

in the farrowing facility. It is important that the excess heat of the sow is removed to prevent her from becoming too warm. Danish Pig Production is therefore studying the effect of floor cooling. The aim is to remove the heat from the sow via floor cooling and thereby increase the wellbeing of the sow in the farrowing facility. This is expected to increase the feed intake and activity level of the sow. Results are not yet available, but measurements show that approx. 60 watt are removed from the sow. In a Dutch study, this was sufficient to increase the feed intake of the sow and the weaning weight of the pigs.

### Development of shoulder ulcers

Danish Pig Production has initiated research that in detail will describe the development and healing of shoulder ulcers. By introducing specific limiting values, it will be possible to make an objective method for evaluation of shoulder ulcers on live animals. It is expected that the results from Danish Pig Production will be included in this work.

### National effort

In order to put extra attention to the prevention and handling of shoulder ulcers, the Danish Veterinary Association, the Danish Agricultural Council and Danish Pig Production have agreed that herd vets must check the level of shoulder ulcers in the herds and make action plans in all sow herds.

Danish Pig Production also participated in a work group under the Danish Ministry of Justice. The work group presented proposals for effort areas and how to set specific goals to significantly reduce the prevalence of shoulder ulcers.

The work group suggested that "yellow cards" be given to producers who exceed a given limiting value for superficial shoulder ulcers or to producers who deliver more than 2% with severe shoulder ulcers in a year. A yellow card increases the risk of the authorities inspecting the herd and results in a requirement for the producer to follow an obligatory action plan for shoulder ulcers.

# Alternatives to castration

## Castration against boar taint

In Denmark and across Europe, the majority of all male pigs are castrated to prevent boar taint in the meat. Boar taint is caused primarily by the substances skatole and androstenone.

Generally, the international markets for Danish pork demand that male pigs are castrated, and Danish consumers are also sceptical of meat from uncastrated pigs.

## The development in Europe

Lately, the welfare implications of castration in pigs have been brought into focus in the EU, and in several European countries, castration has been the subject of a great deal of public debate.

In the Netherlands and Switzerland, full anaesthesia is considered to be a possibility. In Norway, castration without anaesthesia has been prohibited since 2006 and local anaesthesia is used. In the rest of Europe, pigs are not anaesthetised during castration.

Recent studies indicate that there are several drawbacks to local or full anaesthesia, and it is being discussed whether anaesthesia improves animal welfare. Consequently, Danish Pig Production does not consider anaesthesia to be a valid solution.

## Alternatives wanted

Production of uncastrated pigs has several advantages – including advantages as regards animal welfare and production economy. Activities have been initiated to investigate alternatives to surgical castration.

## Sexing of semen

Sexing of boar semen would reduce the need for castration considerably. Danish Pig Production is supporting a development project aimed at developing an immunological method for sorting semen in “male sperm” and “female sperm”.

The method is currently being tested in a pilot study, and it will also be tested in commercial pig herds. Whether the method is applicable in practice will be established by 2010. However, even if this is the case, the



*For sexing of semen, antibodies are bound to surface proteins in “female” sperm cells.*

method will not completely prevent the birth of male pigs.

## Feeding against boar taint

Feeding with low-digestible carbohydrates can reduce the production of skatole in the pigs’ intestines and thereby reduce the level in the fatty tissue.

To investigate this, Danish Pig Production has initiated a trial in which male pigs are given feed containing 15% chicory from 14 days before slaughter. The aim is to clarify whether chicory can reduce the level of skatole in the fatty tissue and the percentage of male pigs with unacceptable levels of skatole.

However, it is unlikely that feeding low-digestible carbohydrates will solve the problem of boar taint by itself as it is not expected to affect the level of androstenone.



*The effect of chicory in pig feed on boar taint is currently being studied.*

## Vaccination against boar taint

Studies have shown that it is possible to almost eliminate boar taint by vaccinating male pigs twice in the months before slaughter. The vaccine has not yet (August 2008) been approved in the EU, but an application for approval in the entire EU is currently being considered.

When pigs are given this vaccine, they produce antibodies against a signal substance in the brain. This signal substance is necessary for the production of sex hormones. Once the signal substance is neutralised by antibodies, the production of sex hormones ceases, and thereby boar taint is almost completely eliminated.

Danish Pig Production is planning a test of the vaccine in Danish herds to establish whether vaccinated pigs have a higher productivity – including a better feed conversion – than pigs that are surgically castrated.

Unfortunately, the vaccine also works on humans, though the effect is most probably temporary. Consequently, it is important to identify work routines that minimise the risk of self-injection. A specific safety injector is being developed by the producer of the vaccine.

It is not known how export markets would react to pork from vaccinated pigs. This must be established before the vaccine can be taken into use in Danish herds.

# Antimicrobial resistance

## Efficient treatment

To eliminate the risk of developing antibiotic resistance, it is recommended, that the choice of antibiotic treatment is based on a determination of the resistance pattern of the pathogenic bacteria in question. Thereby, pig producers are assured the most efficient treatment of pigs. Among other, analysis of antimicrobial resistance

Antibiotic resistance means resistance to antibiotics.

