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Is there any hope?

We have rarely looked so hard for reductions in the European production with accompanying increasing prices.

It seems that the pig cycles in former times are replaced by a more stable production where the increase in efficiency largely sets off the drop of the farmers that stop production.

It also seems that the Danish banks largely choose to support unprofitable production for long periods in the hope of better days instead of bearing the loss.

All in all, a 'war of attrition' in which pig producers as well as lenders participate, even though quick winding-up may some times be a better solution for all parties.

Critical financial situation

For five years now, the average Danish pig farm has been in the red. This has never been seen before!

The main factor to blame for this is the feed prices, but many producers have also lost on trends in market prices on foreign borrowing. Hedging has become an important and necessary discipline in the pig industry.

Credit facilities and the willingness to invest have been extremely limited since the financial crisis in 2008. Investments are estimated to be one third of the normal level, which is obviously not a sustainable situation in the long run.

Long-term competitiveness

Weaner export remained very high.

However, the export of finishers has dropped, and the faith in the competitiveness of Danish slaughterhouses has returned.

Danish pig prices were among the highest in Europe, and, combined with high Danish productivity levels, this helped Danish pig producers to be among those in Europe who did least poorly in 2011.

Structure and environmental regulation

The requirement for group-housed sows by 2013 is rapidly approaching, and it was therefore extremely satisfactory to finally see the introduction of the long awaited scheme for reporting changes. This makes it possible to adapt productions and have full production in the facilities, but for those wishing to develop their production, an actual environmental approval is still the way forward.

Unfortunately, case review administration in the local authorities and the Environmental Board of Appeal is still far too long.

"Animal load" is a quota-like concept that may turn out to be of great importance in terms of development as well as economy for the individual pig producer, and it is therefore absolutely critical that it is handled professionally and fair.

It must not stop the development of the Danish pig industry.

Animal welfare, antibiotics and veterinary alert system

Pig Research Centre has laid down a series of animal welfare objectives towards 2020.

Mortality rates and the use of antibiotics must be reduced. We must reach 10% loose lactating sows. The number of farms completing audits must increase significantly.

Another concept that is now also part of the pig producers' everyday is the Yellow Card scheme where those who use twice as much antibiotics as the average must reduce their consumption. This has been demonstrated to have a significant effect.

To ensure efficient biosecurity, the industry has adopted Danish Transport Standard, which requires all vehicles arriving from other countries complete a safety wash at the Danish border.

Quarantine rules for visitors have also been revised with the result that quarantine is now calculated in proportion to the risk.

Stay in the lead

In 2011, the slogan at Pig Research Centre's annual meeting and congress was Stay in the Lead.

Danish pig producers are still in the lead in a number of areas, and we must fight to stay in the lead.

There is only one way forward; the advances and new technologies described in this report must be implemented and put to work on the Danish farms.

Thank you to all who participate in making this happen; pig producers, breeders, commercial companies, scientists, advisors and veterinarians etc.

Best regards

Lindhardt B. Nielsen and Nicolaj Nørgaard
Pig Research Centre

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Who are we?

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

The departments under Pig Research Centre employing approx. 155 people continue as research centre safeguarding pig-specific research and development tasks.

Tasks and activities in Pig Research Centre are laid down by a Sector Board "L&F Pig Production" that consists of 12 pig producers:

- 3 elected by the Primary Board, DAFC
- 3 elected by Slagteriforum, DAFC
- 3 elected by the three regions for regional pig production committees
- 3 elected by the Danish Pig Producers' Association

Budget and sources of income

Activities in Pig Research Centre are funded by a range of sources of income.

Genetic fees are among the most important ones. A large part of these fees are charged in connection with sale of genetic material.

In 2010, export constituted 33.4% of all genetic fees. The actual genetic fees

charged in Denmark amount to DKK 44.7 million corresponding to DKK 1.60 per pig. Export thereby constitutes a saving of DKK 0.80 per pig, and with the increase in genetic fees it was possible to reduce the charge via the Pig Levy Fund.

Strategy

The current strategy for Pig Research Centre is laid down for the period 2008-2013 with the below main areas of activity:

- Competitiveness
- Environment
- Animal welfare
- Animal health and food safety
- Implementation of know-how

DanBred is still expanding

Pig Research Centre organises and manages the genetic work in DanBred. Structure, new breeding methods and breeding objectives are constantly subject to evaluation and improvement.

Recent examples are genomic selection and the new DanBred strategy and the introduction of genetic fees. A joint marketing strategy will be developed in the years to come, not least on the German market.

New activities in 2012

The Board has prioritised the new activities to be implemented in 2012. Among these are:

- On-farm mixing of feed – quality, productivity and mixing accuracy
- Improved FCR among finishers – Dutch experiences
- Rye for finishers
- Development and testing of production facilities for weaning in the farrowing pen (WIF)
- 35 weaned piglets per sow/year. Tending to nurse sows.
- Electronic identification in Danish pig production
- Undocked tails and risk of tail biting
- Service/control facilities for loose sows
- Farrowing pens and facilities for loose sows – new combi pen
- Optimum production of entire male pigs – androstenone and reduction of boar taint
- Reduction of mortality from birth to slaughter: piglets, weaners and finishers
- Percentage and causes of stillborn piglets
- Supervision of farrowing and shift suckling of large litters
- Vaccination against disease
- High consumption of antibiotics – Leptospirosis
- Optimum use of antibiotics and handling of MRSA CC398
- Optimum treatment of diarrhoea

PRC budget 2011	
Genetic fees	70,000
The Pig Levy Fund	46,983
Funds from Rural Development Programme	20,630
Other income	108,568
Income, total	246,181

Ten years' development

Table 1 provides an outline of the development in the production economy the last ten years for full-time pig farms.

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

For the past ten years, the number of full-time pig farms has dropped by approx. 2,400, or approx. 40%, while the number of sows/year has increased from 187 to 311 (66% increase).

Produced finishers per pig farm increased from 2,545 to 5,180 (104%). Land increased from 93 to 150 ha (61%).

Please note that these are average figures for all pig producers, i.e. the average finisher producer has a production of 7,590 finishers and the average producer of 30 kg pigs has 553 sows/year.

The overall gross margin incl. field amounted to approx. DKK 2 million over the last decade.

In 2010, the annual gross margin increased drastically to DKK 3.1 million following increases in grain prices and pig prices.

Economy per production unit

For the last decade, the gross margin per sow/year has averaged DKK 3,773, while finisher producers had a gross margin per produced finisher of DKK 118. The best years for sows as well as finishers were 2001 and 2006. After hitting rock bottom in 2007, gross margin for sows increased to DKK 4,077 per sow/year in 2010.

Producers of finishers also experienced a decent increase in 2010 landing at DKK 135 per finisher.

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
No of. accounts	2,571	2,353	2,053	1,935	1,852	1,776	1,694	1,508	1,660	1,667
Farms	5,952	5,926	5,655	4,870	4,401	4,176	4,210	3,447	3,154	3,529
Sows/year	187	193	200	199	223	255	241	267	300	311
Produced finishers	2,545	2,777	2,969	3,415	3,397	3,677	4,003	4,713	4,607	5,180
Ha	93	97	104	112	115	125	136	148	148	150
Total economy	Amount per farm, DKK 1,000									
Gross profit	2,491	2,327	3,207	3,534	3,550	4,342	4,156	5,416	5,634	6,760
Gross margin	2,203	1,608	1,471	1,804	1,766	2,321	1,711	2,053	2,211	3,122
Financial key figures	Amount in DKK per production unit									
GM/sow/ year	6,135	3,852	2,853	3,850	4,033	4,811	1,893	2,828	3,398	4,077
Prod. pigs/sow/year	23.1	23.7	23.6	22.6	23.7	24.9	26.1	26.3	26.2	26.6
Price/prod. pig	447	352	309	338	351	368	327	333	354	369
GM/prod. weaner	266	163	121	170	170	193	73	108	127	154
Price per FU, sow feed and weaner feed	1.46	1.40	1.38	1.38	1.35	1.31	1.63	1.95		1.75*
GM/produced finisher	188	111	79	111	138	149	97	86	83	135
FU per kg gain	2.98	2.95	2.90	2.91	2.82	2.96	2.96	2.88	2.86	2.87*
Price per kg, incl. bonus payment	12.09	9.62	8.34	9.25	9.38	9.83	9.15	9.83	9.41	9.93
Price per FU, finisher feed	1.19	1.15	1.10	1.13	1.19	1.08	1.30	1.67	1.34	1.36*

Table 1. Ten-year development in pig production

*) Feed units 2010 are calculated on the basis of production reports and figures from the accounts.

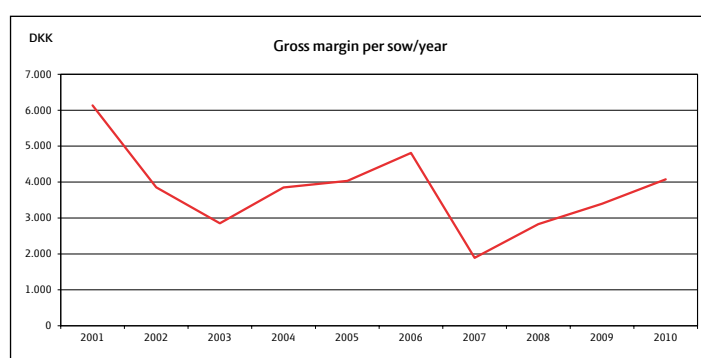


Figure 1. Development in GM per sow/year

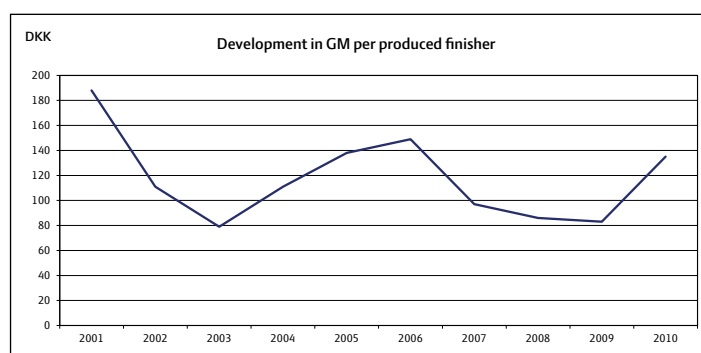


Figure 2. Development in GM per produced finisher

Production control reports

Data are supplied by the local pig advisory centres and include 749 sow farms with a total of 460,000 sows/year; 637 weaner farms with a total of 9.4 million weaners; and 815 finisher farms with a total of 4.8 millions produced pigs.

The results are shown as an average of all farms.

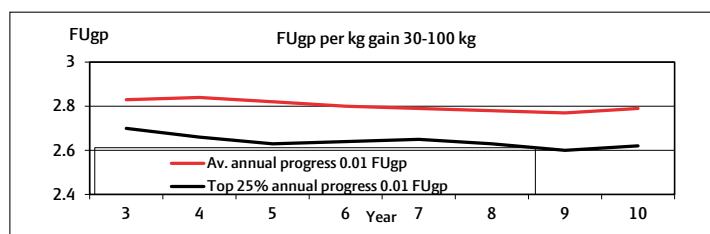
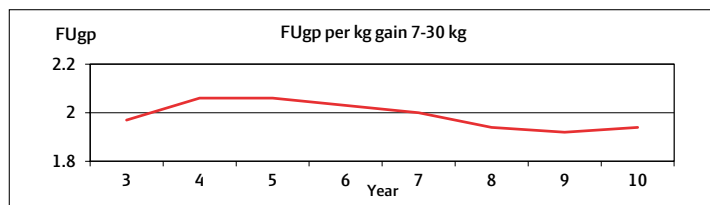
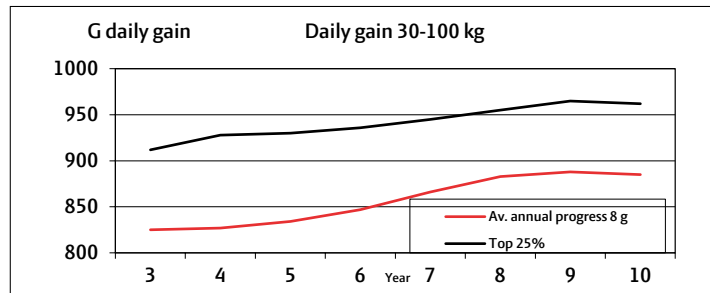
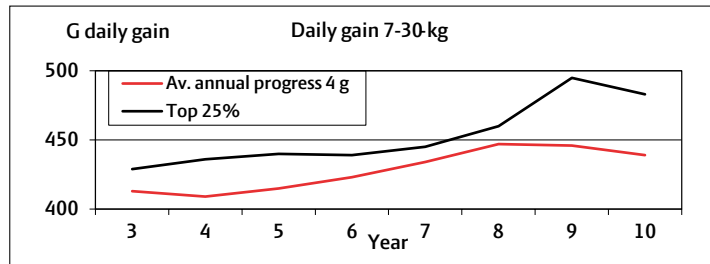
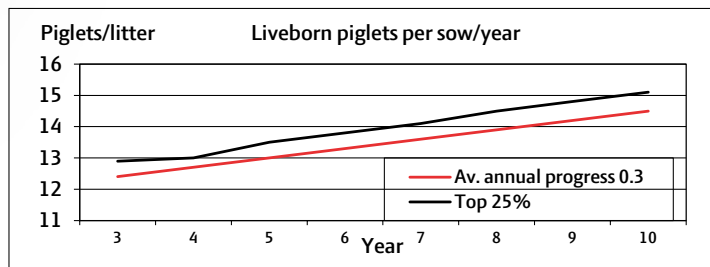
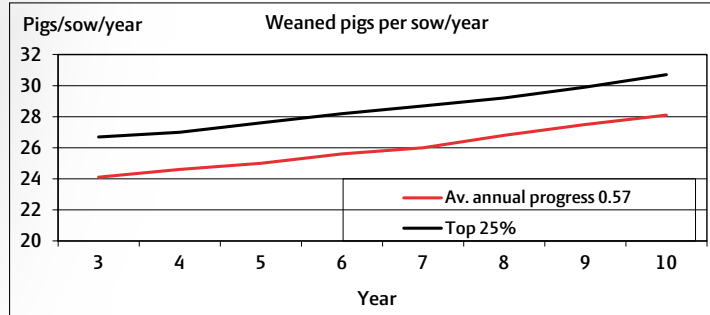
Sow farms weaned an average of 28.1 pigs per sow/year, which is an increase of 0.6 pigs a year compared with last year. Herd size now averages 615 sows/year.

Weaner farms produced an average of 14,817 weaners/year with an FCR of 1.96 feed units per kg gain, a daily gain of 450 g and a mortality of 2.8%.

Finisher farms produced 5,847 pigs a year. Daily gain averaged 895 g, FCR 2.87 feed units per kg gain, mortality 3.8% and rejected/culled 0.2%.

Top 25%

The top 25% of all sow farmers are 4-5 years ahead of the average farms. The top farmers in weaner and finisher production have a production level that is approx. 10 years ahead of the average farms. This demonstrates that a dedicated effort in weaner and finisher production has succeeded in increasing productivity significantly on the average farms.



Global profitability 2010

Globally, the pork prices were fairly good in 2010, which also affected Danish pig prices positively. This was enough to land Denmark third on the scale for financial cost-effectiveness in Interpig.

Unfortunately, Danish pig production produced a deficit for the fourth consecutive year.

In 2010, Denmark had a sensible competitiveness in the EU surpassed only by Spain.

In terms of production costs per kg carcass Denmark was also in the lead in Europe in 2010. Pig prices in 2010 were also better than the German.

In the EU, France had the lowest production costs in 2010, but French cost-effectiveness was lower than the Danish.

2010 brought no good correspondence between production costs and cost-effectiveness in the individual countries.

Competitiveness is not necessarily simply to be able to produce a good at the lowest costs possible.

The price of the product is just as important as the costs and thereby the cost-effectiveness, which is the relationship between: Calculated per kg carcass – production costs.

National pig prices

In 2010, pig prices in Brazil were thus $8.04 + 0.41 = \text{DKK}10.45$ per kg, which was higher than the Danish at $10.36 + 0.43 = \text{DKK} 9.93$ per kg.

Brazil was the only country in 2010 with a profitable pig production industry. Profitability analyses reveal a surplus in Brazil of DKK 2.41 per kg pork.

In Brazil, costs for feed, labour and capital were approx. DKK 0.45, 0.37 and 1.34 per kg lower than in Denmark in 2010.

Increased animal welfare requirements or specialisation in the production may raise pig prices, but not consistently.

Interpig is a group of American and European economists who benchmark pig production.

The UK and Italy have high costs, but also high pig prices. Sweden has high costs, but low pig prices.

Not all conditions are included

There may be different funding schemes, such as attractive VAT schemes in Germany and Ireland, interest and investment grants in Italy and Belgium, and other conditions that Pig Research Centre is unaware of, and these conditions are therefore not included in the figure.

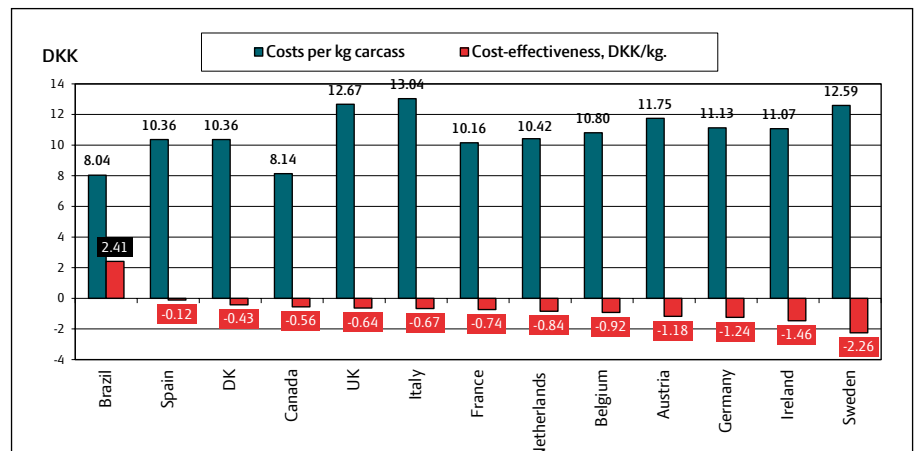


Figure 1: Production costs and cost-effectiveness per kg carcass in 2010.

ECONOMY OF ON-FARM MIXING OF FEED AND OWN PRODUCTION OF GILTS

ECONOMY

Economy of on-farm mixing

In the period 2006-2009, pig producers who mix their own pig feed had a better economy on average than those who purchased the feed. The difference averages DKK 35 per finisher (see Table 1).

Those who mixed their own feed generally have slightly larger herds, while the two groups have approximately the same number of finishers per hectare.

Producers who mixed their own feed achieved a higher gross margin that more than outweighs the additional costs for depreciation and wages. It should be underlined that the differences between the farms in each group are wide.

Is there a profit in own production of gilts?

Analyses of gross margin per sow/year in the period 2006-2010 demonstrate the differences between producers who buy gilts and those who recruit them from their own herd.

Figures reveal a higher gross margin when gilts are recruited on-farm, but when the overall economy is analysed, regard must be made for overheads and capital costs related to own production of gilts. These are in particular related to the space required for the gilts during growth and the labour required for managing breeding.

Furthermore, regard must be made to losses in castrates as these are normally

sold below market price and the price is possibly affected by weaner prices and possible reduction in production scope according to the environmental approval.

Practical example

A producer with 1,050 sows/year and sale of 30 kg pigs considers switching from purchase of gilts to own production with zigzag and nucleus management can make a calculation as shown in Table 2.

The increase in gross margin is primarily attributed to a lower price of the gilt.

Extra room is required for the gilts from 30 kg until transfer to the service facility, and more place units are required in the service facility as slightly more gilts are selected at own production. This totals approx. 175 m² – corresponding to an investment of DKK 750,000.

In their growth period, these extra gilts correspond to 10.8 LU; i.e. there is room for 25 fewer sows within the given environmental approval. Gross margin is thereby reduced by DKK 112,000 a year. Own production of gilts requires 1.5 hours of labour a week for nucleus management and 1 hour for ear tagging etc. This is an increase of 130 work hours a year corresponding to DKK 22,000.

When increased overheads and LU regulations are deducted, the advantage of own production is reduced to DKK 373 per sow/year.

Zigzag castrates are valued DKK 28 lower than the calculated price.

This leaves approx. 1,000 pigs from the nucleus farms, whereby income is reduced by DKK 28,000.

Depending on whether the pig producer manages to maintain the index level, the theoretical value of the weaners may be DKK 5 lower if the index is 10 points below the level in the multiplication herds.