Bacteria may develop resistance to certain antibiotics. This means that the antibiotics no longer have any effect on these bacteria.

can be determined at the Laboratory for Pig Diseases in Kjellerup.

## The Laboratory for Pig Diseases

The laboratory performs daily analyses of resistance patterns of bacteria. In total, in 2007, 786 samples were analysed for the presence of antimicrobial resistance of various bacteria. The resistance patterns of three of these bacteria are mentioned below.

## E.coli 0149 can give diarrhoea

Serotype O149 is the most common E.coli found in piglets and weaners suffering from coli diarrhoea. In total, 75 isolates of E.coli O149 have been analysed.

More than 70% of the analysed isolates were sensitive to neomycin, colistin, ampicillin and amoxicillin /clavulanic acid. This leaves many options for treatment. All antibiotics are marketed under a range of different names. In approx. 75 % of the isolates, resistance was observed to tetracycline.

## Oedema E.coli 0139

E.coli O139, which triggers oedema, is also an important E.coli, where knowledge of the resistance pattern may be decisive to efficient treatment. Twenty-seven isolates of E.coli O139 were analysed.

All 27 isolates were sensitive to colistin, gentamicin, apramycin and amoxicillin/clavulanic acid. Resistance was found to sulphonamide in 80% of the isolates.

## S suis type 2 cerebrospinal meningitis

This type of streptococcus may trigger cerebrospinal meningitis in weaners and finishers. The pig will only recover through quick intervention and correct treatment. In this case, it is also important to know the resistance of the bacterial strain causing problems in the herd. Forty-two isolates of S suis type 2 were analysed.

## S suis type 2 treatment

All 42 isolates of S. suis type 2 were sensitive to penicillin, tiamulin, ceftiofur and sulfa/trimethoprim. More than 70% of the isolates were resistant to tetracycline.



Microbiological analysis.

## MRSA – a possible working environment problem

Every fourth Dane has staphylococci in their nose or on their skin. MRSA (Methicillin Resistent Staphylococcus Aureus) is a staphylococcus that has become resistant to treatment with regular antibiotics. The Danish health care system has known MRSA for a long time.

Healthy people will normally not become ill from MRSA. Persons may carry the bacterium on the skin or in the nose without showing signs of inflammation. However, in case of an infection or need of surgery, it is good

to know that you are carrier of MRSA as it requires treatment with a special antibiotic.

## MRSA cc398

CC398 resembles the other types of MRSA, but is in particular found in pigs and has also been detected in other livestock outside Denmark. CC398 transmits between animals, but can also be transferred to humans. MRSA cc398 is found on the pig, in the dust and therefore on surfaces in the pig facility. Humans can



Hand wash.

transmit the disease via direct contact or indirectly via objects they have touched, for instance door handles.

## MRSA cc398 guidelines

The Danish National Board of Health has issued the following guidelines:

1. Shower and change clothes before leaving the herd
2. Wash hands often and thoroughly. Use disposable towels
3. In case of contact with the health services, explain that you work in a herd positive for MRSA cc398. This ensures treatment with the correct antibiotic.

Persons who are MRSA carriers can have absolutely normal social contact with other people (clubs, schools, visits, etc.).

## Co-operation on MRSA guidance

The Danish Pig Production co-operates with various organisations (including the National Health Board and Statens Seruminstitut) on optimising the guidance on MRSA.



# Vaccination against coli diarrhoea

## Inter-disciplinary co-operation

Together with national research institutes, Danish Pig Production participated in a project aimed at improving production, health and welfare in weaned pigs and at the same time reduce the consumption of medicine.

## Project "Robust pigs"

This project investigated practical methods for increasing the resistance of weaners to post-weaning diarrhoea:

- Protective micro-organisms
- Behavioural and physiological maturity processes involved in protection against post-weaning diarrhoea
- Investigations in herds of the effect on prevention of post-weaning diarrhoea of practical strategies in the lactation period and at weaning.

## Focus on prevention

Pathogenic E.coli bacteria are present in all herds, in both piglets and weaners, but the occurrence of E.coli related intestinal diseases varies significantly between herds and within herds over time.

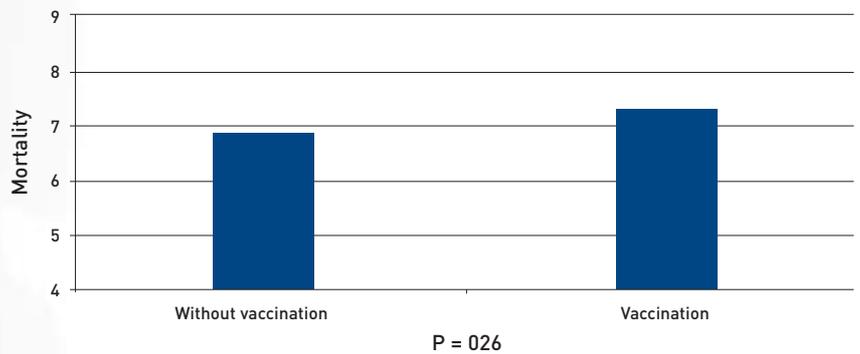
Group treatments are often necessary during outbreaks of post-weaning diarrhoea and these are most successfully done by administering medication in the drinking water.