Excess gross margin (from DB Tjek)	DKK 578
Extra room in facility	DKK 71
Extra electricity and water	DKK 6
Fewer LU – 25 sows	DKK 107
Labour	DKK 21
Result before castrate loss and weaner price	DKK 373
Castrate loss and weaner price	DKK 178
Result after price regulation	DKK 195

Table 2. Economy in own production of breeding stock (DKK/sow/year)

The reduced production value of castrates and possibly lower index value of weaners is valued at DKK 178,000 a year.

This leaves an actual excess income for own production of gilts of DKK 195 per sow/year.

In conclusion, the financial advantage of own production of gilts ranges between DKK 195 and 373 per sow/year, but there are other factors to take into regard as well.

	Purchased feed	Feed mixed on-farm
Agricultural area, ha	117	137
Produced finishers	5,936	6,723
	DKK per produced finisher	
Gross margin ¹	190	227
Cash capacity costs	-167	-171
Operational depreciation	-56	-63
Result of primary operation	-33	-7
Decoupled direct EU aid	48	49
Financing costs	-125	-117
Operating result	-110	-75

Table 1. Average per farm, 2006-2009.

¹Gross margin includes field production.

Own production of gilts:

- Interest and professional management
- Improved economy
- Risk of loss in index value

Buy gilts from another farm:

- High breeding index
- Stable replacement and age distribution
- Easy and safe
- High quality of the sales product weaners

Genetic progress

Table 1 shows the genetic progress per trait for each of the three breeds in the breeding programme in the period 2007-2011 and the average for a DL(Y) finisher for this period.

Considerable progress is still seen in the trait live piglets day 5 (LP5) for the dam lines, Landrace and Large White. Progress in feed conversion ratio remains stable at approx. 0.03 for a finisher, which is mainly attributed to progress in Duroc.

Production level

In 2010/2011, 4,603 boars were performance-tested at Bølgildgård of which 1,942 were Duroc boars. In nucleus breeding herds, more than 35,000 boars and 46,000 female pigs were performance-tested. Average production levels are shown in Tables 2-4.

As is shown in Table 5, Large White had 13.0 live pigs on day 5 vs. 12.4 pigs for Landrace. The figures are based on an average of purebred litters used for breeding.

Breed	Year	Daily gain (30-100 kg). g/day	FCR, FUp/kg gain	Lean meat %	LP5	Conformation points	Daily gain (0-30 kg). g/day	Kill out %	Longevity. %
Duroc	07/08	19.0	-0.038	0.16		0.04	3.5	0.01	
	08/09	12.6	-0.048	0.21		0.03	0.4	-0.04	
	09/10	15.4	-0.040	0.21		0.04	2.4	0.03	
	10/11	18.6	-0.046	0.16		0.03	3.1	-0.02	
	Av.	4 years	16.4	-0.043	0.19		0.04	2.4	-0.01
Landrace	07/08	-5.5	-0.003	0.01	0.55	-0.01	-3.5	-0.02	-0.03
	08/09	14.8	-0.023	-0.02	0.39	0.03	-0.8	0.07	-0.03
	09/10	8.8	-0.033	0.04	0.31	0.04	-0.9	0.02	-0.04
	10/11	1.2	-0.021	0.14	0.36	0.04	-0.3	0.09	0.00
	Av.	4 years	4.8	-0.020	0.02	0.40	0.03	-1.4	0.04
Large White	07/08	-5.6	-0.002	0.04	0.45	0.02	-2.1	0.02	0.00
	08/09	9.5	-0.029	0.04	0.35	0.07	-1.3	0.00	0.01
	09/10	5.5	-0.017	0.07	0.44	0.05	-1.2	0.06	0.04
	10/11	3.2	-0.029	-0.04	0.34	0.10	-0.6	-0.02	0.03
	Av.	4 years	3.2	-0.019	-0.01	0.40	0.06	-1.3	0.02
Av. 3 breeds	4 years	10.2	-0.031	0.10	0.40	0.04	0.5	0.01	0.00

Table 1. Genetic progress 2007-2011 for each trait and breed and an average of a D(LY) finisher.

Breed	Number	Daily gain, g*		Lean meat %	Conformation points	Scanning objective, mm	Scanning weight, kg
		0-30 kg	30-100 kg				
Duroc	6,673	390	1,094	61.0	2.89	7.7	96,1
Landrace	15,193	375	1,004	62.2	2.95	7.4	93,7
Large White	14,041	360	960	61.7	3.09	8.4	94,0
Total	35,907						

* Daily gain (30-100 kg) is based on weighing of live animals, ie. differences in kill out % between the breeds are not included.

Table 2. Nucleus herds - average production results for boars, 2010/11.

Breed	Number	Daily gain, g*		Lean meat %	Conformation points	Scanning objective, mm	Scanning weight, kg
		0-30 kg	30-100 kg				
Duroc	8,667	393	1,053	61.2	2.96	7.4	95.7
Landrace	20,543	379	950	62.5	3.03	8.0	93.5
Large White	17,700	363	920	61.6	3.15	8.7	93.5
Total	46,910						

* Daily gain (30-100 kg) is based on weighing of live animals, ie. differences in kill out % between the breeds are not included.

Table 3. Nucleus herds - average production results for young sows, 2010/11.

Breed	Number	Daily gain, g* (30-100 kg)	FCR, FUp/kg gain	Lean meat %	Kill out %	Scanning objective, mm
Duroc	1,942	1,062	2.38	59.9	24.3	6.9
Landrace	1,323	1,011	2.45	60.1	24.5	7.9
Large White	1,338	932	2.43	60.6	24.2	8.2
Total	4,603					

Table 4. Average production results from performance test station Bølgildgård, 2010/11.

AI boars

Landrace and Large White boars housed on AI stations are in production averagely 6.3 and 5.7 months, respectively, which is an increase of approx. half a month compared with 2010. Average time in production for Duroc has remained stable. The average index level for active Duroc boars has dropped by 1.5 index points (see Table 6).

Sale of semen

A total of 4,647,000 doses of Duroc semen were sold in Denmark, which is a slight increase compared with 2010 (Table 7). In 2009, export of Duroc semen abroad began, and over the last year, export of Duroc semen reached 671,000 doses, which is an increase of more than 60% compared with the year before. Overall, the sale of Landrace and Large White semen in Denmark is stable at approx. 260,000 doses, whereas foreign sales have increased drastically compared with 2010.

Sale of breeding stock

Sale of purebred breeding stock has dropped in Denmark, while export has increased: sales dropped by approx. 500 pigs in Denmark and export increased by approx. 2,000 pigs (Table 7).

This is also the case for sale of hybrids; sale of gilts in Denmark dropped from approx. 275,000 to 269,000 in 2010. However, in that same period export of hybrid gilts increased by 30% from 151,000 to 197,000. Export of hybrid gilts thereby constitutes more than 40% of the overall sale of hybrid gilts (Figure 1).

Currently, genetic fees amount to DKK 71 million a year, which covers a large part of the scientific activities in Pig Research Centre.

Maternal breed	Litter size	LP5	Per cent gilt litters
Landrace	15.5	12.4	73.2
Large White	15.8	13.0	57.5
Duroc	9.8	-	59.2

Table 5. Nucleus herds – litter size of purebred litters, 2010/11 (litters with code 100).

Breed	Boars transferred, 2010/11	Active boars, August 2011	Index for active boars, August 2011	Months in production of boars departed in 2010/11
Landrace	610	353	121.7	6.3
Large White	730	429	121.1	5.7
Duroc	2,585	2,170	111.2	10.7

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

	2009/10		2010/11	
	DK	Export	DK	Export
Purebred females	5,230	10,214	4,711	12,226
Hybrid females	274,700	150,800	268,963	197,048
DD and XX boars	1,290	1,300	1,328	1,493
LL and YY boars	75	970	45	1,481
DD and XX semen, doses	4,557,500	411,000	4,647,000	671,500
LL and YY semen, doses	268,300	-	260,080	-
On-farm breeding sows abroad*	-	101,000	-	156,100

Table 7. Sales totalled 444,579 animals in 2009/10 of which 37% were exported. In 2010/11, sales amounted to 487,295 animals of which 44% were exported. Besides the animals sold from Danish farms, 20,900 hybrid gilts were sold from DanBred Multiplication in foreign countries in 2009/10 increasing to 46,050 in 2010/11.

*Sale of semen doses abroad is not recorded according to doses sold, but according to the number of sows mated with semen from DanBred boars.

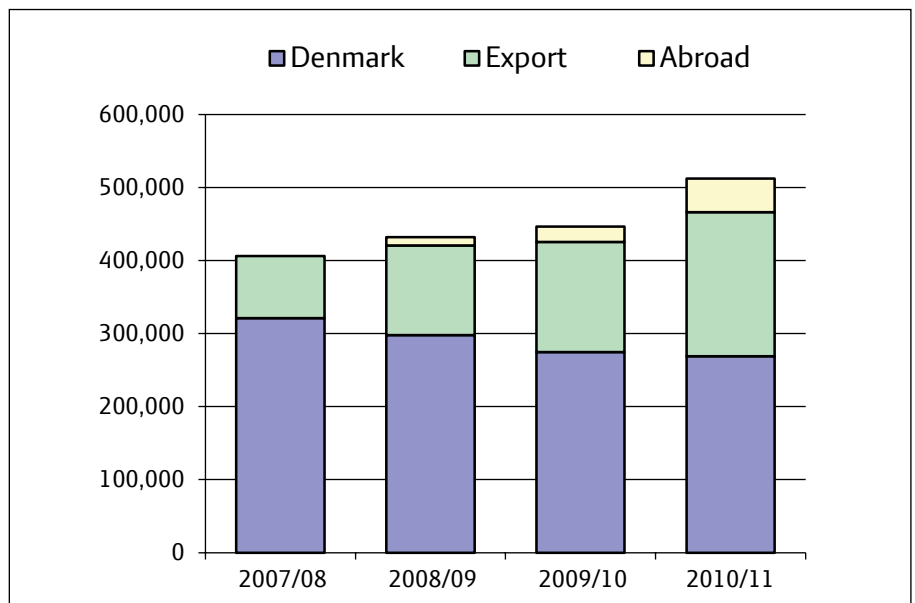


Figure 1. Sale of hybrids from Danish multiplication herds in Denmark and for export, and from foreign multiplication herds in the period 2008-2011.

Revision of the breeding objective

In March 2011, the breeding objective for Duroc, Landrace and Large White was revised. This work includes an analysis of whether the objective comprises the right traits as well as of the weighting of each trait.

At the revision in March, it was concluded to maintain the current traits in the breeding objectives (see Figures 1 and 2).

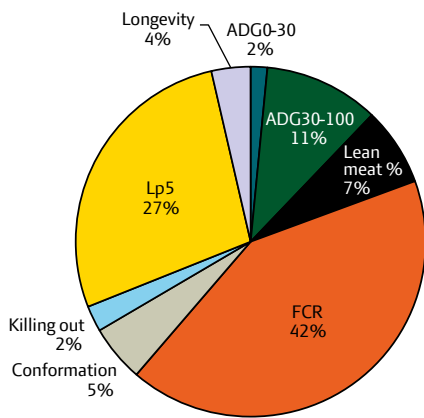


Figure 1. Composition for Large White and Landrace – economic contribution

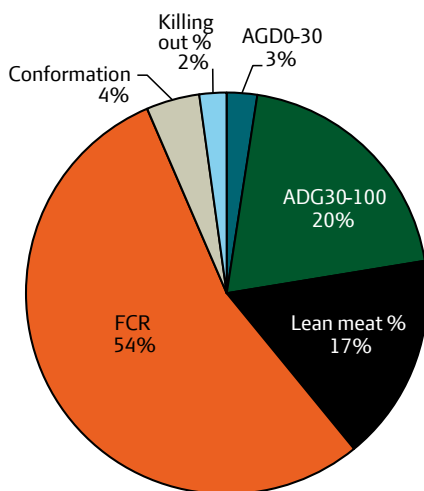


Figure 2. Composition for Duroc – economic contribution

Besides deciding which traits to include, the degree of selection capacity of each trait needs to be established.

DanBred has a long-standing tradition for weighting traits according to the economic value they contribute Danish pig producers.

It is estimated how much in Danish Kroner genetic progress in one trait is worth in the production of one finisher, i.e. including costs for producing one newborn piglet in the sow unit, costs for rearing and payment at slaughter.

In this calculation, more than 200 input parameters are used in a simulation programme in which regard is made to, for instance, production levels, costs related to pig housing, labour and wages.

It will take 5-10 years before the genetic progress made today is reflected on the production results of the commercial herds. The traits should, therefore, not be assigned the value of today, but rather the value they are expected to have in 5-10 years. Put differently, the input parameters for the simulation programme must reflect expectations to the level in 5-10 years.

Some input parameters were updated in this revision of the breeding objective. Analyses have revealed that the production level of the top 25% farms today roughly corresponds to the average 5 years later.

Only the value of LP5 was significantly affected in the most recent revision. The number of live piglets at day 5 (LP5) per litter has increased in commercial herds since the last revision in 2007. The value per finisher of one extra live pig at day 5 has decreased as the costs related to having a litter remain fairly stable and are now distributed on more piglets.

The value of feed conversion remains largely unchanged as the feed price used in the calculations is DKK 150/100 FUgp in 5-10 years.

All in all, this equals a breeding objective with less emphasis on LP5 and thereby relatively more emphasis on all other traits (Figure 1).

Genomic selection

Genomic selection (GS) makes it possible to increase genetic progress for all traits and at the same time reduce inbreeding.

In practice, GS enables - through information from DNA testing - a more accurate estimate of an animal's breeding index than previously.

Breeding programmes using GS do not differ greatly from conventional breeding programmes.

Breeding stock must still be tested and a conventional breeding index be calculated. As it is currently financially impossible to DNA test all animals, the conventional index is used for selecting candidates for DNA testing. With DNA testing, a more accurate index will be calculated, a so-called genomic breeding index, which is used when deciding whether to use an animal for breeding.

New software

In order to maximise the profits of GS, a new software programme called DMU is implemented for calculating breeding values. DMU is continuously being improved by scientists at Department for Animal Science (Aarhus University - AU) who collaborate with Pig Research Centre on this project, but it presents a multitude of options in the form of state of the art methods for evaluating breeding values compared with the software current available.

DMU ensures a more accurate assessment of the breeding stock, which in turn improves genetic progress. The research made by scientists at AU in GS is quite groundbreaking globally, and as DMU is being developed parallel with the latest research results, Pig Research Centre will be at the forefront in the utilisation of GS.

Collaboration with the scientists at AU Foulum – and thereby with those in charge of developing DMU – enables us to influence the further development of DMU. Consequently, in the future, we will

be leading in terms of implementation of new methods that may increase the genetic progress.

White breeds

Pig Research Centre expects to launch GS in Large White and Landrace in October 2011. This will increase genetic progress for all traits, but GS is expected to benefit in particular Landrace and Large White because of the better potential to select the best candidates for breeding. Today, it is very difficult to accurately assess the two dam lines, Landrace and Large White. It is difficult to rank the dam lines as some traits – such as LP5 and sow longevity – are only recorded for females and they are typically not recorded until after the boar is culled from AI.

Using GS, these boars will be ranked more accurately when DNA testing is implemented.

Costs for genetic selection are mainly related to the price of the DNA test itself, but costs also increase because boars that are DNA tested need to be housed for a longer period of time until the results of the DNA tests are available. It takes about four weeks from an animal is tested and until results are available; consequently, costs related to housing, feeding and a reduced slaughter price are increased.

It is therefore only possible to select a few animals for DNA testing, and it remains to be investigated how to select candidates from the white breeds optimally.

Perspectives

There is quite a potential benefit of using GS in the white breeds, but there are still many challenges ahead! So far these challenges have been solved successfully and we therefore have great expectations to GS in pig breeding.

Pig Research Centre has made great progress with GS in the Danish pig breeding programme. Today, DNA testing is used to improve genetic progress for all three breeds and for all traits in the breeding objective.

However, the methods used for estimating genomic breeding values can always be improved. Pig Research Centre has, already included the latest research, but the method is still being investigated and new results are likely to require an update of the models or of the selection of candidates for DNA testing. It is, therefore, an activity that will continue to require resources.

Pig Research Centre is constantly working on the possibility of breeding for new traits, and in this respect GS opens a range of possibilities. For instance, scientists are working on finding new traits that might improve maternal traits and improve sow longevity, and data are being compiled for this. In future, new traits may be included in the breeding objective.

The process of developing GS is taking place in a two-year project that started July 1, 2011.

The project, which is financially supported by GUDP, is a joint venture between Pig Research Centre and Aarhus University.

Breeding against shoulder lesions

For three years, the effect of breeding strategies on the occurrence of shoulder lesions was recorded and data analysed to conclude whether a heritable variation or heritable resistance to shoulder lesions exists.

In nine commercial herds, recordings were made of the occurrence of shoulder lesions on sows with known pedigree.

Data include a total of 77,300 evaluations from 17,019 lactation periods and 8,790 individual sows where each sow was evaluated by a technician 4-5 times in the same lactation period. Data were subsequently summarised for each sow to find the largest lesion measured in diameter recorded on a sow.

In 18.4% of all lactation periods, shoulder lesions were recorded at least once. Of the 8,790 sows in the project, 27.1% were

recorded with a shoulder lesions at least once (lesion 1 cm or bigger).

Results reveal a lower frequency of shoulder lesions in parity 1 compared with the subsequent parities.

Sows in poor body conditions also have a greater risk of developing extensive lesions. Likewise, large variations were observed between the herds.

The genetic analysis is based on data from 469 fathers with at least five daughters on whom recordings were carried out. Daughters from these fathers total 5,740 sows. The trait is defined as maximum lesion diameter (cm) for each sow.

The preliminary analyses reveal a heritability of approx. 15%. Even though results reveal that shoulder lesions have certain heritability, it will be difficult to increase resistance to shoulder lesions through genetic selection as an accurate genetic evaluation of the fathers require recordings of many daughters per father. The advantages of including shoulder lesions in the breeding objective will therefore currently be small. Perhaps, in the future, a new breeding technique might enable inclusion of shoulder lesions as part of a longevity trait.

Decreasing piglet mortality

The number of live and dead pigs in nucleus breeding and multiplication herds has shown positive trends since 2004. Data from purebred sows in nucleus breeding and multiplication herds reveal a steady decrease in mortality since the introduction of the trait live piglets at day 5 (LP5) as shown in Figure 3. The reduced piglet mortality results in more surviving pigs, and the number of live piglets at day 5 has, therefore, increased. In 2004, when LP5 was introduced in the breeding objective, piglet mortality averaged 21% and 23% of all piglets born in the first parity of Landrace and Large White sows, respectively.

By 2011, these figures have decreased to averagely 15.4% and 16.9% for newborn

piglets of the two breeds. Mortalities are based on the overall number of piglets born, which also includes stillborn piglets. Analyses of the changes in the total number of piglets born and live piglets at day 5, furthermore, demonstrate that the change in mortality is almost exclusively attributed to an effect of breeding.

The current recordings show no indications that this trend will stop. Further analyses reveal that the positive trends in live piglets at day 5 and mortality in nucleus breeding and multiplication herds are attributed to genetic progress. LP5 was included in the breeding objective in the 2004 revision of the objective. The result was a genetic reduction in the number of stillborn piglets in the individual litters, while litter size still underwent genetic progress.

Causes of piglet mortality

Results from investigations of the causes of piglet mortality reveal that piglet mortality is heritable to some extent.

The causes “stillborn” and “starvation” had were more heritable than “born weak”, “crushed to death”, and other causes. The investigation was based on recordings of 31,754 hybrids from 1,994 litters produced by 195 Duroc boars and 879 LY/YL sows. The causes were recorded in a commercial herd in the period 2006-2008. Liveborn piglets were ear-tagged at birth and all piglets had known pedigree. The pigs were followed until they weighed approx. 30 kg, and date and mortality cause were recorded for all dead pigs.

Of all piglets, 11.7% were stillborn; 2.3% were born weak; 2.7% died from starvation; 4.3% were crushed to death; and 3.1% died from other causes.

The heritability for the risk of being still-born or from being born weak, starvation, crushed to death or other causes was very low. This indicates that even though piglet mortality is heritable, the advantages of including specific mortality causes in the future breeding work will be small.

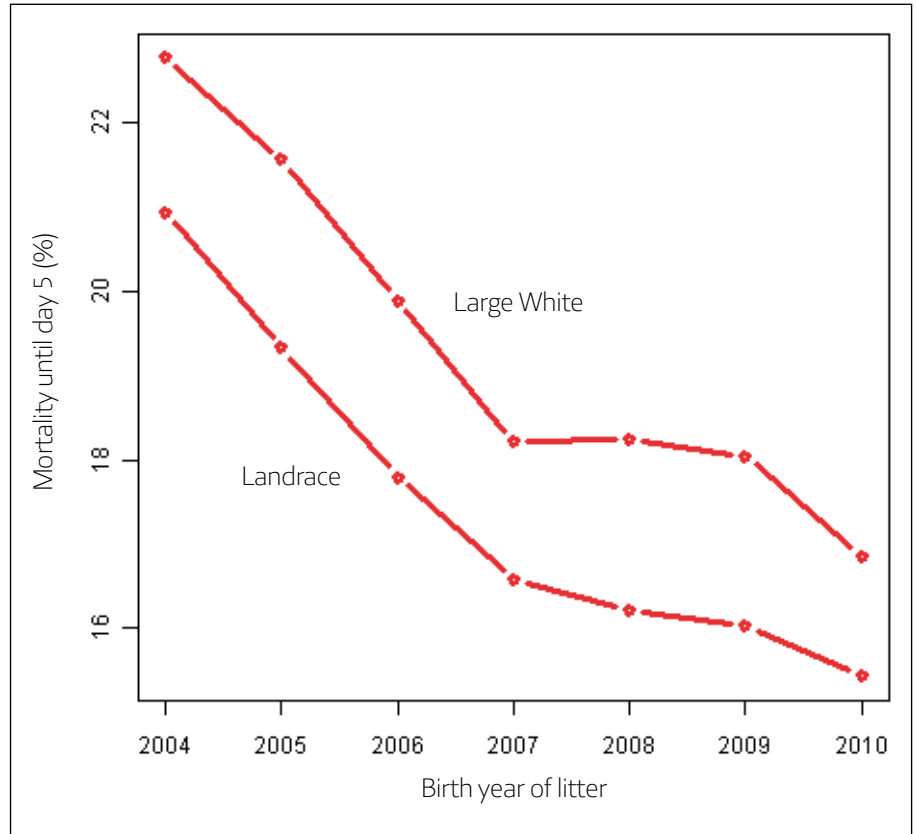


Figure 3. Trends in piglet mortality (including stillborn) of first parity Landrace and Large White sows from nucleus breeding and multiplication herds.

Sale of semen

Sale of semen from DanBred's AI stations dropped by 1% compared with 2010. In 2011, a total of 5.4 million semen doses were sold corresponding to approx. 95% of all matings in Denmark being performed with semen purchased from an AI station.

Sperm quality

Upon collection, semen from DanBred AI stations is subject to quality checks immediately. Quality control procedures also include analyses of whether:

- Semen doses contain the correct number of sperm
- The materials used on the AI station are sperm-friendly
- The quality of sperm from Landrace and Large White boars is as expected

Computer analyses of sperm motility (CASA) are now used for auditing Landrace and Large White boars and the materials used. In the future, it will thereby be possible to cull boars on the basis of this improved method for recording sperm quality.

Audit of AI stations

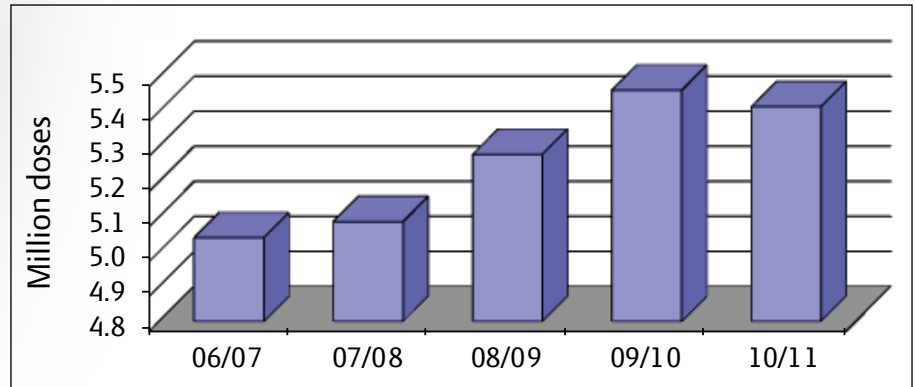
Pig Research Centre conducts a series of unannounced audits on Danish AI stations.

In August 2010, unannounced audits were made of Hatting AI departments in Aalborg, Horsens, Ministergården, Odense, Ringsted and Viborg and of Boar stations Mors 1 and 2.

Results revealed that too many semen doses from Hatting AI Viborg contained too few sperm according to the guidelines.

In January 2011, unannounced audits were made at Hatting AI departments in Aalborg, Horsens, Odense and Viborg and of Boar stations Mors 1 and 2.

Results revealed that too many semen doses at Hatting AI Horsens contained too few sperm according to the guidelines.



Semen sale the last 5 years.

Recording of sperm quality

Recording of sperm quality involves several activities ranging from recording of sperm defects and motility to advanced analyses of biochemical markers on the sperm.

The aim is to improve the predictability of sperm fertility through objective methods. Pig Research Centre has developed an instrument with which it is possible to record whether sperm cells are normal and motile. Pig Research Centre is also working with Copenhagen University Hospital on development of new methods for recording of sperm quality.

Sperm quality and mixed semen

The percentage of motile sperm cells in a semen dose recorded with CASA provides an estimate of the semen's shelf-life. Pig

Research Centre investigated whether fertility is affected when using sperm with reduced motility mixed with high-motility sperm.

Analyses revealed no differences in litter size (stillborn as well as liveborn) between sows inseminated with mixed (high and reduced) sperm and sows inseminated with highly motile sperm. No differences were found in farrowing rates between the two groups. However, sows inseminated with sperm with reduced motility overall gave birth to significantly fewer piglets and had a significantly lower farrowing rate.

It is currently being investigated whether fertility is affected if the semen dose contains sperm mixed from one, three or six boars. Results are expected in 2013.



Analysis of sperm in a semen dose.

Stimulation and oestrus detection

Research results from Pig Research Centre revealed that it is not necessary to stimulate the sow during insemination. It is therefore now being investigated whether it is possible to reduce the time spent on stimulation before starting the insemination process. Oestrus detection is performed on the sows in the control group according to the stimulation plan for 1 minute followed by stimulation where the person is placed on the sow during insemination. In the trial group, stimulation is initiated according to the stimulation plan, but is interrupted the minute oestrus is observed. Results of the trial will be available in 2012.

Oestrus in gilts

On many sow farms, management routines for gilts are inconsistent, and as a result the producer will never know how many gilts in a batch will be in heat and ready for service. Consequently, more work is required for locating gilts ready for service, and gilts are often selected on the basis of size, and not age, when they are served. This leads to uneven sow batches, which makes it more difficult to work in the farrowing facility and cull sows at the right time.

It is possible to affect the onset of the first oestrus in gilts through boar contact, mov-

ing of pigs, feed dose and light intensity. When these elements are implemented in the right order, all gilts in a pen will typically show heat 5-8 days later. Gilts must obviously not be cyclic when they are exposed to these elements. Once oestrus is observed, gilts are marked – for instance with a different colour for each week – and their age is listed. Three weeks later, these gilts enter their second oestrus. The producer now know how many gilts are ready for service and their feed dose can be increased 7-10 days before expected service (flushing). Litter size has proven to increase significantly when gilts are served in their second oestrus combined with flushing (minimum 3.5-4 FUSow a day).

On ten large sow farms, individual action plans were used as a tool to improve management of oestrus in gilts.

The main element in these action plans was organising the gilts to become familiar with their age and time of oestrus. Boar contact, time of moving and light intensity were all elements of the action plans.

As a consequence, the majority of the gilts are now served at a more uniform age interval between 8 and 9 months. Old gilts are culled and only gilts in min. second oestrus that were flushed are served.

Staff on these farms expresses that this helped their work as they now concentrate on a few gilts in the service facility at stimulation and insemination.

Elements in the action plans included

- Checking that gilts were not cyclic at transfer to the service facility
- Transfer of gilts to the service facility on the basis of age, not size
- Systematic introduction of the gilts to boar contact before they become cyclic – typically upon transfer to the service facility
- Individual recording of age of the gilts and oestrus – primarily by using recording forms with different colours for each batch
- Culling of gilts older than 10 months and of gilts in poor constitution and body condition
- Flushing of the gilts 7-10 days before service
- 100 LUX in the pigs' activity area 16 hours a day
- The majority of the gilts must be served when they are 8-9 months old.

The greatest progress was seen on a farm where the average age at service was reduced by 85 days and the spread in age at service dropped from 50 to 20 days. This reduced feed costs by DKK 160,000 a year.

A longer period is required before an effect of these routines in management of oestrus in gilts is seen in the form of improved production results.

Research and development in AI is co-financed by DanBred's AI stations and is financially supported by the EU and the Rural District Programme under the Danish Ministry of Food, Agriculture and Fisheries.

It is an advantage to mark gilts in a batch with different colours according to the week they enter oestrus.



Large litters is a must

Large litters should not jeopardise neither welfare nor survival of sows and piglets. Efficient performance levels require that each sow weans many piglets. This influences the economy of Danish pig producers and is a sales parameter in connection with export of breeding stock.

Breeding for maternal traits

Performance of sows and their ability to rear their own piglets will improve, when the parameters for future breeding for maternal abilities are selected.

In commercial herds with sows with known pedigree, newborn piglets are ear-tagged at birth and live piglets at day 5 are recorded (LP5). Recordings of LP5 in commercial herds demonstrated that the positive effect of LP5 in nucleus and multiplication herds is also reflected in commercial herds.

Several traits are recorded on hybrid sows in commercial herds and these are utilised in the work with genomic selection. When genetic combinations corresponding to the desired high or low levels of certain traits are determined, it is possible to breed for these traits by selecting breeding candidates with just the right combinations.

Over two years, sows' ability to rear minimum 14 piglets from day 1 to day 21 after farrowing was recorded, and this is now a trait called 14G. Sows' longevity expressed as their time in production is also recorded as a trait. This overall reflects a sow's performance and its ability to cope with



All sows must wean many, large piglets.

the environment and handle the infection pressure in the herd. These three traits are routinely recorded in a number of commercial herds, and the results will be used in the project "Genomic selection".

Farrowing pens for large litters

Easy access to the sow's udder is one condition for optimum milk intake in piglets. The aim is bigger piglets at weaning – also in large litters of 13-15 piglets.

Pig Research Centre compared the AP Welfare farrowing crate with the traditional AP farrowing crate. Preliminary results reveal that it is not possible to increase litter weight at weaning in the new farrowing crate. The trial was not designed to test whether only the smallest piglets in a litter benefit from increased space at the udder.

Regardless of brand, farrowing pens for sows come in fairly similar designs and layouts. With the exception of increased width and breadth of pen and crate and extended cover for the piglets, this pen has not developed significantly over the years. It is currently being investigated how to improve the layout of traditional farrowing pens for large litters. At a workshop, managers of farrowing units, among others, discussed "user desires" and proposals for improvement of the layout of farrowing pens to make sure that the pens meet future requirements and are able to adapt to large litters, requirements for working environment etc. The results from the workshop will be new pen concepts that will be tested on-farm in 2012.



Improved access to the udder did not significantly affect litter weight at weaning (AP Welfare farrowing crate).

The Programme began in 2009 and is financially supported by the EU and the Rural District Programme under the Danish Ministry of Food, Agriculture and Fisheries.

Extra vitamin D for sows

Research from the Department of Animal Science at Aarhus University demonstrated that the percentage of stillborn piglets per litter dropped when the inclusion of vitamin D3 increased from 800 iu to 1,600 iu per feed unit gestation diet. However, when these two inclusion rates were studied in practice on two farms, no difference in percentage of stillborn piglets per litter was observed. Consequently, it is recommended that vitamin D3 inclusion in gestation feed comply with the standard of 800 iu per feed unit.

Phase-feeding in the farrowing facility

Theoretically, sows need easily digestible energy to complete farrowing and medium-chain fatty acids to produce colostrum. These theories were investigated with three different starter diets fed to sows from transfer to the farrowing facility and until day 5 post-partum. All sows were subsequently fed a conventional lactation diet. Sows in the control group were fed the conventional lactation diet throughout the entire trial period from transfer to the farrowing facility.

- Two starter diets contained 2.8 and 4.25% coconut oil, respectively.
- One starter diet had a low content of protein.

None of the tested diets improved production results compared with the control. The recommendation remains to feed one diet to sows while in the farrowing facility.

Feed consumption in sow herds

Sows must be assured a sufficient energy intake to manage production of foetuses and milk, and this energy must be accessible in the form of feed whenever the sows need this.

In nine sow herds with a feed consumption above 1,450 feed units per sow/year, causes for this high feed consumption

are being investigated. Preliminary results from the herds indicate that it is possible to reduce the feed consumption.

The below measures were implemented on these farms (in prioritised order):

- Assessment of body condition at service and at transfer to the farrowing facility. Use of different feeding levels for thin, normal and fat sows.
- 3-6 feedings per day in the farrowing facility. Feeding levels to ensure the energy required for milk production is available.
- Maximum temperature in the farrowing facility of 18-20 C°.
- Efficient procedures for heat control and gestation check to keep the number of non-productive days low.
- When many piglets stay with their mother, the need for nurse sows is kept at a minimum.
- Frequency of gastric ulcers is kept low when sows are fed medium-coarsely ground diets or pelleted feed that includes 10-15% grain that is not heat-treated.
- Strategies for oestrus detection in gilts to ensure that gilts are served in their second heat.

Each farm will be monitored for approx. 12 months, after which the effects on the overall feed consumption per sow will be analysed.

Milk production

The posterior teats often turn inactive on lactating sows. In one trial, tape covered the pair of teats in 2nd and 4th row of teats. The sows were then given ten piglets to rear. With the exception of one sow, all sows weaned 9-10 piglets. This demonstrates that the posterior teats are also able to produce until weaning. If a normal teat is inactive during a period of lactation, a piglet will grow just as well using this teat in the subsequent lactation period. If a piglet dies, it is therefore not essential that another piglet takes its place to keep the teat active.

In another trial, development of teats was followed from weaning of a female pig until it, as a sow, weaned the first litter. It



Even if some teats are not suckled during one lactation period, they will still produce normally in subsequent lactation periods.

is easy to count the teats in a piglet if it is held with the stomach upwards, whereas it is more difficult when it is held in the hind legs. It is not possible to properly evaluate the quality of the teats of a gilt until the gilt is close to farrowing. In this trial, approx. 10% of the sows weaned more piglets than the number of productive teats at farrowing. This reveals that the number of functional teats does not always determine how many piglets a sow is capable to rear in the last part of lactation.

Keep an eye on the smallest piglets

The smallest piglets in a litter take in sufficient colostrum, but subsequently compete poorly by the udder. It is therefore essential that they are assured access to a functional

teat. It is recommended to use a “nurse sow for small piglets”, Here the smallest piglets are assured a functional teat without competition from large litter mates. Piglets have enough energy to survive the first 24 hours at the sow after which in particular the smallest piglets are at risk of dying if they do not get access to a functional teat. Large piglets may die in a larger litter later in lactation. It is therefore essential to keep monitoring the piglets’ development for more than just the first 24 hours.

Advice improves productivity

Four farms are currently participating in a demonstration project aimed at increasing productivity levels and reducing mortality rates. Every two months, the farms are visited by an advisor from the expert group “Farrowing Facility Management”.

Target areas

Farm 1 (before: 26.9 weaned pigs per sow/year):

- Quality of the gilts and recording of gilts’ first heat
- Handling of newborn piglets (colostrum intake, cross-fostering and nurse sows)
- Strategies for exchanging litters and for detection of piglets that do not thrive.

Farm 2 (before: 31.7 pigs per sow/year):

- Switch to purchase of gilts to utilise genetic progress

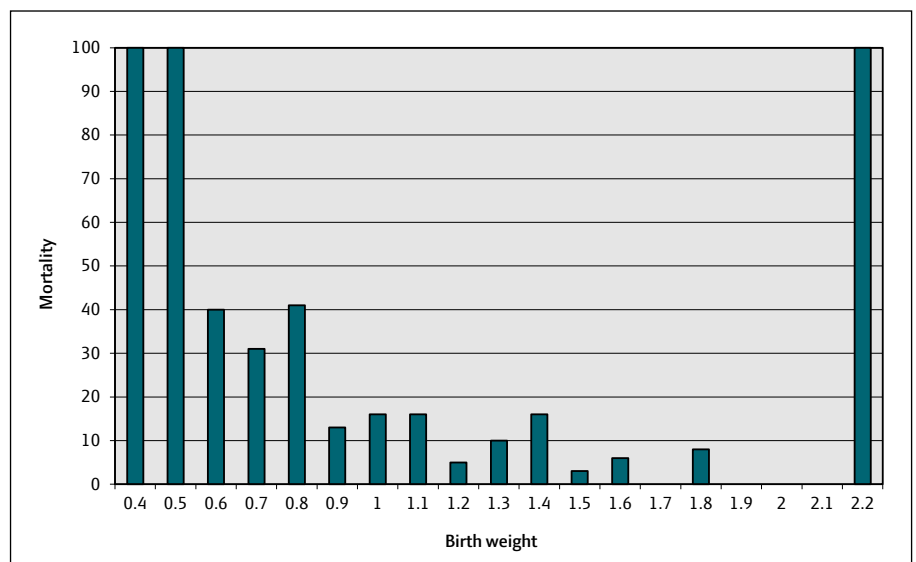


Figure 1. Mortality rates in relation to increasing birth weight. Only one piglet weighed 2.2 kg.

- More co-operation in the farrowing facility with focus on management, detection of piglets that do not thrive and colostrum intake
- Additional staff employed
- Optimised feed compounding and revision of the feeding strategy.

Farm 3 (before: 28.8 pigs per sow/year):

- Laboratory examination lead to an increased focus on handling of viruses (veterinarian)
- Piglets assured access to colostrum
- Focus on a high feed intake in the farrowing facility and on insemination techniques to increase litter size.

Farm 4 (before: 25.7 weaned pigs per sow/year):

- Increased light intensity in the service and control facility
- Focus on detection of piglets that do not thrive
- Management of floor heating in the creep area
- Culling of sows after 6th parity if they do not perform well.

Mortality dropped

Piglet mortality varied greatly among the four farms at the start of the project. Overall, piglet mortality dropped by 2.9 percentage points despite an increase in litter size of 0.3 piglets.

More piglets weaned per litter

Three farms managed to significantly increase the number of piglets weaned per litter, while one farm is still struggling with high mortality rates due to insufficient milk production among the sows.

More piglets weaned per sow/year

In one year, productivity increased by averagely 1.9 weaned piglets per sow/year, while the national average in the same period increased by "only" 0.4 weaned piglets per sow/year.

Expert group for advisors

The herd advisors in the demonstration project were supported by the expert group "Farrowing Facility Management".

This group consists of 14 pig advisors specialised in management in the farrowing facility. The focus point for this group is the manual "Guidelines for Farrowing Facilities", which is continuously updated and extended.

Continued focus on welfare

In "selection for maternal traits", the first calculations of heritability for number of weaned pigs (14G = 14 weaned per litter) have now been made. New farrowing pens are being tested that are expected to improve the working environment for the staff and to improve the microclimate for the piglets. In years to come, trial activities will focus on the piglets that are weakest at birth and on runt piglets. The optimal feed composition for lactating sows is investigated to ensure the sows have enough energy to give birth to strong piglets and at the same time produce enough milk.

The programme "35 weaned piglets per sow/year" continues with renewed financial support from the EU and the Rural District Programme under the Danish Ministry of Food, Agriculture and Fisheries.

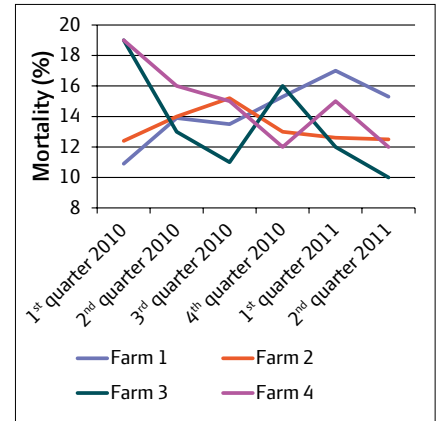


Figure 2. Development in piglet mortality. The vertical black line indicates the start of the project.

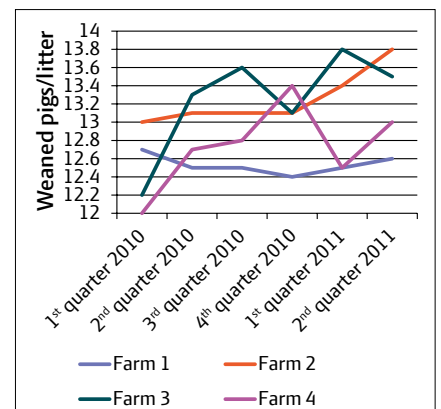


Figure 3. Development in weaned piglets/litter.