E.coli bacteria tend to develop resistance during long-term antibiotic treatment. It is therefore important to focus on preventive measures. Already at birth, the pigs are capable of producing antibodies, and it may therefore be possible to activate their immune system with production of specific protective antibodies through vaccination of the pig before weaning (active immunisation). Danish investigations have demonstrated that it is possible to protect weaned pigs against oedema post-weaning by vaccinating them before weaning and by treating them with oedema serum before or after weaning.

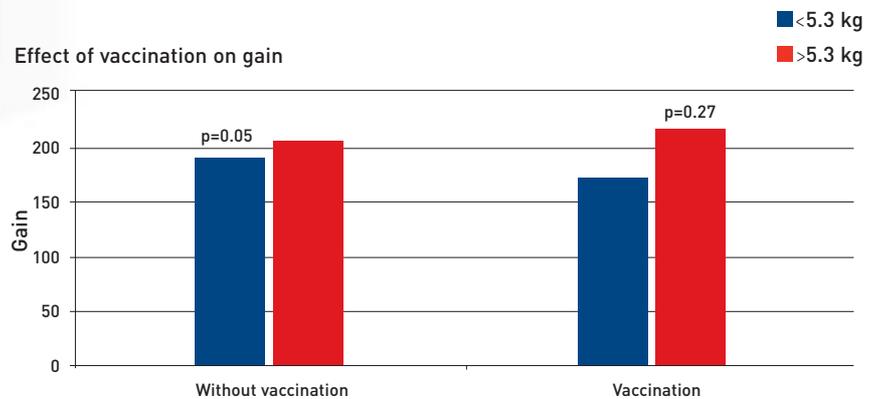
## Vaccination against coli diarrhoea

Inspired by the positive results of vaccinating against oedema, Danish Pig Production together with Research Centre Foulum, the Veterinary

Effect of vaccination on mortality



Effect of vaccination on gain



Institute and Copenhagen University, Faculty of Life Sciences investigated the possibility of vaccinating piglets against post-weaning diarrhoea.

The effect of vaccinating pigs in their first and third weeks of life against E.coli related post-weaning diarrhoea was studied in one herd with high mortality rates due to E.coli O149. A vaccine was used that is normally used for vaccination of sows before farrowing so that the piglets are protected against coli diarrhoea via colostrum in the lactation period. The study comprised 1,311 weaned pigs.

Mortality among the vaccinated pigs was 1.5% lower than for the pigs that were not vaccinated. However, this difference was not significant. Pigs weighing less than 5.3 kg in the group that was not vaccinated grew 5 g more a day than the vaccinated pigs.

Blood samples collected from 60 pigs before the first vaccination and four weeks post-weaning revealed no dif-

ferences in the level of antibodies between vaccinated pigs and pigs that were not vaccinated. This indicates that the vaccine did not affect the antibodies against coli in the pigs.

The conclusion of this study was that it is not possible to reduce mortality caused by post-weaning diarrhoea by vaccinating the pigs in their first and third weeks of life.



# PMWS

## PMWS in Denmark

PMWS is still a problem in Denmark, and the disease no longer affects only weaners, but also finishers. Besides increased mortality, also low gain and non-uniform pigs are seen among pigs suffering from PMWS. Scientists have successfully isolated PCV2 virus from aborted pig foetuses, and it is therefore believed that PCV2 may also cause reproduction problems. Previously, the disease was successfully kept under control through management changes, but in recent years specific PCV2 vaccines have been developed.

## PCV2 vaccines in Denmark

Two vaccines are authorised in Denmark for European marketing: CIRCOVAC for sows and Ingelvac CircoFlex for pigs. A third vaccine, Suvaxyn PCV, was also available, but the vaccine was taken off the market as it is not authorised for European marketing. However, if it is not possible to supply sufficient amounts of Ingelvac CircoFlex, Suvaxyn PCV can be sold in Denmark again. A fourth vaccine is also available, Circumvent PCV, though not in Denmark.

## Effect of PCV2 vaccines

In German, French and Danish herds, data were analysed before and after sows were vaccinated with a PCV2 vaccine (see table below). Generally, vaccination has a positive effect on the productivity.

However, it is difficult to say whether this improvement would have developed time regardless of the vaccination. To establish thus, trials in which you follow pigs of vaccinated sows and pigs of non-vaccinated sows are much better suited. Few of that kind of stu-

dies have been made of CIRCOVAC, but Danish Pig Production is currently testing the vaccine in three herds. Internationally, many trials have been made of the three PCV2 vaccines for pigs, but none in Denmark. Generally, positive effects are seen of vaccinating the pigs; mortality drops and gain increases. Danish Pig Production is currently compiling the results from multiple trials to analyse whether the vaccinations have the same effect and at the same time to describe this effect.



*Vaccination of a sow in one of the herds participating in the CIRCOVAC trial under Danish Pig Production.*

## PMWS and genetic deficiency

PCV2 is not the entire explanation of PMWS. Studies have indicated that part of the explanation why some pigs become very sick and die from PCV2 may be that they have a higher susceptibility to the virus. In other countries, several pigs originating from certain boar lines have been observed with PMWS. Pigs from the same litter growing up under similar conditions have been seen to suffer differently from the disease. This is a well-

known pattern for hereditary diseases where the parents may have different genetic predisposition for the disease and where the susceptibility of the offspring to the disease depends on the genes inherited from the parents.

Together with Section Genetics and Bioinformatics, the Faculty of Life Sciences at Copenhagen University, Danish Pig Production is involved in a research project, which includes ten litters of pigs from Danish herds. The aim is to demonstrate whether there is a correlation between heritability of "good genes" and healthy animals and between heritability of "bad genes" and sick animals. A gene was found that seems to be decisive to whether a pig becomes severely ill from a PCV2 infection. This may provide an entirely new and basic fact in understanding PMWS.



*Unthrifty pig.*

## Information

For more information on PMWS, visit [www.pcvd.org](http://www.pcvd.org) and [www.dansksvineproduktion.dk](http://www.dansksvineproduktion.dk).

Country	Parameter	Herds	Before vaccination	After vaccination
Denmark	Mortality, weaners	34	4.1%	3.5%
	Mortality, finishers	11	6.5%	4.3%
Germany	Mortality, weaners	198	8.0%	3.1%
	Mortality, finishers	109	5.7%	3.0%
	Gain, weaners	116	345g	371g
	Gain, finishers	77	716g	749g
France	Mortality, weaners	24	3.0%	2.2%
	Mortality, finishers	24	7.2%	5.1%



# Guidelines for Eradication

## Outline

Total eradication of a herd is a major financial decision, and many practical factors must be considered before a final decision is made. Until recently, no publication provided a complete outline of the factors to consider if a pig producer is considering total eradication. This is now available in the Guidelines for Eradication published by Danish Pig Production.

## Systematics

The Guidelines are compiled by a work group consisting of pig producers, local pig advisors and employees from SPF Denmark and Danish Pig Production. They include checklists, action plans, work routines and solutions to all the challenges faced in the process of total eradication. The Guidelines are aimed at pig producers and advisors who are interested in advising and assisting pig producers in connection with a total eradication.

To introduce and promote the Guidelines, a detailed presentation of eradication management was provided at the National Centre in Skejby in May 2008.

## Before, during and after eradication

The Guidelines are divided into chapters concerning with conditions before, during and after an eradication process. Before deciding to eradicate, the producer should consider whether the lack of extension possibilities or the risk of re-infection caused by the location of the herd form good bases of eradication. Furthermore, the costs related to the eradication must be reasonable compared with the expected profit in the new herd. The shorter the amortization time on an eradication, the more attractive it is to eradicate seen from a financial point of view.

The Guidelines do not provide an answer to whether it is sensible to replace the entire herd, but it does systematise the considerations that the producer needs to make. Ultimately, the decision is made by the pig producer and his advisors.