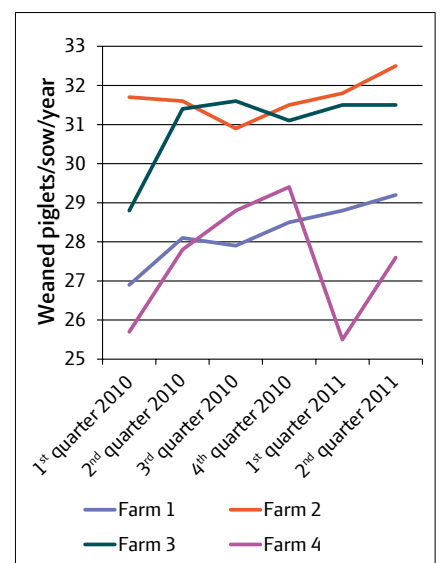


Figure 4. Development in weaned piglets per sow/year.

Before farrowing

At birth, piglets come from 39 C° in womb of the sow to room temperature in the pen. To put minimum pressure on the piglets, it is crucial to make sure that the sow as well as the pen is ready for farrowing. This includes preparing and drying the farrowing facility as described in the Fact Sheets in the manual Guidelines for Farrowing Facilities.



Farestaldsmanual version 3.3 - maj 2011



The manual Guidelines for Farrowing Facilities includes 29 Fact Sheets that briefly describe best practice in the farrowing facility. All Fact Sheets are available in Danish and English at www.vsp.lf.dk.

Reduction in stillborn

As a result of the implementation of the breeding objective LP5, the percentage of stillborn piglets has dropped. However, sows must not be too fat in the farrowing facility and obstetric aid must be efficient so that all sows regularly supervised during farrowing. Two hours are allowed to pass between the birth of each of the first four piglets in a litter. When piglet number 4 is born, staff should intervene if no piglets are born within an hour, which is the time it takes for all the piglets that are born to dry completely. On three sow farms, the percentage of stillborn piglets dropped by 25% when regular supervision routines were introduced. At Pig Research Centre's website, a video provides detailed instructions in how to perform obstetric aid to prevent uterus infections in the sows.



No two piglets are identical at birth; many factors, such as BMI ("thin" or "fat"), influence a piglet's chances of surviving.

More piglets are weaned

LP5 also increases survival rates post-partum. During lactation it is also important to employ all the existing know-how presented in the Guidelines on Farrowing Facilities. Experts from the local pig advisory offices can help prioritise the recommendations for each farm and prepare action plans and work routines matching the needs of staff and farm.

The first 24 hours after birth is the most crucial period as this is when most piglets die. Particularly energy intake and heat are among the factors that determine whether a piglet survives, and these two factors are therefore included in several Fact Sheets in the Guidelines.

Pinpointing piglets at risk of dying

With large batches and large litters, it is essential to be aware of piglets that are at risk of dying. On one farm with loose

By 2020, piglet mortality rates must be reduced by 20% to 20% stillborn and dead during nursing through:

1. Implementation of existing know-how on all Danish farms
2. Development of new know-how
3. Continued breeding for live piglets on day 5 (LP5)

farrowing sows, Pig Research Centre investigated the importance of the piglets' physical characteristics in relation to their chances of survival and growth.

The majority of the piglets that died during nursing were male piglets. They had a low BMI, i.e. they were thin, and were born of first or second parity sows. Post-mortem examinations of 291 piglets that died within 24 hours post-partum revealed that 79% had empty or almost empty stomachs. Of the 227 piglets that died within days 2-26 post-partum, 55% had empty or almost empty stomachs.

This underlines the importance of piglets being assured of a sufficient milk intake – particularly the piglets at risk of dying.

From birth to slaughter

This is a new programme concerning strategies for supervision of farrowing, analyses of causes of stillbirths, and strategies for ensuring that sows rear as many of their own piglets as possible. Different management routines and health will be compared between farms with high and low mortality rates from birth to slaughterhouse.

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

Reverse phase-feeding

The effect on weaner productivity and diarrhoea of diets with increasing content of protein was investigated in a trial where the pigs were given feed with either high or low protein content in the period 7-16 kg.

From 16 to 31 kg, the pigs were fed one of six different diets with increasing concentrations of protein and amino acids with a fixed ratio between the individual amino acids and protein.

Preliminary results demonstrate that treatments days per pig dropped (1.3) when the pigs were fed low-protein feed in the period 7-16 kg compared with high-protein feed (crude protein and lysine, respectively: 153 and 9.5 vs 155 and 11.6 stdig. per feed unit). No effect was observed of protein content on diarrhoea in the period 16-31 kg.

With the current prices, "reverse phase-feeding" (low protein from 7 to 16 kg and, for instance, 10.5 g stdig. lysine per feed unit from 16 to 31 kg) did have a financial advantage. The actual production value (including the current feed prices per protein concentration) is illustrated in Figure 1.

Origina for weaners

Origina, which is an additive containing ethereal oils extracted from oregano, was investigated in feed for weaners (approx. 7-31 kg). The first two weeks post-weaning, 1 kg Origina was added per tonne finished feed decreasing to 500 g in the remaining part of the trial period.

Overall, trial results revealed no benefits from adding Origina to the feed as production values were identical in control and trial groups.

Rapeseed for weaners

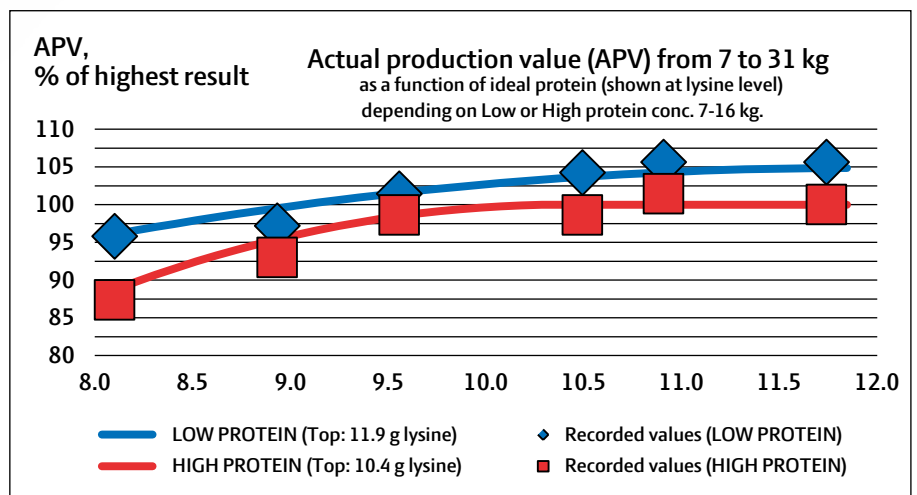
High glucosinolate concentrations in pig feed are assumed to reduce productivity and the effect of glucosinolate concentrations and processing conditions on productivity was therefore investigated.

Two different varieties of rapeseed; Excalibur (high glucosinolate) and Lioness (low

glucosinolate), were used for the production of rapeseed cake. Three different types of processing conditions were studied; high and medium temperatures and cold-pressed. Starter diets included 8-9% rapeseed cake and weaner diets included 15% rapeseed cake.

Results revealed no significant differences in daily gain, FCR, treatments for diarrhoea and mortality rates between the groups.

The results demonstrated that the pigs were capable of digesting feed containing rapeseed cake regardless of the processing of the rapeseed.



Protein	Control	Rapeseed cake				
		Medium	High	High	Cold	Cold/dehulled
Processing conditions	-	Medium	High	High	Cold	Cold/dehulled
Glucosinolate in rapeseed cake, µmol per g	-	Low 13	Low 10	High 23	Low 12	Low 12
g/day	510	495	496	508	488	480
FUgp/day	0.89	0.89	0.85	0.87	0.83	0.81
FUgp/kg	1.74	1.80	1.72	1.73	1.71	1.69
Index, identical prices	100	94	99	101	97	98

Table 1. Productivity and production value in the trial period 7-30 kg (preliminary results)

Production results, 7-16 kg	Low protein	High protein
Stdig. crude prot, g/FUgp	136	155
Stdig. lysine, g/FUgp	9.5	11.2
Pens	239	237
Daily gain, g	316	353
FCR, FUgp/kg gain	1.70	1.58
Days spent on treatment for diarrhoea per pig (of 24 days)	0.50	1.60

Table 2.

Phase-feeding at pen level

When fed dry feed ad lib, finishers have a high feed intake towards the end of the growth period, which results in a high daily gain, but also a poor FCR and low lean meat percentage. This is a problem, in particular for castrates that have a higher feed intake (approx. 0.2 FUgp higher) during growth than female pigs.

It was therefore investigated whether it is possible to restrict pigs' feed intake towards the end of the growth period by feeding a low-energy diet in this period (end diet).

The pigs in the trial were divided into groups according to gender; castrates switched from a grower diet at 48 kg to the end diet for four weeks, whereas female pigs switched at a weight of 73 kg and were fed the end diet for three weeks. A phase-feeding system was used for the gradual transition. The phase-feeding principle was compared with a unity mix for both genders.

Preliminary results reveal a reduction in energy intake when the pigs switched to the end diet. As expected, daily gain dropped and lean meat percentage increased by 0.2 percentage point for both genders. However, for the castrates in the trial, FCR decreased in the long end period on high-fibre feed.

	Control	Trial
Sows*	100	105
Castrates*	82	81

*Table 1. Production index
* Index calculated with identical feed prices.*

When productivity for the entire production period is analysed, the strategy with an end diet did have a positive effect on female pig productivity, but had no effect on castrates (see Table 1). However, the positive effect on female pigs was "eaten up" by the more expensive grower diet, and there was therefore no economic benefit in using this phase-feeding strategy.



Feeding pigs a low-energy diet towards the end of the growth period did not improve the economic results.

Liquid feed curves

Preliminary results from trial activities on two farms show no economic benefit in using a feed curve with a feed strength of 3.1 FUgp a day versus 2.8 FUgp a day in the last part of the pigs' growth period. Pigs' daily gain increased when fed 3.1 FUgp in this period, but FCR and lean meat percentage dropped.

When daily gain increases, it becomes possible to produce more pigs per place unit annually or produce more kg per pig. However, in both cases the benefit is lost as FCR deteriorates and lean meat percentage drops, and the financial result is therefore unchanged. If the production scope cannot be extended, an increase in feed strength towards the end of the growth period will result in a financial loss.

Feed strength should therefore only be increased if it is not possible to reach optimum slaughter weight or if sections are not empty for long enough to allow washing and drying of each section before the next batch moves in.

Ronozyme WX and Porzyme 9302

Xylanases are added to pig feed to increase the digestibility of carbohydrates in the feed.

The effect of adding the xylanases Porzyme 9302 or Ronozyme WX to finisher

feed was studied on one farm (trial report 892). Porzyme 9302 was added in three inclusion rates corresponding to enzyme activities of 1000, 2000 and 4000 U/g finished feed, respectively. Ronozyme WX was added in two inclusion rates corresponding to enzyme activities of 200 and 400 FXU/kg finished feed, respectively.

The trial diets were compared with a control diet that did not include xylanases.

Analyses revealed large variations in enzyme activity levels in the diets to which enzymes were added. Porzyme 9302 was least heat-stable and averagely 46% of the expected enzyme activity was lost during pelleting, while for Ronozyme WX averagely 19% of the expected enzyme activity was lost.

The results did not demonstrate significant effect on productivity of adding neither Porzyme 9302 nor Ronozyme WX. Based on available trial results, it is, however, still recommended to add xylanases to pig feed to increase the utilisation of carbohydrates.

All activities were financially supported by the EU and the Rural District Programme under the Danish Ministry of Food, Agriculture and Fisheries.

Analyses of ingredients

Pig Research Centre's activities include routine revision of standard values to ensure that feed for Danish pigs be as correctly formulated as possible. Samples of the grain harvest are annually analysed to determine content of nutrients and Fusarium toxins. In 2010, analyses also included nutrient levels in soy products. All standard values are available at www.vsp.lf.dk.

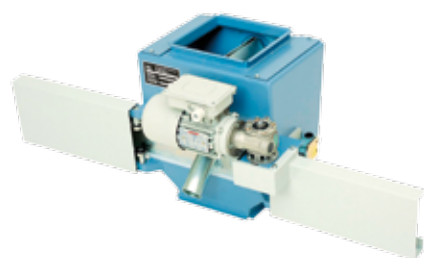
Analyses of soy products

From summer 2010 to spring 2011, scientists sampled six different soy protein concentrates/soy bean products and dehulled soybean meal. Eight samples of each soy concentrate and 12 samples of dehulled soybean meal were analysed at Eurofins Steins Lab. Table 1 shows an extract of the analysis results.

In each batch of analysis all products were represented, which improves the basis for comparing the different soy protein concentrates. The old standard values were thereby replaced by the updated ones. The standard value for dehulled soybean meal was also revised, and, together with the previous standard, the new values are included in a weighted average.

How to check energy content

Diets formulated on the basis of analysed ingredients are declared to have a certain energy content, but is it possible to recover this in an analysis? This was investigated by letting all ingredients (with the exception of palm oil) included in a diet pass through the automatic sampling equipment at the feedstuff factory. These representative samples were analysed when the finished diet was analysed.



Automatic sampler

It is thereby possible to confirm if the analysed (control) and calculated content (declared) correspond. Results revealed that the lab routines needed more focus on deadlines in the analysis instructions for EFOSi. In March 2011, the procedure was rectified, and when the differences (control vs declared) before and after are analysed, it is clear from Table 2 that the calculated energy content (FUgp and FUSow) was now easily recovered.

Up to February 2012, Pig Research Centre will keep working on improving analyses for EFOS and EFOSi, and is focusing on grinding of the samples and sample sizes.

Toxins

Wet weather when wheat grows and a wet, late harvest increase the risk of Fusarium contamination that may ultimately lead to production of toxins. In 2010, heavy rain delayed harvesting, which resulted in germinated grain and lodged grain. A small-scale investigation of

18 wheat samples from fields with lodged grain and incipient germination demonstrated no increased risk of excessive Fusarium toxin contamination in these samples (for more information, see report 1017).

Extreme rain also delayed part of the harvest in 2011. In cooperation with Knowledge Centre for Agriculture, Plant Production, samples were at the time of writing being screened for Fusarium toxins. Since 2003, samples were routinely screened for Fusarium toxins.

All activities were financially supported by the EU and the Rural District Programme under the Danish Ministry of Food, Agriculture and Fisheries.

Product	Crude protein (% of dry matter)	Energy (FUgp per kg DM)
HP 300	60.8	1.07
HP 200	57.6	1.05
AlphaSoy PIG 530	55.8	1.12
AGB Soya	54.7	1.11
Vilosoy	57.2	1.07
AlphaSoy PIG 600	65.9	0.99
Dehulled soybean meal	52.5	1.07

Table 1. Extract of results of analyses of soy protein concentrates and dehulled soy bean meal.

Procedure corrected	Before	After
Number	6.0	6.0
Crude protein, %	-	-
Crude fat, %	0.3	0.3
Ash, %	-0.1	-0.1
Fibre, %	0.2	0.2
EFOS, %	-0.4	-0.4
EFOSi, %	-0.7	-0.2
I-factor, %	-0.4	0.2
FUgp, per 100 kg	-0.4	0.2
FUSow, per 100 kg	-0.2	0.2

Table 2.

Rapeseed cake and sunflower meal

Finisher feed with inclusion of 10% or 20% rapeseed cake or sunflower meal was compared with a control diet based on soybean. Prior to trial start, the rapeseed cake used was analysed for nutrients and harmful substances. Results demonstrated that the product had been subjected to gentle heat-treatment. Nutrients content was also analysed in the sunflower meal before it was added to the feed.

The pigs in the control group had numerically higher performance levels than all the other pigs in the trial with the exception of those given 20% rapeseed cake where results revealed a significant difference. The improved performance of the pigs in the control group was primarily ascribed to a better feed conversion ratio and a higher daily gain. The pigs fed rapeseed cake had a lower lean meat percentage than the control pigs.

The reduced performance observed among the pigs fed rapeseed cake may have been caused by glucosinolates in the feed. It remains unclear why the pigs fed sunflower meal had a lower, non-significant performance level compared with control.

Rapeseed cake for weaners as well as finishers will be studied further to investigate the possibilities for use in pig feed.

Group	Control	10% rapeseed cake	20% rapeseed cake	10% sunflower meal	20% sunflower meal	10% rapeseed cake + 10% sunflower meal
FUgp/day	2.60	2.55	2.49	2.58	2.50	2.49
FUgp/kg	2.75	2.79	2.83	2.81	2.78	2.77
Daily gain, g/day	947	919	883	922	902	904
Lean meat %	60.2	60.0	59.8	60.2	60.4	60.3
Index	100	91	83	92	93	93

Table 1. Productivity and production value (identical feed prices) in the trial period 32-109 kg (preliminary results).

Corn cultivated in Denmark

Corn requires preservation immediately after harvest. On eight farms, experiences were analysed in order to:

- Describe systems for preservation, storage, inclusion and grinding
- Describe practical experiences
- Clarify feed value and feed quality
- Establish costs related to storage and handling.

Farm owners generally experienced positive effects on pig health when using corn in liquid feed.

In practice, costs for storage, grinding and handling of corn depend on existing on-farm conditions. Four examples of newly established facilities were used to illustrate all costs including annual costs for the equipment, operation and maintenance (incl. labour). All four examples demonstrated that oxygen-free silos are cheapest per FUgp and require less work than ensiling.

Analyses revealed large differences particularly in water content in corn from different farms, which resulted in large differences in energy value (FUgp/kg corn) – see Table 2. Reliable analyses of water content in corn are therefore essential before corn is included in pig feed.

On two farms, inclusion rates had to be lowered due to excessive levels of Fusarium toxins to which the pigs reacted with reduced appetite. One farm had to

Harvested (year)	FUgp/100 kg
2008/09	72.8 to 94.5
2010	41.9 to 95.4

Table 2. Variation in wet corn

discard batches of corn because of high toxin levels.

When corn was stored correctly, the microbiological quality was very fine, but quality deteriorated when oxygen was let into the storage site of the corn. Routine checks of the gas-tightness of the storage containers are crucial to keep corn healthy.

Corn is now being compared with wheat in one feed trial, and the stability of silaged corn is being analysed in another trial.

The activities were financially supported by the EU, the Rural District Programme under the Danish Ministry of Food, Agriculture and Fisheries, and the Pig Levy Fund.



Oxygen-free silos are cheapest per FUgp and require less work than ensiling.

New scheme for reporting changes

In April 2011, it became possible to report changes required for:

1. compliance with the 2013 welfare requirements for group-housed gestating sows
2. changes in the composition of categories of pigs (finisher, weaners etc.)
3. once again filling up finisher facilities
4. establishment of slurry tanks

Reporting vs approval

The use of this scheme requires unchanged or reduced environmental impact. Extension of a farm, construction of a new farm, or radical renovation of an existing facility will always require approval for full environmental approval.

Environmentally, neither nature nor neighbours must be adversely affected, and the framework is therefore narrower than in approval situations. If the extension is small, it must be constructed away from nature or neighbours to make sure that the break-even point of the building is not moved closer to nature (distances below 300 m) or to neighbours (distances below 100 m).

2013 welfare requirements

With the scheme, it is possible to meet statutory requirements for group-housed gestating sows in situations where the number of livestock units remains unchanged. However, renovations and/or extensions must still comply with the welfare requirements in legislation on indoor keeping of gestating sows and gilts (2013 requirement).

It is allowed to remove pen partitions in the existing gestation facility and design the facility to accommodate sows in groups including the addition of the necessary 2 m² required to keep the sow unit as it is. However, environmental approval is required if a producer wishes to replace existing facilities by a new gestation facility for all his gestating sows or if an additional farrowing section is built.

Change in animal categories

It is now possible to change the distribution of sows, weaners and finishers. However, any changes made must not increase the

environmental impact (nitrogen, phosphorus, and odour and ammonia emissions).

Extensions are not allowed, but producers are allowed to replace equipment and slatted floor elements by solid or drained floor elements. Changes in animal categories may be combined with changes following the 2013 welfare requirements.

Full houses

Environmental progress in finisher units is also benefited; under certain circumstances, it is now possible to increase production scope by 10%.

Today, a pig producer with an 8-10-year old environmental approval will have to leave the facility empty for up to 40 days a year to comply with the environmental approval. In fact, most pig producers are able to increase their production by 10% in existing facilities - even with reduced environmental impact - compared with the original approval.

Neither neighbours nor environment must be negatively affected, and this

presents two significant restrictions:

1. Distance requirements for odour must comply with the full odour instructions
2. Livestock manure must not be spread on areas in phosphorus classes 2 and 3 (3 and 4% of the areas, respectively).

In some parts of the country it will be difficult to use the scheme for reporting changes due to the rules of no spreading of livestock manure on areas in phosphorus classes 2 and 3.

The strict phosphorus requirements cannot be justified from an environmental point of view nor from the basis of the EIA Directive. Pig Research Centre has therefore once again engaged in talks with the Danish Environmental Protection Agency on this problem.

Simplified environmental approval

For years, the approval system has operated with unclear livestock legislation, which has resulted in all parties disagreeing on the rules. Chaos developed to perfection when the Environmental Board of Appeal

Recommendations incorporated in the Danish government's 2020 growth plan

1. More de minimis thresholds mean that, for instance, staff room, refrigerated wells etc. can be established without prior permission.
2. More schemes for reporting changes whereby minor changes to livestock units will not need approval (for instance conversion from conventional to organic operation / demarcation of open grazing land etc.).
3. BAT requirements for construction of livestock facilities at Order level
 - Requirements at time of application apply regardless of case handling time
 - BAT requirements are implemented in 2012
 - Requirements must be followed by the applicant as well as the local authorities
 - Repeal of general reduction requirement for ammonia
4. Increased flexibility in environmental requirements during testing of new environmental technologies

If the test concerns, for instance, a facility that is located sensibly in relation to vulnerable nature, this facility does not necessarily need comply with current requirements for reductions when the test is finished.
5. Municipal grants are made activity-specific, ie. granted in proportion to number of completed cases.
6. The Environmental Board of Appeal must focus on the appeal matter and not the full decision.
 - Currently visitation rules for cases handed in after January 1, 2011
 - Currently expected case hearing period of max. 12 months

subsequently repeatedly disallowed current guidelines from the Danish Environmental Protection Agency.

As a result of the Green Growth Agreement, a committee for livestock regulation was set up in 2010. The committee analysed ways to simplify, improve and integrate livestock legislation with other environmental and food regulations, but the level of environmental protection was not on the agenda.

Short term

Short-term, the committee proposes a clearer legislative basis to reduce the current estimate of the local authorities compared with today. Several of the recommendations of the committee are already incorporated in the 2020 growth plan of the Danish government (see fact box).

Long term

Long-term, the committee proposes radical changes to the approval scheme.

The first proposal is that regulation of livestock facilities be increasingly based on ammonia emissions, which would mean the end of the current regulation based on livestock units. Regulations would thereby lean on EU regulations and resemble regulations for industrial industries.

It is also proposed that pig facilities and areas be regulated independently. Today, a lot of work is put into the evaluation of areas in connection with environmental approval of livestock units even if the environmental impact is fairly small. If, instead, regulations are based on the vulnerability of the areas it will be far easier to supply slurry to a new plant breeder where, in principle, the only documentation required is that enough land is available.

The committee does not as such advocate a tightening of the environmental requirements, but proposes a model that simplifies regulation of areas. If a tightening is introduced, it will be as a consequence of decisions made in the Nitrogen Committee to meet environmental goals in the work with the aquatic plan. It is essential that the proposals of the committee for new regulations be integrated with the proposals

expected from the Nitrogen Committee in autumn 2011.

Complex livestock legislation

This is complicated reading; Danish legislation is challenged by a range of EU directives that each limits how far it is possible to go in terms of simplifying the regulation of livestock units.

For the agricultural industry, it is important that the regulation framework is as closely associated with the basis of the directive and that pig producers are able to flexibly adapt productions without jeopardising the level of protection – including full use of the facilities.

Denmark is the only EU country in which farmers must comply both with general fertilization rules and further special requirements for areas of spreading of livestock manure.

A transition to regulation based on vulnerability would have to take place over a couple of years, partly as sufficient knowledge is required and partly to allow the industry time to adapt to the new regulations.

A high degree of differentiation may mean that some areas (farmers) are hit so hard that they will need to be compensated for their losses, whereas other interventions may be so tight that they release liability in damages.

It will be a couple of years before regulations based on the below factors will be seen:

- a) areas increasingly regulated according to vulnerability
- b) environmental approval based on environmental impact instead of production scope.

This is not a 'carte blanche' to do as one likes, but farmers will be able to plan productions in a more flexible manner.



Four different possibilities for locating extensions – required extensions of buildings are covered by the scheme for reporting changes. The last picture shows a possible extension along the length of an existing facility in the same architectural style and materials, and slope of the roof.

BAT requirements for phosphorus

Requirements for phosphorus are stated as the lowest level of P obtainable without increasing costs when phytase is used in regular Danish pig diets. The requirements were stated as max. content of P in manure per livestock unit, and are shown in Table 1 in which requirements are converted to gram P per feed unit.

BAT = Best Available Technique

BAT requirements for ammonia

Ammonia requirements were updated in June 2011 and now comply with the calculation models in the new IT application system. Regard is made to the type of flooring in existing facilities whereas no regard is made to selected types of flooring in new buildings. As far as extensions are concerned, requirements increase with the size of the extension up to 750 livestock units.

For existing facilities, requirements will in most cases be met when low-protein feed is used, but this involves additional costs in particular for finishers housed in pens with fully slatted floor and drained floor. Covered slurry tanks reduce requirements for the feed.

Requirements for new accommodation for sows, finishers and weaners are so strict that the use of fully drained floor is out of the question unless air cleaning or acidification is installed. On partially solid floor, compliance will in many cases be obtained through a combination of several technologies such as low-protein feed, covered slurry tank and slurry cooling.

Tables 2 and 3 present requirements for ammonia emissions in proportion to emissions in 2005/06. As emissions have dropped over the last years, some of the requirements for existing facilities will be fulfilled alone by using the latest standard figures.

Odour

In connection with environmental approvals, odour emissions from a finisher facility and thereby the nuisance distance to

neighbours will be calculated on the basis of the pigs' total weight in the facility. In a normal production, pigs' weight in a facility typically averages 65-70 kg.

In all in-all out management at site level, the pigs in a section will grow at the same speed up to mature weight and the average weight in the facility will be close to 95 kg when the first pigs are picked up for slaughter. Consequently, the total weight of the pigs in all in-all out will be higher than in a "normally" run section, and odour emissions will also be calculated to be approx. 45% higher for the environmental approval.

However, research demonstrated that odour emissions per 1,000 kg animal decrease when the pigs' average weight

increases. Results revealed that odour emissions per 1,000 kg animal from pigs weighing 106 kg was 43% lower than from pigs weighing 53 kg. Consequently, odour emissions from a section run according to all in-all out will only be approx. 10% higher just before slaughter than from a section run "normally".

The moderate increase in odour emissions is attributed to the fact that the slurry surface remains unchanged and feed intake per 1,000 kg animal drops as weight increases.

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

	Kg P per livestock unit, max	P, g/feed unit, max.*
Sows	23.0	4.76
Weaners	27.8	5.31
Finishers	20.5	4.59

Table 1. BAT requirements for phosphorus.

* Applies to FCR and weight intervals as the national average

Animals	Reference	Requirement < 210/250 LU*		Requirement > 750 LU	
	Kg NH3-N	Kg NH3-N	Reduction	Kg NH3-N	Reduction
Sows, per sow/year	3.41	2.53	26 %	2.12	38 %
Weaners, 7.4-32 kg	0.045	0.0366	19 %	0.0326	28 %
Finishers, 32-107 kg	0.43	0.30	30 %	0.22	49 %

Table 2. BAT emission requirements for extensions.

* Limit is 210 livestock units for finishers and 250 livestock units for sows and weaners.

Facility and animal	Standard 2005/06, kg NH3-N	Requirement NH4-N	Reduction
Gestating sows, group-housed, partially solid floor	2.51	2.11	16 %
Farrowing facility, fully slatted floor	1.66	1.43	14 %
Farrowing facility, partially solid floor	0.90	0.75	17 %
Weaners*, drained floor	0.084	0.081	4 %
Weaners*, partially solid floor	0.045	0.043	4 %
Finishers*, drained floor	0.517	0.40	23 %
Finishers*, 25-49% solid floor	0.43	0.36	16 %
Finishers*, 50-75% solid floor	0.34	0.31	9 %

Table 3. Requirements for ammonia reduction in existing facilities regardless of size.

* Applies to weight interval 7.4-32 kg for weaners and 32-107 for finishers.

Climate chambers at Grønhøj

For three years, researchers have investigated the most efficient ways of at-source extraction of air in finisher facilities with drained floor in the lying area. Research was conducted in the climate chambers at Experimental Station Grønhøj.

The aim is to improve the air quality in the facility and to collect the main part of the most contaminated air in a small concentration of air and then clean this.

The efficiency of at-source extraction was improved by reducing the slots in the slatted floor. However, results demonstrated that the location of the suction point under the slatted floor was more important than slot width.

A suction point placed under the pigs' lying area was significantly more efficient than under the dunging area as this location utilised the natural flow of air under

the slatted floor. It is, of course, essential that the pigs use the pens as intended.

In the summer 2011, at-source extraction was investigated with two different levels of air output (7 and 14 m³/pig) to document the optimum output. Preliminary results indicate that both these output levels result in equally good air quality. The consequences for emissions have not yet been analysed.

Full-scale trials

Three different ventilation technologies for full-scale at-source extraction are currently being investigated. The aim is partly to prove that the technologies work under full-scale conditions and partly to analyse pros and cons of the systems.

Preliminary recordings

Preliminary recordings demonstrate that Farm 1 found at-source extraction to be efficient. On Farm 2, a system was

installed in the attic for uniform at-source extraction. However, it is essential to optimise the system over time in terms of condensation and blocking. On Farm 3, a fairly uniform at-source extraction was obtained by varying the diameter of the Ø400 pipe.

At-source extraction must not be confused with traditional pit ventilation. With at-source extraction, the points of extraction are placed in areas of the house where the contamination is highest, and extraction only covers a small part of the maximum extraction capacity of the ventilation system.

Three different technologies for at-source extraction are being investigated on finisher farms to analyse environmental effect, reliability, and economy of each technology.



Farm 1

The air duct for at-source extraction is placed at the back of the pen under the lying area where 25% of the floor is solid. The slots of the slatted floor are also reduced through drained floor in 25% of the pen.



Farm 2

At-source extraction is established in the form of "Ø160 extraction pipes" between every other pen in pens with 50% drained floor under the lying area at the back of the pen.



Farm 3

At-source extraction is established in the form of Ø400 in the slurry pits under the lying area in pens with 33% drained floor under the lying area at the back of the pen. The air from at-source extraction of seven sections is collected in a chamber below the central passageway and led to a biological air cleaner.

Technology List

Results from a wide range of the trials conducted by Pig Research Centre are used by the Danish Environmental Protection Agency (EPA) in the evaluation of environmental technologies for possible approval.

Approved technologies are listed on the EPA's so-called Technology List that is continuously updated and available at EPA's website. New technologies were added to the List in 2011 some of which were approved for reduction of odour by up to 73%.

SKOV A/S

Since 2002, SKOV A/S has developed and marketed biological air cleaning systems, and Pig Research Centre has tested several versions of their air cleaner.

Today, SKOV A/S markets two types of biological air cleaning systems:

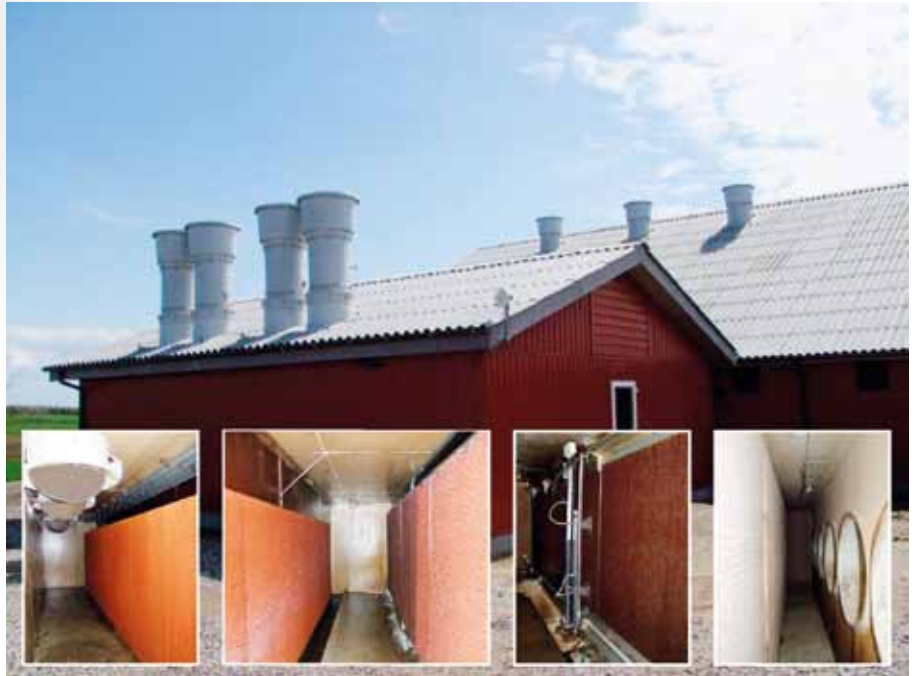
- Farm Airclean BIO Modul
- Farm Airclean BIO Flex

In 2011, SKOV's systems were approved for odour reduction up to 73% vs 30% previously, while ammonia reduction averages 70% or down to 1-2 ppm.

The most recent investigation of SKOV air cleaners concerned operating costs, labour and reliability in weaner and finisher facilities.

BIO modules cleaning 40% of maximum ventilation capacity were investigated in a weaner facility. Results revealed an overall reduction in ammonia emissions by 81%. The total excess costs for running the air cleaners and ventilating the sections amounted to DKK 0.7 per produced pig when costs for ventilating weaner facilities without air cleaning were deducted.

When costs for maintenance and changing of filters were included, the overall operating costs amounted to DKK 3.5 per produced pig. Maintenance and replacement of parts of both air cleaners primarily concerned the washing robot.



The Technology List includes the air cleaner from SKOV A/S with 73% odour reduction.

An average of 11 minutes a week was spent on inspecting each air cleaner. This was handled by staff from SKOV A/S, and the time spent may therefore increase when the pig producer has to do this himself.

A BIO Flex air cleaner with a new, third filter step and modified controller was investigated in a finisher facility.

Ammonia concentrations were reduced from av. 14.0 ppm to av. 0.6 ppm in the first two filter steps and the odour concentration was reduced by 76% during the summer period. After the third filter step, the ammonia concentration was reduced further to 0.4 ppm and the odour concentration was reduced by 80% in total

A test was also made on a German farm, and results from both trials formed the basis of the EPA's decision to accept SKOV A/S on the Technology List with a 73% odour reduction.

The operating costs relating to the modified controller have not yet been analysed.

Rotor A/S

Rotor A/S was also accepted on the Technology List in 2011 with the Dutch DORSET air cleaner.

The air cleaner was tested by Pig Research Centre and AgroTech on two farms. On the basis of these results, the air cleaner was included on the List with 40% odour reduction and more than 70% reduction in ammonia.

The air cleaner tested by Pig Research Centre cleaned all ventilation air from a section with finishers.

Operating costs amounted to DKK 2.80 per produced finisher when costs for ventilation of finisher facilities without deduction of air cleaning.

Throughout the trial period (one year), the filter did not block and it was at no point necessary to wash the filter.

Munters A/S

Pig Research Centre is currently testing a chemical air cleaner from Munters A/S on two finisher farms.

Measurements have been done on one farm and are now initiated on the other farm. Once completed, it is expected that Munters' chemical air cleaner will be accepted on the Technology List.

Results from Farm 1 revealed a 95% reduction in ammonia concentrations. No reduction in odour concentration was recorded. Similar results have been seen in other trials with chemical air cleaners.

The economy of Munters' air cleaner has not yet been analysed, but analyses of operating costs for one year on Farm 1 reveal a consumption per finisher of 0.9 kg acid (H₂SO₄), 65 l water and 9 kWh for operating the air cleaner including the energy required for ventilation.

The production of nitrogenous water constituted 16 l liquid per finisher.

Waste water

Pig Research Centre is highly aware of the amount and manure value of the liquid that these environmental technologies release to the manure storage tank.

Biological air cleaners and chemical air cleaners release roughly the same amount of N to the slurry tank. However, the concentration of the liquid differs between the two systems. Waste water from biological air cleaners from SKOV A/S and Rotor A/S had a nitrogen content of approx. 3 kg/m³, whereas the chemical cleaner from Munters produced less liquid, but with a higher nitrogen content,

For biological air cleaners, good agreement was observed between the conductivity of the system and total N in the liquid leaving the system (see Figure). This can be used to evaluate the amount of nitrogen in the liquid passing from the air cleaner to the slurry tank.

The amount of liquid produced should be included in the future general financial evaluation of environmental technologies.

More storage capacity is required, and costs for spreading the extra liquid must

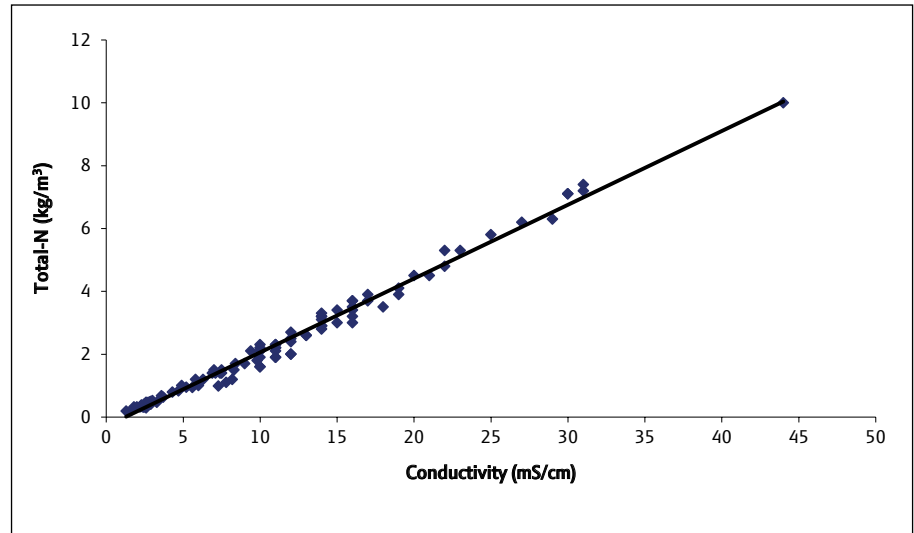


Figure: Correlation between conductivity and content of Total N in liquid from biological air cleaners.

also be taken into consideration. Calculations demonstrated that costs for extra storage capacity and spreading amounted to DKK 22-28 per m³ in 2011.

Infarm A/S

Infarm A/S is also represented on the Technology List with a slurry acidification system that is approved for 70% ammonia reduction from pig houses, but it is not approved for odour reduction.

Infarm A/S developed and installed the first acidification system for pig houses in 2004, and the company is currently improving the system to also include odour reduction.

In autumn 2011, Pig Research Centre started recording the assumed reduction of greenhouse gases to document the effects.

J.H. Staldservice A/S

In summer 2010, J.H. Staldservice A/S installed its first slurry acidification system on a Danish pig farm, and in 2011, another one was installed. Pig Research Centre is testing the system on both farms to establish whether the technology will be accepted on the Technology List.

Preliminary measurements on the first farm demonstrate that ammonia emissions were reduced by 70%, but the con-

sumption of acid remains to be clarified. Results are expected in 2012.



Acid tank and processing tank of the slurry acidification system from J.H. Staldservice A/S.

Slurry additives

In the climate chambers at Experimental Station Grønhøj, Pig Research Centre investigated whether ammonia emission dropped when the slurry additive Viscolight was added. The trial comprised two trial sections with Viscolight added to the slurry and two control sections.

Measurements made in two batches of finishers in the winter 2010/2011 revealed no significant difference on ammonia emissions from sections with and without Viscolight.

The EPA's Technology List does not include any slurry additives besides systems

using sulphuric acid for acidification of slurry.

In development

Pig Research Centre is running a number of research and development activities concerning odour and ammonia reductions in cooperation with several companies and research institutions (Aarhus University, Aalborg University, Syddansk University and Copenhagen University).

These activities include:

- Air cleaning with LECA as filter material
- CEBONA project on pre-filtering of air in connection with air cleaning systems and optimisation of processes in connection with biological air cleaning
- New methods for recording of odour
- Further development of slurry acidification systems to also include odour reduction
- Odour reduction with the use of alkaline water for air cleaning

The activities are financially supported by the Innovation Act, the Economic Expansion Scheme, the Danish Council for Strategic Research, GUDP and the Rural District Programme.