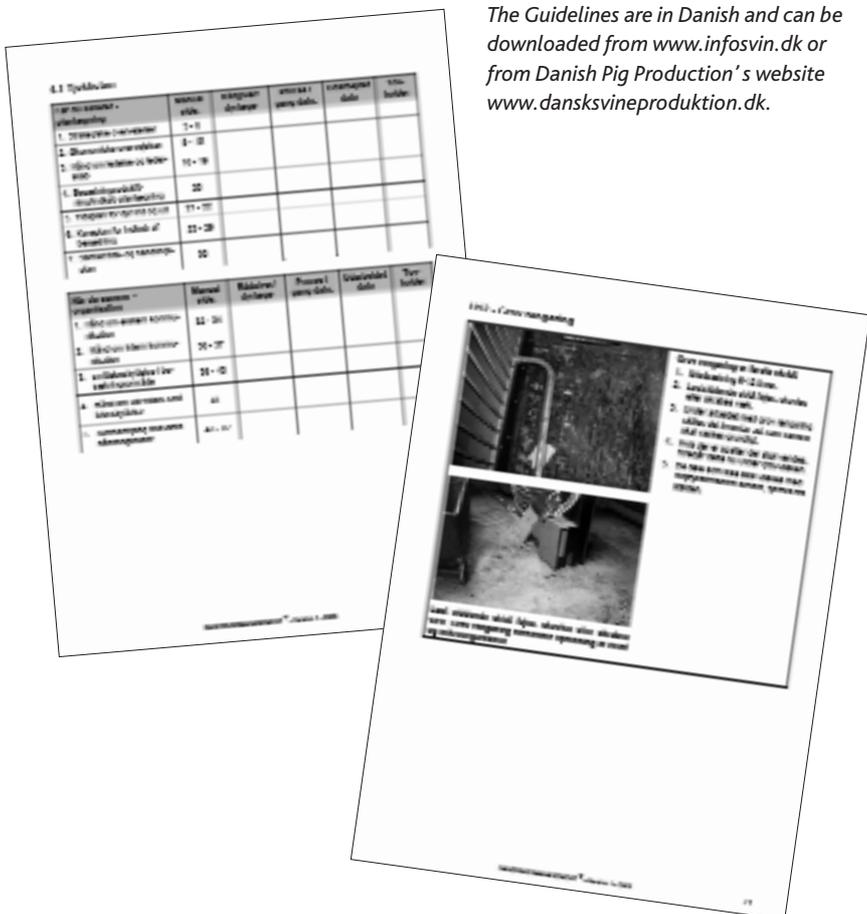
## Information is paramount

A total eradication process involves many people in and outside the herd. It is a managerial effort to inform all parties in due time. It is particularly important to pass information on to the staff. If all parties and staff are informed at an early point in the process, there will be no doubts or questions of how to go about the tasks.

Once the facilities are empty, thorough cleaning is a major task. The Guidelines describe in detail how to go about the individual tasks. Many producers opt for advice from specialists and maybe leave the entire cleaning to a professional company. Regardless of who cleans the facilities, it is important that another person inspects the quality of the work. If you eradicate for a disease that transmits through manure, cleaning is extremely important. Once the facilities are dry and have been empty for

three weeks, they are ready for a new batch of pigs. The Guidelines thoroughly describe transfer and handling of new gilts and provides detailed checklists.

The Guidelines are in Danish and can be downloaded from [www.infosvin.dk](http://www.infosvin.dk) or from Danish Pig Production's website [www.dansksvineproduktion.dk](http://www.dansksvineproduktion.dk).



# DKK +25 per finisher

## Phase 1

The aim of the project "DKK +25 per finisher" is to communicate as much of our knowledge on finisher production as possible to the pig producers. The project is run in close co-operation with local advisors (pig advisors and vets) and the herd owners. The project is supported by funds from the Rural Development Programme.

There were two reasons for starting this project; the average productivity figures for finishers did not show the expected positive development, and there is a huge spread between the producers in results and profit.

Approximately 50 pig producers participate in phase 1 of the project. An action plan was made for each of these herds with the aim of improving the production results and the financial bottom line. The two advisors of each herd (vet and pig advisor) routinely followed up on the implementation of the action plan through frequent visits. The herd owners and their local advisors are extremely important players in this project.

## Typical problems

The actions plans generally focus on design of the facility, ventilation, disease and prevention of disease, nutrition and feeding, and management.

## What have we learned?

There were large differences between how quickly the plans were implemented, and how much was implemented. Some producers implemen-

The following areas were included in the majority of the action plans:

- Optimum ventilation and climate
- Establishment and use of hospital pens
- Feeding strategy when liquid feed is used
- Recordings in the feed computer and grinding of grain
- Correct diagnosis and prevention of diseases.

ted the entire action plan straight away, whereas others only implemented parts of the plan. Some producers decided not to use the action plan and left the project.

It was demonstrated that an important prerequisite for success in such a project in the individual herd is that the producer and his staff are motivated to change their daily routines and that their motivation is maintained through follow-up visits.

## Supplementary training

The project also included supplementary training of the advisors within areas such as climate/ventilation and mixing feed on-farm/liquid feeding.



*So far, nine courses have been held under the project.*

## Preliminary results

The preliminary results reveal improvements in the production figures in the period when the action plan was implemented. All data are not yet available, but analyses of results from approx. 30 herds with after-periods of

1-3 production record periods (which makes the figures somewhat uncertain) show the following changes in productivity:

Daily gain:	+ 75 g
FUgp/kg gain:	-0.09 FUgp
Lean meat %:	-0.1 percentage unit
Mortality:	-1.1 percentage unit

It should, however, be noted that in many of the action plans, it was recommended to deliver pigs for slaughter at an optimum slaughter weight. However, there was a period when it was impossible to for pig producers to deliver the pigs at the desired time. As a result, slaughter weight increased and that affected the feed conversion ratio, among other things.

The preliminary results do show that the producers on average are on the right track. However, the figures obtained so far vary greatly.

## Phase 2

Phase 2 was kicked off in June 2008. Approximately 80 pig producers have signed up for phase 2, and it is now the local advisors (vet and pig advisor) who assist the producers in setting goals for the production and reaching these goals based on the experiences obtained in phase 1. The overall object remains to increase the profit of the producers.

In phase 2, the co-operation between herd owner, vet and pig advisor is also an important factor. It is also important that the production units are analysed systematically to pinpoint the areas where optimisation is required.



# Follow-up with a specialised advisor

## Specialised advisor

A specialised advisor in a given area (management of the farrowing facility, gestation management, liquid feed management, growth management etc.) has the necessary competencies to make a difference. A specialised advisor has documented experience in assisting in these areas. As the name suggests, a specialised advisor is the advisor referred to by other colleagues when special advice is required, and the specialised advisor spends a great deal of his time on assisting in his particular area.