Maintenance

It is difficult to calculate the actual costs for maintenance of air cleaning and slurry acidification systems.

Pig Research Centre has therefore drawn up a maintenance contract in cooperation with the manufacturers that includes:

- 2-3 annual on-farm service calls and wearing parts
- Free calls and spare parts (except filters)
- Free software updates in connection with maintenance inspections
- Free hotline in the time period 8 am to 3 pm
- Free inspection of compressors, pursuant to legislation (only applies to slurry acidification systems).

For finisher farm with 500 livestock units costs amount to approx. DKK 2.5-3.0 per produced finisher.

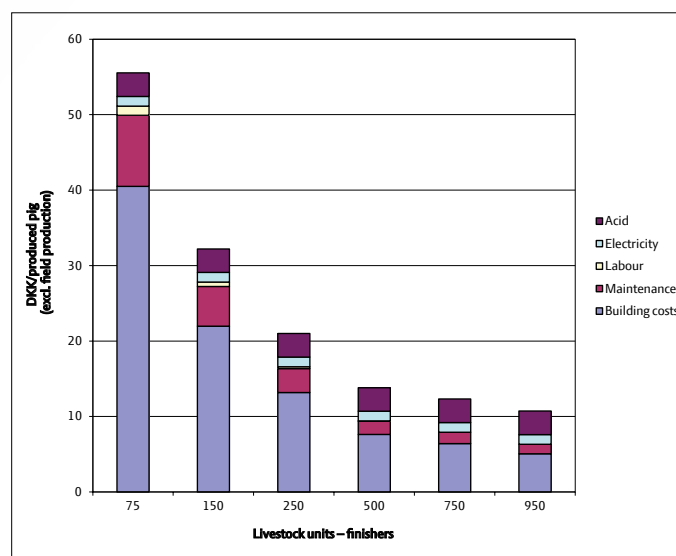
Economy

The EPA has issued an outline of the costs of various environmental technologies depending on herd size.

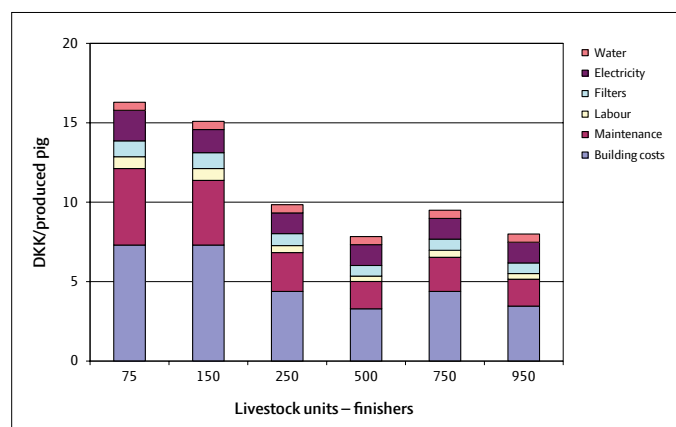
Pig Research Centre has contributed with information on building costs and costs for operating and maintenance of the systems.

An external engineering company (NIRAS) delivered the financial calculations on basis of the economic input information.

The price of slurry acidification ranges from DKK 7 to 51 per produced finisher depending on herd size with the lowest costs found for large farms. Cleaning 20% of the ventilation capacity costs DKK 7-16 per produced finisher with the lowest costs once again found for large farms. Acidifying the slurry, or cleaning 20% of the ventilation capacity both reduce the ammonia emission by 70% from finisher units.



Costs for acidification of slurry in finisher facilities (impact on field production by acidification not included). According to NIRAS calculations, the excess value of the slurry amounts to DKK 4.5 per pig if the value of increased concentration of nitrogen and sulphur in slurry is priced at the value of substituted commercial fertilizer. This value is not included.



Costs for biological air cleaning of 20% of maximum ventilation capacity in finisher facilities. According to NIRAS calculations, the excess value of the slurry amounts to DKK 0.75 per pig if the value of the nitrogen that is led to the manure storage tank from the air cleaner is priced at the value of substituted commercial fertilizer. This value is not included.

Benchmarking of consumption of heat

Pigs must be assured of a good immediate environment and a good air quality through the supply of heat. Heat must be distributed and managed correctly, but consumption should not be greater than necessary as heat constitutes a significant expenditure in pig production. The consumption of heat can be benchmarked on the basis of guidelines listing the energy required for heating up a new, well-insulated pig facility.

Management and control

It is recommended to routinely check the consumption of heat by installing energy meters on central locations in the heating system. A pig producer should as a minimum know the consumption of heat for the entire pig unit, but ought also know the consumption for gestating and lactating sows, and for finishers and weaners. If oil is used for heating, oil consumption can be recorded as an alternative. If the oil burner has an operating efficiency of 85%, one litre of oil will generate 8.5 kWh heat.

If the consumption of energy significantly exceeds the figures listed above, ventilation and heating systems should be checked. An excessive consumption of heat is primarily attributed to incorrect management of minimum ventilation and humidity, but other parameters may also play a part.

Dimensioning of floor heat

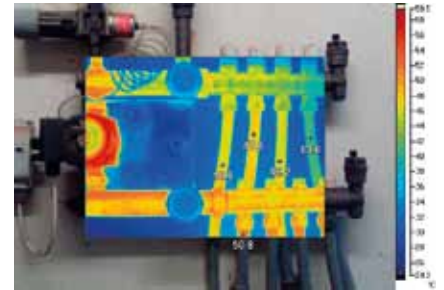
It is essential for the immediate environment that floor heat in farrowing facilities and weaner facilities be dimensioned and managed correctly. However, climate studies made by Pig Research Centre reveal that even in new facilities this often causes problems.

If the inlet temperature is too high, too low or if it varies, the consequence may be an inadequate immediate environment, poor health and low production levels. The immediate environment may also be jeopardised by large differences between the inlet temperature and the recirculation temperature.

Floor heat should therefore be dimensioned according to the below requirements:

- Effect to be emitted, W
- Inlet temperature
- Max. cooling, °C

Depending on design, a typical weaner unit requires 5 W/pig and farrowing units up to 90 W/place unit. As a rule of thumb, inlet temperature with embedded pipes must be 40-42 °C and cooling must not exceed 2-3°C. Once these requirements are established, the capacity of heat supply, pipe dimensions and pump capacity can be dimensioned to deliver the desired amount of water under the current pressure loss.



Manifold with adjustment screw must, as opposed to this image, be regulated for temperature to be identical in all circuits.

Type of facility	
Gestation facility	kWh per sow/year
Partially solid floor, lightly bedded lying area	24
Partially solid floor, thick layer of bedding in lying area	2
Farrowing facility	
Partially solid floor	135 ¹⁾
Fully slatted floor	161 ¹⁾
Weaners	kWh per pig
Partially solid floor, two-climate	2.9
Drained floor/fully slatted floor	14.1
Finishers	
Partially solid floor, dry feeding	0.6
Partially solid floor, liquid feeding	1.8
Drained floor/fully slatted floor, dry feeding	2.2
Drained floor/fully slatted floor, liquid feeding	7.1

Guiding figures for consumption of heat in a well-insulated pig facility.

1) The majority of the consumption of heat is attributed to constant emission of heat from floor heat in the creep area and the use of heat lamp at farrowing.



Correct dimensioning and management of floor heat is essential to pigs' immediate environment.

Be ahead of the construction process

Checklist for construction of new pig housing or renovating existing facilities is now ready. With this checklist, pig advisors and construction advisors ensure that pig producers have a solid foundation on which to make decisions, and that a new/renovated building is profitable.

The checklist provides an outline of requirements and subjects that must be included in the planning of a pig facility be it a new pig one or renovation of an existing one.

When this checklist is being used, producers are assured that the design of the pig facility creates the framework for a well-functioning production that meets the requirements for animal welfare, working environment and the surrounding environment.

It can be used as tool in making big decisions in the early stages of construction, as

tender material for developers, and for reviewing the construction project when the environmental approval is obtained.

Cooperation between professions

This checklist underlines the situations when cooperation between different trades such as economy, environment, building trade and production is essential to obtain the best result.

The checklist is drawn up as a tree structure with the top level outlining the overall time table for the construction process. The next level provides a detailed time table for the process with emphasis on the points when the pig advisor plays an important part.

The list then proceeds with descriptions of selected areas of a pig farm: farrowing facility, gestation facility, service facility, finisher facility, weaner facility, facilities for supply and service, and working environment.

For all units

All paragraphs concerning the areas of a pig farm include descriptions of: design and layout of facility and pen, equipment, feed and water, climate, ventilation and heat, handling of manure and, for some areas, of straw.

For each of these points, the checklist outlines: statutory requirements, environmental requirements, functional requirements, specific requirements and "practical experiences".

Practical experiences

The checklist is being used by pig advisors and construction advisors who are part of the expert group DLBR Pig Facilities, and they ensure continuous updating of the section on practical experiences.

The checklist is written and financed by Pig Research Centre in cooperation with the local pig advisory and construction centres.



The report

Pig Research Centre’s report on future production systems was published in 2011. The report presents an estimate of how to construct production systems today to match the development of the next 10-15 years.

1. Sows are housed in groups (Electronic Sow Feeding) from 4 weeks after service (CLASSIC).
2. Sows are housed in groups after weaning (GAF).
3. Sows are housed in groups for the entire cycle, ie. also in the farrowing facility (GROUP).

with systems with one stall per sow. The farrowing pens used in GROUP are bigger and more expensive, and consequently costs will increase by approx. DKK 6 per produced pig compared with CLASSIC.

If changes in productivity levels and labour, which are the consequences of housing all sows in groups, are included in the analysis, costs related to GAF will increase to approx. DKK 12 per pig. The increases are attributed to expected reductions in reproduction; increases in sow mortality rates and increase in labour. GROUP will increase costs by DKK 50 per pig compared with CLASSIC as piglet mortality will increase as will the labour required in the farrowing pen.

For growing animals, CLASSIC gives a slightly better result than WTF and WIF as long as daily gain, mortality rates and FCR are identical for the pigs in all three systems.

Production costs per pig increase by DKK 5 and 4 in WTF and WIF, respectively.

The overall “rent” per produced pig is higher in WTF and WIF and is not quite covered by other savings despite the fact that in these two systems pigs are not moved as many times as in CLASSIC (ie. transport costs are lower, less labour is required, and the area that needs washing per produced pig is smaller). However, provided that WTF and WIF deliver the expected improvement in efficiency compared with CLASSIC, the total production costs for these two systems will be DKK 7 and 11 lower per pig, respectively, than in CLASSIC. These two production systems may thereby be attractive, but the WIF pen requires further development still.



Weaning pigs in the farrowing pen (WIF) may be an interesting alternative to the classic production system for growing animals if daily gain increases by 50 g; FCR improves by 0.04 feed units; and mortality rates drop by 0.74 percentage points.

Six examples

Three examples of production systems for sows and three for growing pigs were analysed and economic model calculations made for all six. The examples were based on Pig Research Centre’s expectations to future requirements for animal welfare and labour and are an attempt to create durable production systems that benefit the pigs’ health.

For sows, the examples are primarily selected to illustrate the economic consequences of the strict welfare requirements that are expected to apply in 10-15 years. For growing animals, the examples of production systems have an expected potential in the form of improved health and productivity and reduced labour.

Examples – sows:

1. Reference: the current classic production system in which sows are housed

Examples – growing animals:

1. Reference: the current classic system with weaner and finisher facilities (CLASSIC).
2. WTF system (WTF).
3. Pigs are weaned in the farrowing pen (WIF).

If efficiency levels for sows remain unchanged, costs per produced unit will hardly increase when CLASSIC is converted to GAF as electronic sow feeding is fairly cheap per place unit compared

Examples – growing animals	CLASSIC	WTF (0)	WIF (0)	WTF (1)	WIF (1)
Total costs per pig, DKK	800	811	816	815	804
DKK/kg carcass	9.76	9.89	9.85	9.93	9.81
Costs compared with CLASSIC (0), DKK/pig		5	4	-7	-11

Table 1. Break-even costs in three examples for animals in growth incl. WTF (1) and WIF (1) with expected improvement in efficiency. Calculations are based on sows housed in groups after weaning (GAF).

ACCOMMODATION FOR WEANERS AND FINISHERS

HOUSING

Ban on fully slatted floors

As of January 1, 2013, increased requirements apply to pens with fully slatted concrete floors if pig producers wish to be able to use them until July 1, 2015.

As a result, floors must fulfil certain requirements for slots and slat width. In finisher pens with concrete fully slatted floors, gaps between slats must not exceed 18 mm and slats must be min. 80 mm wide.

As of July 1, 2015, fully slatted floors are banned, and by then, minimum half of the floor space required for weaners must be either solid or drained. In finisher pens, one third of the floor space required must be either solid or drained.

A maximum limit of 10% in aperture in the drained area is introduced for drained floors vs typically 18-20% for conventional concrete slatted floors.

Several options are available for pig producers wishing to convert existing accommodation to meet the new regulations:

Converting to drained floor by

- Replacing existing floor elements with drained floor elements in part of the pen.
- Closing some of the gaps with fittings.

Converting to partly solid floor by

- Casting part of the pen.
- Placing mats/boards in part of the pen.

All of the above suggestions are also legal after July 1, 2015, provided that



In 2012, Pig Research Centre will be testing fittings to cover some of the aperture between the slats.



Trial results revealed no differences in production values, and it is thereby factors such as feed wastage, build-up of clotted feed, and adjustability that will determine which feeder to recommend.

apertures do not exceed 10% and that requirements for solid or drained floor for individual categories of pigs are fulfilled.

Tube feeders

Five tube feeders for finishers were investigated:

- Ergomat XL from K.J. Klimateknik A/S
- Funkimat slagtesvin, ACO Funki A/S
- MaxiMat porker, Skiold A/S
- TUBE-O-MAT TOP, Egebjerg International A/S
- Vissingmat 100 with platform, Sdr.Vissing Staldinventar A/S

Preliminary production results did not indicate any differences in pig performance regardless of the feeder used.

It is thereby the evaluation of the technical design of the feeders that will be the deciding factor in which feeder to choose. The evaluation process was still in progress at the time of writing.

A test of tube feeders for weaners demonstrated no differences between the feeders in terms of production value. Nor were there any differences in the functionality of the feeders.

Feeder	MaxiMat Weaner Skiold A/S	FunkiMat ACO Funki A/S	Ergomat XXL with shoulder partition, KJ Klimateknik A/S	TUBE-O-MAT VI+ Jumbo Egebjerg International A/S	PicNic Jumbo Big Dutchman
Feed wastage and hygiene	***	***	****	***	***
Easy to adjust	****	****	***	**	****
Pigs' use of feeder	***	***	***	****	****
Bridging	***	****	***	****	**
Build-up of clotted feed	****	****	***	****	***
Easy to clean	****	***	**	****	**
Durability and wear	****	***	****	**	****
Overall functionality index	*** Good	*** Good	*** Good	** Below average	** Below average

Table 1. Evaluation of functionality of tube feeders for weaners.

Farrowing pens

In farrowing accommodation taken into use after May 15, 2003, sows and piglets must have permanent access to enrichment and rooting materials. In farrowing pens with solid floor, straw or similar material can be supplied in front of the sow, but in pens with fully drained floor, straw will immediately pass through the slats. In these pens, another type of material, such as wooden blocks for the sow and rope for the piglets, is therefore required.



A wooden block on a chain may function as enrichment and rooting material for sows housed in farrowing pens with fully drained floor.



Rope is highly suitable for piglets.

Dispenser with straw pellets

The applicability of a dispenser with straw pellets from Ikadan is currently being stud-



Enrichment and rooting material in the form of straw pellets in a dispenser from Ikadan.

ied for weaners. The dispenser is based on the concept that pigs are willing to work for a reward (straw pellets). The settings of the dispenser must maintain the pigs' interest and consumption must be kept at a reasonable level.

Full-length straw or chopped straw?

Results of a trial in which finishers were given 100 g either full-length or chopped straw a day revealed no difference in pigs' behaviour directed against straw or rooting behaviour directed against pen mates (abnormal behaviour). This demonstrates that chopped straw meets pigs' need for rooting to the same degree as full-length straw.

Results also demonstrated that:

- Pigs weighing 40 kg root more with straw than pigs weighing 80 kg
- Female pigs root more with straw than barrows
- The smallest pig in the pen – regardless of gender – roots more with straw than the biggest pigs in the pen.

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

Straw dispenser and liquid feed

In pens where finishers are fed liquid feed in long troughs the material must meet the requirement for rooting as well as enrichment as liquid feed does not meet the requirement for rooting. This can typically be solved with two wooden blocks on a chain, but that is not always the optimum solution. The chain wears on the slats and tools are required to replace a wooden block.

Preliminary investigations revealed that a straw dispenser with cut straw placed above the liquid feed trough, close to the point where slurry is extracted, may actually function without causing problems with slurry disposal systems. Small slurry pits (two or four pens per pit) are more capable of handling straw due to a greater flow in slurry disposal.

Dispensers must be refilled averagely 2-3 times a week, which corresponds to a daily consumption of approx. 20 g per finisher. This will be further investigated in 2012.

Sows housed in stalls

Sows housed in stalls in service/gestation facilities are assured of permanent access to enrichment and rooting materials through, for instance, wooden blocks on a chain, straw briquets, or straw allocated manually or automatically.

Group-housing by 2013

As of 2013, all gestating sows must be housed in groups no later than four weeks after service and until farrowing.

Today, at least 70% of all sows are already housed in groups, but many producers have yet to accommodate sows in groups in existing facilities or build new facilities for the sows. There are still many problems to be solved.

However, the financial crisis in combination with environmental legislation has stalled many construction activities, and many producers are forced to choose cheap solutions for accommodating the pigs in groups.

Renovating existing facilities

The scheme for reporting changes to buildings made it possible to convert existing gestation facilities with stalls to group-housing without prior environmental approval. It is also possible to build an extension to maintain the production level in terms of sows a year.

Each case must be reviewed by relevant case officers – read more about this under “Environmental regulation” in this report.

Nationwide workshops

Together with local pig advisors, pig veterinarians and construction companies, Pig Research Centre held 10 workshops in Denmark for pig producers.

These workshops focused on conversion from stalls to group-housing in situations



Discussion of construction drafts produces many ideas.

where pig producers choose to renovate existing facilities. The workshops included professional presentations and discussion of drafts and construction plans that the participants had brought along. In these situations, factors such as feeding principles, management of body condition, group size and space requirements were central elements in the planning phase.

Feeding principles

The best solution is to use feeding principles that are based on individual feeding; free access stalls and electronic sow feeding (ESF). Both principles provide plenty of opportunities for managing sows' body condition, which provides the basis for good production results.

In feeding systems where pigs are fed on the floor or fed liquid feed in long troughs, competition for feed will arise, and it becomes difficult to manage body condition. Sows should therefore not be housed in groups until four weeks after service, and the group should be split into smaller groups according to body condition.

Group size

According to legislation, sows housed in small groups (up to 40 sows) must have a larger unobstructed area per sow than sows housed in large groups.

It may be tempting to operate with large groups or dynamic groups, but this is generally not recommended. The highest priority should always be management of body condition.

1.3 m² bedded lying area per sow

Regardless of feeding principle and pen design, each sow must have a bedded lying area with solid and/or drained floor. There are many situations in the renovating process where it is difficult to place the lying area in the pen. It is also important to keep in mind that slurry disposal may become a problem if too much straw falls into the slurry pits.

A pilot trial will investigate different ways to design pens with stalls that are

converted to free access stalls or ESF, respectively.

Remember hospital pens!

Recommendations say approx. 5% hospital pens in systems with individual feeding and approx. 10% in systems with competitive feeding principles, ie. floor feeding or feeding in long troughs.

According to new legislation, there must at all times be a capacity of available hospital pens corresponding to 2.5% of the place units for group-housed gestating sows. This applies to new pig facilities from January 1, 2011, and to all facilities as of January 1, 2021.



Bedded lying area in a renovated pen with free access stalls (photo: Morten Hansen).



Bedded lying area in a renovated pen with free access stalls.



Bedded lying area in a renovated pen with electronic sow feeding.

Keep the sow loose – as much as possible

The aim of the farrowing pen is for the sow to be housed loose to the greatest extent possible, but without this jeopardising the survival of the piglets.

As the sow is loose most of the time in the farrowing pen, it requires attention to design and management to have a well-functioning pen. Traditional pens with temporary crating in which crate sides open or pens with a similar design will not work for loose sows as they face away/move away from the trough when they defecate. In the near future, many activities will focus on development of pens that can function for sow, piglets and staff alike and also come with the possibility of using a crate for short periods.