## DKK +1,000 per sow/year

There is a great earning potential in efficiently utilizing all aspects of the advisory service. Vast amounts of know-how and years of experience on efficient production of pigs are available. Income increases when this know-how and experience are implemented.

A conservative realistic estimate is that, by implementing the manage-

ment tools available (management of the farrowing facility, gestation management, liquid feed management, growth management etc.), the pig producer can easily increase his gross margin by DKK 500-1,000 per sow/year and by DKK 25 per finisher. This opportunity is available for all. Even the best can get better.

## Full benefit from the advisory process

Many pig producers get too little value for money in terms of advice. Some advisors are not used to making demands of the pig producer to ensure he gets full value for the money invested in this service. At the same time, many pig producers are not aware of the demands they must make of themselves to fully benefit from the advice they receive.

## Everyday practice

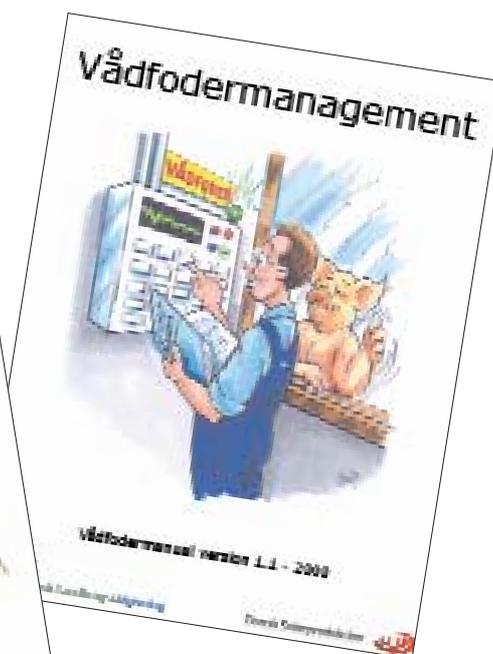
Until today, pig advisors, together with the producers, have normally closely analysed all the areas in the production to pinpoint where efficien-

cy and profit could be increased. The result was often a long list of good advice and initiatives. So far, so good. However, they failed in setting the joint goals necessary for the process to become a success just as often. And often, the 2-3 most important elements were not prioritised or agreed upon. If that had been taken care of, the task would have been easier to access for the people involved.

## Measurable goals and follow-up

The advisor needs clients who, together with the advisor, dare set detailed goals for an optimised production. The staff and the advisor must obligate each other via binding agreements to make sure that initiatives are indeed implemented. Dates must be set for follow-up visits. The consequences of goals that are achieved or not achieved must be accepted jointly. If the goal is not achieved at first, new steps must be agreed upon. And when a goal is achieved, a new one must be set.

*An advisor specialised in farrowing ensures that the farrowing management advice is very specific and targeted.*



*An advisor specialised in liquid feed ensures that the liquid feed advice is very specific and targeted.*

### Focus and specialisation in the inspection alley

Measurable goals obligate all parties involved. It is essential that the producer and the advisor are both willing to set clear goals for the outcome of the advisory process. Focus and specialisation are key words. This provides overview and ensures progress. The specialised advisor has the know-how to focus on the 2-4 initiatives that will make the most difference in co-operation with the producer.

### Perseverance

Last, but not least, the advisor needs perseverance to see the agreements through. Most pig producers are willing to pay for follow-up visits. Follow-up visits are essential for the work of the advisor to have an impact throughout the entire production.

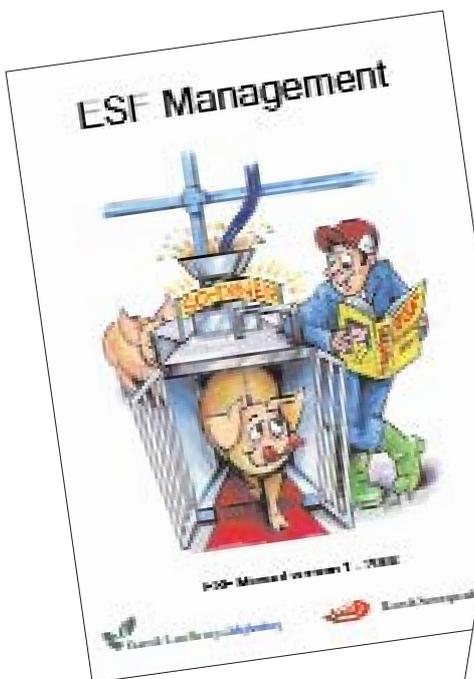
### Value for your money

As client in the advisory service, the pig producer will get full value for his money by being aware of his status

as a client. He must be aware of the demands he can rightly place on his advisors. It is essential that specific goals are set and binding agreements are made.

### Advice for highly-specialised dynamic pig producers

It requires training and specialisation of the advisors for their work to have an impact in the herds of highly-specialised dynamic pig producers. This training and specialisation of the pig advisors is therefore given a high priority. This takes place in work groups under the development work and ensures that the pig advisors are at all times able to match the most specialised and dynamic pig producers.



*An advisor specialised in ESF ensures that the ESF management advice is very specific and targeted.*

*Guidelines for eradication procedures ensures that the eradication advice is very specific and targeted.*



# Information from Danish Pig Production

## Annual Meeting and Congress

At the Congress for Pig Producers you will be presented with new knowledge and inspiration, and with 2,000 participants, more than 100 speakers and 70 presentations, it is the largest pig event in the world. It is also an excellent opportunity for socialising.

Before the Congress, Danish Pig Production holds its well-attended Annual Meeting where the situation of the Danish pig industry is summarised. What are the political, financial and professional challenges in a constantly changing world and business?

The Congress offers a highly varied program including topics such as the world around us, management, economy, sow production, weaners/finishers, feed, welfare and health, and environment and pig facilities.

Speakers present the latest knowledge and provide examples of how they believe Danish pig production will develop in the future, and what pig

producers, staff, and advisors can do to meet the requirements.

In 2009, the Annual Meeting and the Congress will be held on October 20 and 21.

## www.dansksvineproduktion.dk

On Danish Pig Production's web you will find a myriad of useful information on all the areas in which a modern pig producer needs to be updated. These include:

- News
- Legislation
- Publications
- Weaner and finisher prices

## InfoSvin

The pig database "InfoSvin" takes up a separate area on the website. Here all information is presented and ordered logically and systematically to make the site work as an efficient and comprehensive encyclopaedia for pig producers. You can access InfoSvin directly on this address: [www.infosvin.dk](http://www.infosvin.dk).

## Fact sheets in several languages

You will also find a wide range of technical subjects accompanied by practical guidelines on our website. These are made in A4 format and can be printed and placed wherever you may need them. We now co-operate with the Danish technical magazine SVIN and, monthly, SVIN will feature a new topic with practical guidelines in Danish, English and Russian that are also available for download from our website.

## Technical videos

As a novelty, Danish Pig Production will release technical knowledge on video. Videos are available for download that illustrate guidelines for "assessment of body condition" and "the strong gilt". The videos can be downloaded from [www.infosvin.dk](http://www.infosvin.dk) and are in Danish. In the future, these videos will also be available from InfoSvin in English and Russian versions.

We look forward to seeing you again at the Annual Meeting and Congress on October 20 and 21, 2009.

## In 2009, the Annual Meeting and the Congress will be held on October 20 and 21.



Fact sheet on selection and housing of gilts.

# Published results: 2007-2008

## Reports

- No. 0709: Product trial of feed stations (ESF)
- No. 0710: Bedded lying area with drain and combined feeding in long troughs and feeding/resting crates for gestating sows
- No. 0711: Importance of sperm defects to fertility
- No. 0712: Optimising design and use of hospital and buffer pens for weaners and finishers
- No. 0713: Cure in hospital pen and solid growth
- No. 0801: Ozone treatment of slurry in climate chambers with finishers
- No. 0802: Odour emissions from sow and weaner facilities in the winter

## Other reports

- No. 31: Validation of SpermVision CASA for analysis of sperm motility

## Trial reports

- No. 796: Soybean meal for weaners
- No. 797: Comparison of survival of offspring of Duroc boars and HD/Dh boars
- No. 798: Examination of sows with shoulder ulcers in to slaughterhouses
- No. 799: Ear ulcers in weaners – results from Studies in one herd
- No. 800: Study of damages to the genetic material of sperm cells
- No. 801: Additional vitamin E for lactating sows and weaned pigs
- No. 802: Controlling coccidiosis without using Baycox®
- No. 803: BIO-REX Hartmann Bio Filter tested in a finisher facility
- No. 804: Osteochondrosis in the elbow of finishers in four herds
- No. 805: Pen Concepts for loose farrowing and lactating sows
- No. 806: Conditions predisposing weaners to ear and tail bites
- No. 807: Study of the BIO-REX Hartmann filter in a finisher facility

- No. 808: Intra-uterine insemination using a two-chamber bag
- No. 809: Semen quality of Duroc boars
- No. 810: Reduced discharge of phosphorus from sow facilities
- No. 811: Phosphorus in finisher diets with a low content of plant phosphorus
- No. 812: Phosphorus in finisher diets with a high content of plant phosphorus
- No. 813: Risk factors of poor feed conversion ratios in finishers
- No. 814: Correlation between back-fat thickness and gilts' fat content
- No. 815: Comparison of results from the Danish odour labs
- No. 816: Heat during lactation
- No. 817: Housing finishers according to gender and ad lib feeding from tube feeders with and without water supply
- No. 818: Commercial weaner diets purchased in South-East Jutland in the winter 2007/2008
- No. 819: Study of the vertical according to American principle
- No. 820: Ammonia reduction and operating costs related to the Bovema S-air one-step air purifier in a Werner facility
- No. 821: Extra amino acids for gestating sows
- No. 822: PMWS transmits through air
- No. 823: Effect of vaccinating sows against pneumonia and pleuropneumonia – assessed in respiratory diseases in finishers in all in-all out management

## Other information material

- Ten-point plan for handling of shoulder ulcers
- Use the hospital pen in time
- Ten-point plan for reducing sow mortality
- Suitability for slaughter

### Note:

You can sign up for "News from Danish Pig Production" (only available in Danish) at [www.dansksvineproduktion.dk](http://www.dansksvineproduktion.dk) and receive an e-mail with links to the latest publications. The InfoSvin database is available at [www.infosvin.dk](http://www.infosvin.dk).