Pens for loose farrowing sows

The outcome of a project supported by the Innovation Act was a pen designed by several partners, and this pen is now recommended for loose farrowing sows.

The pen worked well; the solid floor was dry, which suggests that sow and piglets defecated and urinated on the slatted floor. Solid, dry flooring also makes it possible to supply, for instance, straw without the straw becoming dirty or immediately passing through the slats into the slurry pit. Except when nursing, the piglets primarily stayed in the creep area, whereby staff can supervise the pigs without actually entering the pen. It also reduces the risk of the piglets being crushed by the sow. However, it should be noted that the trial facility used for this investigation only had 14 pens.

Partners in the project conducted under the Innovation Act: Jyden Bur, the Danish Animal Welfare Society, Aarhus University – The Department of Animal Health and Bioscience, Svend Aage Christiansen A/S, Skiold A/S, Perstrup A/S, Hedegaard, Skov A/S, Ergofloor, Pig Research Centre.



Pen for loose farrowing sow. The pen measures approx. 2 x 3 m and has a lying/resting area and an activity area. The resting area has closed pen sides, part-solid floor, support for the sow when it lies down, and a straw rack to assure the sow of access to straw at all times, and more straw can easily be supplied during supervision. The activity area has open pen sides and slatted floor. All creep areas face passageways.

Management

Pig Research Centre analysed experiences from eight pig farms with loose farrowing and lactating sows. On two farms, sows were loose housed in the farrowing house, whereas on the remaining six, there were some pens for loose sows and the rest were housed in traditional farrowing pens with crates.

Pig producers found it easy to transfer sows to the pens and to move sows and pigs out of them at weaning.

Gilts seemed more affected by disturbances in the facility or by inspection in the pen during farrowing than the sows. On one farm, gilts made more mess on the solid floor than the sows, and on

another farm, more gilts farrowed on the slatted floor in stead of on the solid floor compared with the sows.

On most farms, the majority of the sows used as nurse sows were calm sows that were not disturbed by staff supervising the pigs in the pen or by the creep area opening. Consequently, temper was more important than whether the nurse sow was a gilt. Experience demonstrated that agitated gilts and sows often failed as nurse sows.

Piglet mortality presented quite a challenge to the farm owners in this investigation. Three of them quoted low piglet mortality as a prerequisite for establishing more pens for loose sows.

The staff on all farms was familiar with assessing sows' temper when evaluating whether entering the pen was safe. Even just a few pens for loose sows underlined the fact that more attention to the sow was necessary compared with traditional farrowing pens.

Climate in the pens

As in traditional farrowing pens, high production results and well-functioning pens require clean and thoroughly dry environment before pigs are transferred. Ventilation systems should be dimensioned to an output of approx. 400 m³/h/sow.

In 2012, Pig Research Centre will analyse floor heating and floor cooling in sows' activity area to affect the way sow and piglets use the pen.

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

New welfare policy

In 2011, Pig Research Centre (PRC) launched a new welfare policy for the Danish pig industry. The new objectives for welfare are laid down by the industry itself.

In January 2011, PRC held a 24-hour seminar with participation of 80 pig producers representing pig producers inside and well as outside the elected system. It was here decided which future target areas to work for in the pig industry.

Objectives were laid down on the following areas:

Reduction in mortality

It is generally agreed in the pig industry that high mortality rates are a challenge in terms of welfare as well as economy. The objective is therefore to reduce the average mortality rates by 20% among piglets, weaners and finishers by 2020. For sows, a 25% reduction in the period 2008-2013 had already been agreed.

The objectives will be reached through several measures such as:

- Effect of breeding. Great emphasis is put on breeding for survival and for viable piglets with the breeding objective "Live pigs on day 5" (LP5). This includes improving the sow's maternal traits, milk production and ability to rear piglets so that minimum 14 healthy pigs are weaned in each litter.

- Manuals and advice. Danish pig advisors support these objectives. With the use of "Growth manual for weaners and finishers" and "Guidelines for Farrowing Facilities" all farms are assured of correct routines and staff instructions.
- Self-audit for animal welfare. All pig producers are required to keep daily recordings of dead animals. In farrowing facilities, piglet mortality must be recorded daily by noting date and number of dead piglets at litter or section level.

Recordings of mortality are an important management tool that makes it possible, together with colleagues and the herd veterinarian, to assess current mortality in proportion to forecasts for the farm in question.

Forms for daily recordings of mortality can be downloaded at PRC's website.

Reduced consumption of antibiotics

In the period 2010-2013, antibiotics consumption per pig must be reduced by 10%.

To reach this objective, PRC supports veterinarians and pig producers through, for instance:

- Manual on good antibiotic practice, which is available at PRC's website.

- PRC will help with and cooperate on developing new vaccines, diets, pen layout etc. to reduce disease outbreaks.

Loose sows

The industry supports the conclusions in the report "Work group for keeping pigs" in which the aim is for all sows to be housed loosed in all new facilities by 2021. The conversion to loose housing in all sections is an extremely comprehensive and expensive task, and, for a wide range of areas, housing and pen systems are not yet fully developed. PRC will therefore:

- Improve on-going development tasks to ensure that new requirements are implemented in a sensible and production-safe manner.
- Work for the development of an incentive structure that promotes the objectives in the report of minimum 10% loose lactating sows by 2020.

Hospital pens

The use of hospital pens improves animal welfare and reduces mortality rates. However, on some farms hospital pens are not adequately designed, and sick and injured pigs are not handled properly.

As of January 1, 2011, the DANISH inspection increased the audits of hospital pens and inadequate destruction.

Good husbandry

Good animal welfare starts by discussing and evaluating attitudes and actions on the farms and in work groups.

PRC has prepared the material "Welfare in pig production – where is the limit?", which is available at the website.

PRC also offers pig producers an audit where a welfare advisor from the local pig advisory office participates in one audit of the farm and in the subsequent work group meeting to maximise the profit of welfare discussions. So far, 65 work groups have signed up to the scheme.

DANISH Product Standard

On January 1, 2011, DANISH and the UK Control were tightened further on a



A farm's self-audit programme must ensure compliance with current animal welfare legislation.

number of areas. The management group increased audit procedures of several significant points, such as:

- Are the piglets minimum 21 days old at weaning?
- Are space requirements for sows met in all sections with stalls?
- Are requirements for enrichment and rooting materials met in all facilities, particularly in the farrowing facility, service facility and gestation facility?
- Is pain relief administered during castration and is this documented?
- Are gestating sows under the UK standard housed in groups the entire period?

Rules for participating in the scheme were also increased and consequently it is now possible to exclude members after just one new audit if non-compliances have not been rectified.

The group also decided that up to 10% of all audits for UK must be conducted as unannounced audits to ensure that production conditions comply with requirements for UK pigs.

Audit of sections

There are many advantages to a DANISH certification of a pig farm. It helps provide an outline of possible inadequacies in production routines. A DANISH approval is also a pig producer's proof of compliance with Danish legislation, which is essential to a good image for Danish pig producers and general acceptance in society.

Results of DANISH audits demonstrate that farms on which all sections are routinely inspected and on which unambiguous procedures are agreed with the staff on good welfare practice pass the audits with flying colours.

It is particularly important that the staff is included in deciding clear procedures for correct:

- Use and maintenance of enrichment and rooting materials in all sections
- Layout and use of hospital pens
- Tail docking
- Destruction or treatment of sick/injured pigs

It is also crucial that all pig producers ensure correct traceability procedures on their farm. This is ensured through correct registration in the CHR database in terms of production scope, sales agreements, and, in particular, transfers of pigs to and from the site.

Dialogue meetings

PRC holds two annual dialogue meetings with representatives from the Danish Veterinary and Food Administration, the Ministry of Justice and the Danish Plant Directorate. The aim is to ensure that audits are performed in uniform manners regardless of the auditor handling the audit. At these meetings, audits of specific areas, e.g. hospital pens and requirements for enrichment and rooting materials, are discussed and calibrated.

Cross-compliance

Cross-compliance regulations greatly influence whether a pig producer is eligible for full agriculture aid.

There is a total of 28 welfare requirements for pigs all deeply rooted in EU legislation. Specific Danish statutory requirements are not covered by cross-compliance.

Cross-compliance audits are not independent audits, but are performed in connection with existing public audits.

For instance, animal welfare audits are handled by auditors from the Danish Plant Directorate/Danish Veterinary and Food Administration in connection with the 5% audits. It should be noted that non-compliances observed at the public audits will be reported to the Danish Food Industry Agency and may result in sanctions. This also applies to, for instance, non-compliances observed at the 5% inspections and reports made to the local police at the public meat inspections at Danish slaughterhouses.

After the audit, it is important to form an outline of the result of the audit and of possible non-compliances. If a pig producer wishes to submit remarks to the audit report or to the letter from the auditing authority, this must be detailed, well-written and it must include documentation where possible. It is essential to meet deadlines and to review all parts of the auditor's evaluation, including:

- The requirement that the non-compliance in question concerns
- The severity, extent and duration (grades) of the non-compliance
- Whether the non-compliance was negligent or deliberate.

At PRC's website, guidelines/leaflets can be downloaded containing information of how to handle the process in case of non-compliances.



Piglets must not be weaned before they are 21 days old unless the welfare or health of sow or piglets would otherwise be jeopardised.

Pain relief

On January 1, 2011, pain relief of piglets during castration became a statutory requirement. Legislation was revised following the requirement for pain relief introduced by the pig industry in 2009. The drugs approved for treatment mainly affect the pain experienced by piglets after castration. Pig Research Centre is currently investigating practical methods for reduction of pain during castration.

Cost-benefit

The productivity levels of male pigs, female pigs and castrates from 30 kg until slaughter fed liquid feed according to a curve were compared to analyse the cost-benefits of male pig production. The preliminary results from one farm are shown in Table 1. Ad lib dry feeding is being investigated on another farm in a similar trial.

Skatole averaged 0.09% and 3.4% of the pigs were rejected.

Preliminary results demonstrate that male pigs performed significantly better than castrates, but when male pig reduction of DKK 25 per male pig is deducted, there is no economic benefit in producing male pigs if approx. 5% are rejected on the slaughter line.

Improvac

In cooperation with Pfizer, Pig Research Centre tested the Improvac vaccine. Male pigs are injected with Improvac at 30 kg and again max. four weeks before slaughter. The vaccine affects the general sex hormones and suppresses the production of androstenone, the hormone that triggers boar taint and taste.

The trial was conducted on two farms, and daily gain, FCR and lean meat percentage of the vaccinated male pigs were compared with those of castrates and female pigs (see Table 2).

There were no differences in daily gain between vaccinated male pigs and castrates, but significant differences were observed in FCR and lean meat percentage.

In conclusion, Improvac pigs managed just as well as female pigs and better than castrates.

Sexing of semen

Pig Research Centre has participated in the development of an immunological method for sorting semen into female and male sperm.

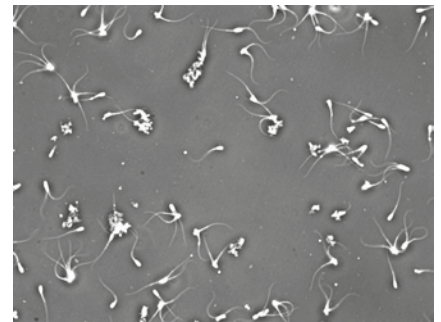
Gender specific proteins exist on the surface of sperm. Several of these proteins were identified, and antibodies against some of them were developed. The intention is to develop a method for separating the sperm by combining these antibodies with a "killer" molecule that eliminates the male sperm.

The addition of different doses of antibodies to the sperm had no damaging effect on the sperm. Approximately 40 sows were inseminated to document fertility of the sperm and possible distribution of genders in the litters born. High gestation rates were recorded at scanning on day 21. The sows were slaughtered 40 days into gestation (when it is possible to tell male embryos from female embryos), but, unfortunately, no differences were found in the distribution of gender. Litter sizes were normal, ie. treatment with antibodies had no negative effect on sperm fertility.

Sperm treated with antibodies was subject to PCR analyses to document gender distribution in the semen doses, but the

positive results previously demonstrated with semen from cattle were not confirmed with boar semen.

The future of this project is currently being evaluated.



Sperm tends to clot when antibodies are added.

Reduction of boar taint

Pig Research Centre has initiated several activities to locate methods for reduction of boar taint. It is a well-known fact that the addition of chicory root to pig feed reduces skatole levels, but the product is too expensive for use in practice.

	Castrates	Male pigs	Female pigs
Gram/day	929	920	900
FUgp/kg	2.78 a	2.65 b	2.69 b
Lean meat %	59.3 a	60.6 b	60.6 b

Table 1. Differences in performance between genders. Production value 100 112 * 105.
* Production value for male pigs does not include male pig deduction.

30-100 kg	Farm	Castrates	Improvac	Female pigs
Lean meat %	1	60.1 a	61.2 b	61.3 b
	2	59.6 a	60.4 b	60.7 b
FCR	1	2.89 a	2.75 b	2.74 b
	2	2.57 a	2.51 b	2.48 b

Table 2. Effect of Improvac.

Gastric health

Gastric health is pivotal to pigs' welfare and productivity. Pig Research Centre has therefore initiated a series of activities on gastric health and texture of pig feed.

In 2011, a general survey of gastric health among finishers and slaughter sows was completed, and this is followed by several activities in 2011 and 2012 where the timeframe for development of gastric ulcers in finishers will be investigated. Trial activities will also include possible correlations between lung disorders and gastric health in finishers. It will also be investigated whether gastric health is affected by feeding frequency and dose in order to improve recommendations for sow farmers with gastric ulcer problems in the herd.



Veterinarian examines a normal stomach (index 0) at the slaughterhouse.

The pig's stomach

The stomach is elastic and muscular and covered by a thick, sticky layer of basic mucus protecting the stomach against gastric juices. The mucous membrane at the mouth of the oesophagus in the stomach is unprotected, and this area is called the white part of the stomach. This is where gastric changes in particular develop and possibly develop into lesions and wounds that may ultimately develop into oesophageal stricture.

Scoring of gastric ulcers

A pig's stomach is scored on a scale from 0 to 10. Finishers with an index of 6 or more have a lower gain than other finishers. Sows with an index of 6 or more have reduced feed intake and therefore reduced productivity.

Gastric index	
0	Normal stomach
1-3	Cornification of the gastric mucous membrane
4-5	Superficial damages to mucous membrane
6-8	Ulcers or scars from previous ulcers
9-10	Oesophageal stricture

Overall gastric health

Gastric health was examined in 1,102 Danish finishers and in 1,060 slaughter sows. All stomachs were visually evaluated by the same vet from Laboratory for Pig Diseases.

Results of gastric study

Results revealed that 71% of the 1,102 finishers had an index of 6-8 and 4% had an index of 9 or 10. No differences were found in gastric index between females and castrates.

Among the 1,060 slaughter sows in the investigation, 49% had an index below 6%; 44% an index of 6, 7 or 8; and 7% an index of 9%.

Farm owners also supplied information

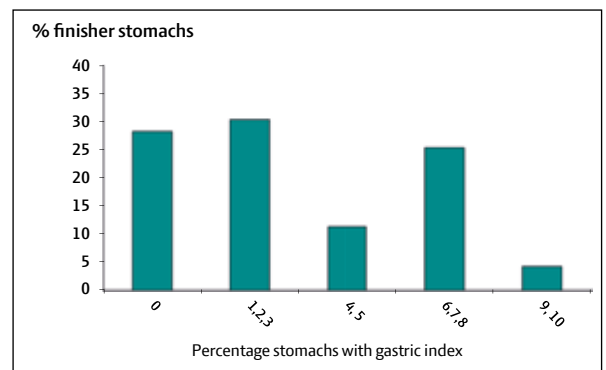
Farm owners provided information on the feeding of the pigs, and this information supported what we already know about the correlations between gastric changes and pelleted/very finely ground feed. On 29 farms, the pigs were fed feed mixed on-farm or purchased feed. Feed mixed

on-farm is generally more coarsely ground, and the figure below underlines the fact that pigs fed feed mixed on-farm generally had better gastric health. However, a high prevalence of gastric indices of 6 or more was observed on a few farms.

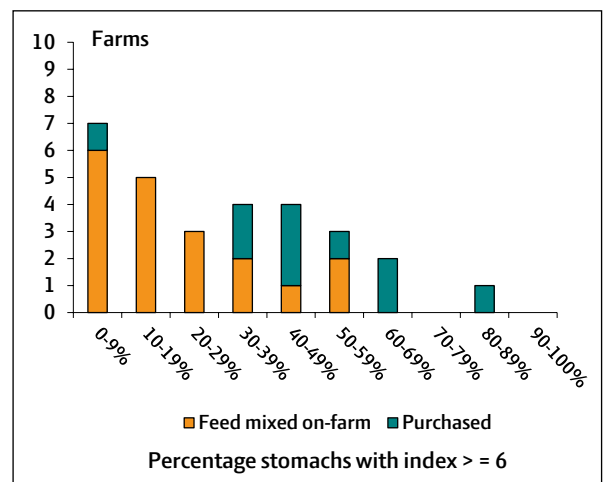
More than just feed texture

Screening results suggest that the development of gastric ulcers is not only affected by the texture of the feed. This will be analysed further in 2012.

Stomachs were examined at the slaughterhouses in cooperation with Danish Crown. The project was financially supported by the EU and the Rural District Programme under the Danish Ministry of Food, Agriculture and Fisheries.



Distribution in per cent of gastric indices in 1,102 finishers.



Percentage of stomachs with gastric indices of 6 or more in proportion to feed type (data from 29 farms).

Reduction in shoulder lesions

In 2007, a range of trial activities were initiated to reduce the prevalence of shoulder lesions on Danish farms.

The activities described below have finished and readers are referred to Pig Research Centre's website for more publications related to the projects.

"Breeding against shoulder lesions" has not yet finished – read more about this in the section on genetic research.

Rubber mats in farrowing pens

It was investigated whether the use of rubber mats in farrowing pens may prevent shoulder lesions.

Three groups were compared in farrowing pens with part-slatted floor:

- Concrete solid floor (control)
- Regular massive rubber mat (17 mm)
- Rubber mat with a core of foam rubber that gives way to the sow's weight.

On one of two farms, rubber mats with a foam core were seen to have an effect. In the group with rubber mats with foam core, hygiene on the floor under the sow improved. It is therefore unclear whether the effect is attributed to the rubber mats or to the dry floor in the pen. On both farms, shoulder lesions were primarily observed among sows in poor body condition and/or sows with scars from previous shoulder lesions – these sows are also called "risk sows".

For more information on this trial, see trial report 912.

As primarily risk sows develop shoulder lesions, it is still recommended to place a rubber mat in the farrowing pen of these sows. Results from the trial indicate that the mat should be more flexible to the sow's weight than traditional, massive mats.

Floor cooling in farrowing pens

Shoulder lesions develop in particular in the summertime. Sows' immediate environment must benefit their ther-



Rubber mats are recommended in pens for sows at risk of developing shoulder lesions.

mally neutral comfort zone, and this can be obtained through the use of floor cooling. However, trial results from two farms revealed that floor cooling did not affect the prevalence of shoulder lesions. On both farms, less than 5% of the sows developed shoulder lesions. Results were published by the end of 2011.

Clinical scale

In 2011, Danish authorities introduced a surveillance scheme and the Yellow Card Scheme in an attempt to mini-mise the prevalence of shoulder lesions and to prevent the development of severe shoulder lesions. A clinical scale was therefore developed for assessment of shoulder lesions on lactating sows, but the scale has not yet been implemented in practice.

The scale has three scores:

No or insignificant skin changes – no skin changes or skin changes smaller than 2 cm in diameter.

Mild shoulder lesion – shoulder lesions measuring 2 cm or more in diameter and that are not severe shoulder lesions.

Severe shoulder lesion – shoulder lesions measuring 5 cm or more in diameter with callus formation.

The scale is based on detailed clinical recordings made on 167 sows on seven farms. These recordings were subsequently compared with patho-anatomical

observations and other measures for lesion depth.

The scale was validated by 24 people experienced in assessing shoulder lesions who assessed shoulder lesions on 89 sows.

Furthermore, a practical tool for assessing shoulder lesions was developed that can also be used as a calibration tool in combination with educational material. Material was collected in the form of ultra sound images, digital images and biopsies for possible use in the development of a more accurate calibration tool.

Danish politicians have yet to decide how to implement the surveillance scheme, and the new scale is therefore not yet implemented. The scale was developed in cooperation between Pig Research Centre, Aarhus University, Copenhagen University, the Danish Veterinary and Food Administration, and the Danish Veterinary Association.