# Subject index

DKK +25 per finisher .....	51	Fertility.....	16	Pneumonia.....	14
Advice .....	24,50	Finisher herd .....	6	Polymer .....	31
Air purifier .....	29,30,33	Finishers .....	22,25,37,51	Post-weaning diarrhoea .....	12,48
Alarm system .....	33	Floor cooling .....	44	Production costs .....	8
Amino acids .....	22	Floor exhaustion .....	32	Production level.....	10
Ammonia .....	26,29,31,32	Flushing .....	18	Production systems.....	6
Ammonia emissions .....	5	Food safety.....	5	Production technology.....	4
Animal welfare .....	4,39			Productivity .....	7
Annual meeting .....	54	Gastric changes.....	42		
Aquatic Environment Scheme III.....	25	Genetic progress .....	10	Rate of return .....	9
		Genomic selection .....	12	Resistance .....	12
BAT .....	27,28	Gilts .....	18,19	Respiratory disease.....	15
Benchmarking .....	8			Rooting and enrichment material.....	36
Benzoic acid.....	26	Heat .....	19	Rubber mats .....	44
Biofilter .....	29	Heat check .....	18,19		
Boar taint.....	14, 46	Heredity .....	43	Sampling .....	24
Breeding objective.....	12	Hernia .....	14,40	Self-inspection .....	39
Breeding stock - sale .....	10	Horse beans.....	21	Semen .....	17,46
Business Check .....	8,9	Hospital pen.....	42	Semen - motility .....	16
Børgildgård .....	10			Semen quality .....	16
		Inbreeding .....	13	Service .....	18,19
Castration .....	46	InfoSvin .....	54	Sexing of semen .....	17
Chicory.....	46	Insemination .....	17	Shoulder ulcers .....	34,43
Coli diarrhoea .....	48	Iron.....	20	Slatted floor .....	44
Competitiveness .....	1,5,7			Slurry .....	30,32
Congress 2009 .....	54	Lactating sows.....	34	Slurry treatment .....	31
Corn .....	23	Lactation period.....	35	SmellFIGHTER.....	31
Crushing .....	36	Landrace .....	10,12,16	Solid floor .....	34-37
		Large White .....	10,12,16	Sorghum .....	23
Daily gain .....	26	Leg health .....	38	Sorting acc. to gender .....	46
DANISH .....	39	Liquid feeding - guidelines .....	52	Source separation .....	31
Danish Agro .....	21	Liquid feeding system .....	23	Sow herd .....	6,20,41
Demonstration project .....	41	Litter size.....	12	Sows .....	25,34
Development .....	7	Livestock units .....	6,27	Strategy .....	41
Diet.....	21	Longevity .....	20	Streptococci .....	47
Diet - composition .....	42	Luxation .....	40	Structureal development.....	8
Digestibility .....	25	Lysine .....	21,24		
Drained floor .....	35			Tail bite .....	40
Drying.....	23	Management .....	51	Traditional farrowing pen .....	34
Duroc .....	10	Management of condition .....	42	Transport .....	40
		Mess.....	37		
E.coli .....	12,47	Methionine .....	24	Vaccination .....	46,48
Environment .....	4	Mineral diets .....	24	Vaccines .....	49
Environmental authorisations .....	27,33	Mortality .....	41,48,49	Ventilation .....	30,37,38,51
Environmental requirements .....	28	MRSA .....	47	Video .....	54
Environmental technologies.....	28,29			Vision .....	4
Enzymes.....	22	Nesting material .....	34	Vitamin B12 .....	20
Eradication manual .....	50	Nurse sows .....	18		
Eradition - guidelines .....	52			Weaner diets .....	21
ESF management - guidelines .....	53	Odour .....	29,31	Weaners .....	21,25,37
		Operating costs .....	29	Weaning .....	35
Fact sheets .....	54	Ozone .....	30,31	Welfare inspection.....	39
Farrowing facility - guidelines .....	52				
Farrowing pen .....	38	Partial purification.....	33		
Farrowing rate .....	18	PCV2.....	49		
Feed.....	20,26,43,51	Phosphorus .....	5,23,25		
Feed consumption .....	26	Phytase .....	25		
Feed conversion ratio .....	12,13,51	Pig Levy Fund .....	5		
Feed prices .....	8	Piglet mortality .....	36		
Feeding .....	46	Piglets .....	35		
		PMWS.....	49		