The project ended in 2010, and was financially supported by the EU and the Rural District Programme under the Danish Ministry of Food, Agriculture and Fisheries.

Programme: “Better legs”

The activities under the programme “Better legs” finished in 2011, and were financially supported by the EU and the Rural District Programme under the Danish Ministry of Food, Agriculture and Fisheries.

Lameness in sows

Causes of lameness in gestating sows were investigated on two farms with a high frequency of leg disorders among the sows. Forty-two lame sows were destroyed and examined at the Laboratory for Pig Diseases in Kjellerup.

Results of post-mortem examinations of lame sows

Chronic articular changes / osteochondrosis	19 sows (45 %)
Arthritis / osteitis	14 (33 %)
Hoof injuries	6 (14 %)
Back disorders	1 (2 %)
No observations	2 (5 %)

Results revealed chronic articular changes to be the most frequent cause of lameness (45%). Articular changes cannot be cured with antibiotics, which may therefore indicate chronic articular changes. Lameness in sows can often be cured with pain relief in a hospital pen.



A sow is delivered to the lab for post-mortem examinations for lameness.

On-farm production of gilts

Manual on Gilt Management advises pig producers on how to handle on-farm production of gilts from birth to service. The

Manual includes 14 Fact Sheets that are available at Pig Research Centre’s website.

Assessment of gilts and sows

Leg position and locomotive ability were assessed on 623 gilts and 875 gestating sows on five farms. Preliminary results demonstrate that gilts and sows with non-uniform, large hooves are at a significantly higher risk (OR) of being culled before the next service. Weak pasterns were observed in 61% of the gestating sows; these sows have a 42% higher risk (OR) of being culled before their next service.

Hooves, non-uniform

	Number	%	OR, risk of culling
Gilts	623	3	4.01*
Gestating sows	875	11	2.50*

*: Significantly higher risk of culling

Hindlegs, weak pasterns

	Number	%	OR, risk of culling
Gilts	623	13	1.62
Gestating sows	875	61	1.42*



Assessment of leg position and locomotive ability in gilts.

Growth of gilts

Results from investigations on two farms demonstrated that the growth rate of gilts in the period 60-125 kg had no influence on gilt survival up to their third litter. In the control group, gilts gained approx. 900 g a day, and the gilts in the trial group gained approx. 710 g a day.

Socialisation of gilts

Through socialisation, gilts gain experience with ranking in groups with older, gestating sows before service.

The effect of socialisation on longevity until service for the third litter is currently being investigated on two farms where gestating sows are housed in groups and fed in ESF systems. Approx. one month before transfer to the service facility, the gilts are transferred to a training pen located in the gestation facility. The pen accommodates 30-35 gilts.

After two weeks in the training pen, the gate is opened to an adjoining sow pen housing older sows and remains open for the last two weeks of the training period. The gilts in the control group are housed in the training pen for four weeks.

Gilt accommodation

It is investigated whether it is possible to increase the percentage of gilts that make it to service for the second litter by using one accommodation principle over another. Three types of accommodation are compared – all using electronic sow feeding. The gilts are accommodated in one of three types of groups:

- Dynamic group with gilts
- Dynamic group with sows
- Stable group with sows

The activities concerning socialisation and accommodation of gilts will continue in 2012 as parts of the programme “Healthy group-housed sows”.

Outline

"Healthy group-housed sows" was selected by Pig Research Centre as a strategic target area comprising several activities all aimed at creating as much success as possible on Danish sow farms in terms of production parameters and welfare. The aim is for the knowledge obtained in the activities to improve sow health and welfare and reduce sow mortality.

By 2013, all gestating sows must be housed in groups, and staff on the farms is a decisive factor in making this a success.

The activities in "Healthy group-housed sows" were financially supported by the EU and the Rural District Programme under the Danish Ministry of Food, Agriculture and Fisheries.

Team SoLiv ("sow life") is a project aimed at demonstrating that improved motivation among staff and an understanding of work procedures will result in thriving sows returning the favour with a high productivity levels. Well-being is the central point.



Well-being in humans and pigs

Results from a previous trial demonstrated that with a dedicated effort from pig advisors, herd managers and staff it was possible to reduce sow mortality. Often, staff-related problems on the farms affected sow well-being, and pig advisors found this type of problems difficult to solve.

In Team SoLiv, the staff on the farms is included in the work that clarifies responsibilities and tasks, analyses staff well-being, and includes staff interviews and staff profile. Analysis of responsibilities and tasks will clarify whether all staff members know who does what or whether the structure needs be changed. Analysis of well-being among the staff provides a general indication of the general well-being on

the farm. Staff interviews attune expectations between herd owner and employee; is the work performed to everybody's satisfaction and does the employee need more training, more or less responsibility etc.

Staff interviews are confidential, which makes it possible to discuss the well-being of the employee. Staff profiles make all staff members aware of each other's similarities and differences whereby it becomes easier to clear up misunderstandings and solve conflicts.

All these tools will help staff members work together as a team. A well-functioning team results in joy in working and gives the energy needed to focus on the important element of the job, ie. to tend excellently to the sows 24/7 and reduce sow mortality.

Demonstration project

This project includes six farms to each of which an HR advisor and a pig advisor are attached besides the herd veterinarian.

High mortality rates among sows are often caused by the same factors, and the most prominent subjects in this project were gilts, hospital pens, legs and hooves, and daily routines.

Young sows need nursing

Many young sows were culled on these six farms, and the main focus was therefore on gilts. Selection of gilts requires some experience to ensure that only high-quality gilts are served. Accommodation is essential; gilts need space and socialisation to learn to manage among bigger sows. They must learn how to use a feeding station if they are accommodated in systems with electronic sow feeding. A good upbringing makes a strong gilt with good longevity.

24/7

It is crucial to intervene when pigs are sick and this requires systematic routines. Strategies for supervision of sows, treatment and use of hospital pens are necessary to be able to save a sow and avoid culling. Medical records were therefore

introduced stating date of transfer to hospital pen, diagnosis and treatment.

Farmer Field Schools

Team Soliv is trying a concept called "Farmer Field Schools" that was previously tried with organic cattle farmers and now forms part of the obligatory health inspection.

Farmer Field Schools is a slightly different way of meeting compared with work groups. The main purpose is for the participants to help each other solve the problems they encounter in their daily work.

Herd managers in Team Soliv are highly experienced in practical routines and they use this experience when they solve specific problems, such as the best way to introduce gilts to older sows in the gestation facility.

Farmer Field Schools differ from traditional work groups in that the participants learn from each other. There is no expert to provide the right answers. All participants are herd managers with a clear understanding of the complicated work and they know what can be changed.

Team spirit

Feedback demonstrates that the focus on sows and staff is highly motivating. Everyday habits are eliminated and participants now look differently at routines on the farm. Staff profiles provide a good understanding of each other's colleagues and help avoid or handle little conflicts everyday. Overall, the team spirit improved on the six farms.



Team meeting.

Design of the gilt pen

More research is required on design of the pens for gilts housed in large dynamic groups accommodating up to 40 gilts a pen. On some farms, a very large percentage of the gilts never make it to service. One cause is slippery floors resulting in tendencies to slip and thereby culling of the gilts.

A low stocking density will result in a fairly large dunging area in proportion to the number of pigs in the pen, and faeces may accumulate in several parts of the pen. It is being investigated if sprinkling can reduce the accumulation of faeces on the slats. It is also investigated if straw boards in the lying area and keeping straw on the solid floor reduce the pigs' tendency to defecate on the solid floor.

Gilts and young sows are vulnerable

It is essential to introduce gilts gently to life in the gestation facility to avoid unnecessary stress and injury – read more on socialisation on page 43. Gilts constitute a fairly large percentage of the animals in the group of slaughtered and killed pigs. The reason is often leg problems that are largely ascribed to conflicts arising when hierarchy is established the first few days in a new group.

Due to their low body weight, gilts and young sows are placed lowest in the hierarchy in a group of gestating sows.

Flooring in gestation facilities

On one farm with electronic sow feeding, different flooring in the activity area in



Hospital pen with drained, bedded lying area. To keep the straw in the lying area, a 15 cm high board is required.

two pens is being investigated. Flooring appears non-skid, and should thereby reduce the frequency of leg injuries. The investigation finished in 2011.

Bedding in hospital pens for sows

Seven different types of bedding in hospital pens for sows were investigated. Besides straw, two types of rubber mats were included that comply with the requirement for soft bedding in hospital pens. For an in-depth description of the individual rubber mats, see report 1109.

Hospital pens with drained, bedded (straw) lying areas seemed soft and dry during the entire trial period. Each week, 2 kg straw was allocated to each pen.

To avoid luting, dry straw had to be moved from the dunging area back to lying area daily – with the exception of this, mucking out was only required rarely.

Pig Research Centre's website provides an overall outline of rubber mats that meet the requirements for soft bedding.



Rubber flooring from ErgoFloor (left), DUO slats from Sunds (right). Flooring is placed in the middle of the activity area where most fights for hierarchy arise.



Hospital pen with rubber mat. The lying area will appear dry provided the bedding has a slope of approx. 5%.

BLOOD VALUES AND ENERGY TURNOVER IN HIGH-PROLIFIC SOWS

HEALTH

Blood values in sows

Blood samples are essential when diagnosing infections as well as metabolic diseases in humans and pets.

In pigs, blood samples are used exclusively to diagnose infections (serology). It is still unclear what normal blood values in sows are and whether deviations are important. A catalogue is available for vets that describes normal values for 27 parameters that can easily be analysed in blood samples from pigs. Most results matched the reference values of Danish laboratories, while some deviated greatly from "normal" as the normal is established on the basis of blood samples from finishers and gilts. Figure 1 shows recordings of cholesterol in blood from sows compared with the Danish reference (red line) and the official US reference (green line). Figure 2 demonstrates that parity does matter when, for instance, haemoglobin levels are analysed in sow blood: 8 g/dl are more frequently found in first parity sows, whereas 6 g/dl are frequently seen in older sows.

Calcium

The time it takes for Danish sows to complete farrowing has increased over the last years. Calcium is essential to muscle power, and deficiency in calcium may therefore be partly to blame for the increase. Results from a small-scale study revealed that sows with low calcium levels before farrowing had more stillborn piglets. Results of 150 blood samples taken from 30 sows before and after farrowing demonstrated that calcium levels are stable until day 1 before farrowing when the levels change. Subsequently, 455 sows were blood sampled the week before farrowing.

Calcium levels were related to the percentage of stillborn piglets, but it was not possible to confirm the correlation found in previous trials between low calcium levels and a high percentage of stillborn piglets.

Ketosis

Farrowing is a marathon process for the sow and requires a massive supply of carbohydrates. This means fibre and starch, whereas large amounts of dietary fat are

expected to be hard on a sow's metabolism. Milk production is low the first days post-farrowing and some sows stop eating in this period. If failure to eat is triggered by MMA, the sow can be treated. If a sow shows no indication of infection and still stops eating, it will often be difficult to make it start eating again. It was long discussed whether ketosis may be the cause of this problem.

Results from a series of investigations made by the Department of Animal Science, Aarhus University, have once and for all established that primary ketosis (the sow is unable to produce sugar for completion of Krebs cycle) is not seen in sows. However, imbalances between fat and carbohydrates in feed or insufficient amounts of feed may trigger secondary ketosis whereby the sow mobilises and metabolises its fat reserves.

Fructosamin

Sugars are quickly absorbed in the blood via the intestinal tract and quickly disappear as they are either metabolised or deposited in tissues. Sugar levels in blood therefore vary greatly depending on the last feeding.

Fructosamin is produced when sugar in blood is bound to albumin. The amount of fructosamin produced depends on the amount of sugar available. Fructosamin is secreted extremely slowly, i.e. the levels provide an indication of the blood sugar level for the last couple of weeks. Consequently, a blood sample with high fructosamin levels indicates that the sow has had periods with high blood sugar levels (= high feed intake), while low fructosamin levels indicate a low blood sugar level for the last couple of

weeks. This method may possibly be used for detecting low-ranking sows accommodated in group-feeding systems, and where these sows have eaten too little.

The programme started in 2009, and is financially supported by the EU and the Rural District Programme under the Danish Ministry of Food, Agriculture and Fisheries.

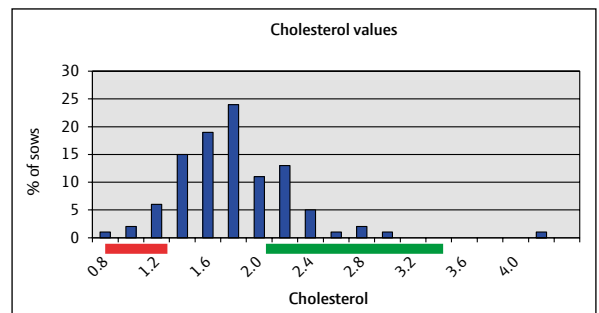


Figure 1. Cholesterol values in Danish sows (blue columns) compared with official standard values (red and green lines) in pigs.

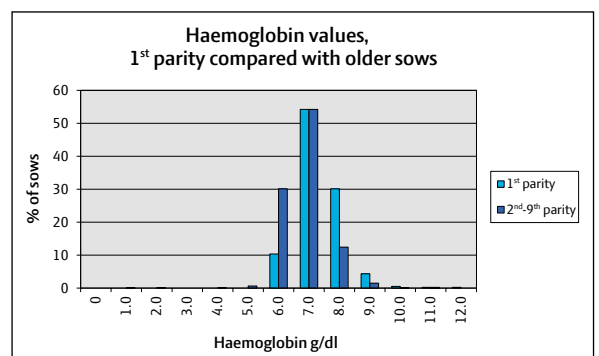


Figure 2. Distribution of sows with increasing haemoglobin levels. 1st parity = light blue, 2nd – 9th parity = dark blue.

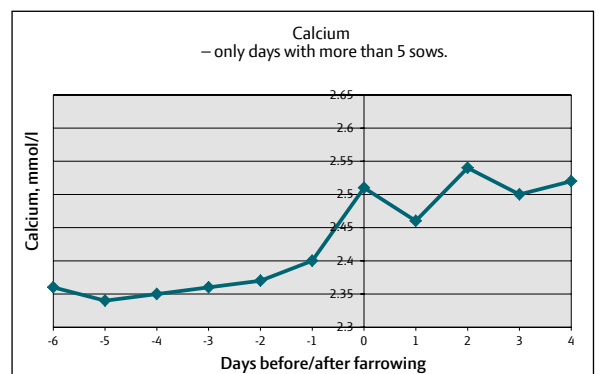


Figure 3. Calcium levels in sows' blood are stable in the days leading up to farrowing. From the day before farrowing they increase to a higher, stable level once the sow has farrowed.

Documentation of health status

Within the areas SPF (Specific Pathogen Free), health and diagnostics, Pig Research Centre handles the service activities delivered by Laboratory for Pig Diseases in Kjellerup, the SPF Health Inspection and SPF Health Status. The activities are financed through user payment, which covers the capital bound for the activities.

Laboratory for Pig Diseases

Since January 2010, the Lab is the only laboratory in Denmark handling post-mortem examinations of pigs. The result was a significant increase in activities combined with the introduction of the Yellow Card Scheme in which many vets and pig producers started paying more attention to post-mortem examinations and microbiological analyses to target the consumption of antibiotics.

DTU Veterinary Institute is still a significant collaborator when it comes to special analyses to identify pathogen bacteria and viruses.

In 2011, it was expected that the Lab would perform approx. 4,000 post-mortem examinations and organ examinations. These examinations will also include bacteriological analyses and analyses for resistance.

The Lab analyses the majority of all serological examinations made in the Danish SPF system.

In the second quarter of 2011, the Lab provided serological analyses for PRRS to red SPF herds and to all SPF herds from the third quarter.

Serological analyses are a very significant activity, and the goal is to be able, at all times, to provide quality analyses to pig farms at competitive prices.

SPF Health Inspection

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



Preparation of blood samples for analysis.

document the health declaration of the herd.

Demand for breeding stock with health declaration continued to increase in 2011 in Denmark and in Europe.

On July 1, 2011, 238 CHR numbers were given red SPF status. The trend of the last few years continues with a slight drop in the number of herds, but an unchanged number of breeding stock.

The Health Inspection also monitors animal welfare of Danish breeding and multiplication stock with particular focus on shoulder lesions, tail biting, stocking density and hospital pens.

The trend of the last few years continues, but on most farms conditions have generally improved.

The SPF Health Inspection also functions as practising veterinarian for a number of breeding and multiplication herds, and as supervising veterinarian on all Hatting AI stations and quarantine facilities.

SPF Health Status

SPF Health Status is in charge of maintaining the SPF database of all SPF herds in Denmark.



Blood sampling during health inspection.

The Danish SPF system declared herds for the following diseases:

- Pleuropneumonia (Ap types -10 and 12)
- Pneumonia (myc)
- Pig dysentery
- Rhinitis
- PRRS (DK and vac)
- Lice
- Mange

As of July 1, 2011, there were 2,896 blue SPF herds and 238 red SPF herds.

SPF Health Status also maintains and updates SPF health regulations and SPF transport regulations.

Currently, 8 hauliers have received SPF approval.

- More than 98% of all breeding stock sold in Denmark are SPF red.
- More than 70% of all Danish sows have SPF status, which means that more than 70% of all weaners sold in Denmark have SPF status.

Saliva versus blood samples

Blood samples are often used for diagnosing and monitoring disease in pig herds. It is time-consuming, expensive and often an unpleasant experience for the pig. The use of saliva as sample material is a far cheaper, easier and animal-friendly method.

Saliva from pigs' oral cavity contains the same antibodies and/or virus as the blood, only in far lower concentrations.

Besides being easy and animal-friendly, it is also possible to sample material from many more animals.

Collection of saliva samples

A cotton rope is hung in the pen in the pigs' shoulder height. For approx. 30 minutes, the pigs in the pen chew on the rope and leave saliva. In 30 minutes, approx. 90% of all pigs in the pen will have chewed on the rope. The rope is cut down, put in a bag, and wrung, and saliva is extracted and poured into a container. This leaves approx. 2.5 ml saliva that can be used for analysis.

What can be detected in saliva?

Analysis results from other countries revealed PRRS, PCV2, the flu, pneumonia and pleuropneumonia in saliva from pigs.

In Denmark, the method is only approved for diagnosing of PCV2.

However, in cooperation with DTU Veterinary Institute, Pig Research Centre is working for an approval of the method and thereby making it possible to have saliva samples analysed for other diseases such as PRRS, the flu and Lawsonia. Until this work is done, saliva samples can still be submitted for analysis, but the result may be negative even though, for instance, PRRS is present. This is primarily due to the fact that saliva samples from pigs contain not only saliva, but also various impurities.



Pig delivering a saliva sample.

On-farm use

Traditional blood sampling is expensive, which is why as few samples as possible are taken and it is believed that the samples taken represent the entire batch. By using rope in a pen, a 80-90% representation of the pigs in a pen is achieved, which presumably gives a far more accurate analysis result at lower costs.

This method has multiple uses, for instance monitoring PRRS infection in weaners and finishers.

It is a simple method for determining whether a batch is infected with PRRS. Saliva samples can also be used when initiating and evaluating, for instance, PCV2 vaccination. Instead of using blood samples as the basis for deciding whether to vaccinate against PCV2, ropes are hung in some of the pens and if the pigs excrete high levels of PCV2, vaccination procedures should be implemented.

If vaccination does not produce the desired effect, saliva samples can be tried

once more, and if analyses reveal large excretions of PCV2, vaccination procedures should be evaluated.

The future

In the future, it may be possible to monitor exotic diseases on farms where pigs are particularly exposed to infection. As a result, possible introduction of diseases such as swine fever, foot and mouth disease etc. will be discovered much quicker.

Upon suspicion, it will also be possible to sample many pigs in an easy and fast manner compared with traditional blood sampling.

Lawsonia in finishers

On three finisher farms infected with *Lawsonia*, the effect on daily gain among untreated pigs was investigated for 6-8 weeks. Results demonstrated that daily gain among pigs with diarrhoea and with 10^5 - 10^7 *Lawsonia* bacteria per gram faeces was approx. 65 g lower than among pigs with less *Lawsonia* in faeces.

Daily gain of finishers with more than 10^7 *Lawsonia* bacteria per gram faeces was approx. 400 g lower and varied significantly.

Large variations in gain often make it difficult to produce pigs under all in-all out.

Faecal samples were collected for analysis when *Lawsonia* infection peaked. The pigs were monitored for 2-4 weeks after excretion peaked.

Daily gain was recorded over a fairly short period, and the importance of the infections may therefore have been underestimated. On the other hand, for the remaining part of the finisher period, the



Left untreated, Lawsonia may cause severe intestinal changes.



Large variations in daily gain make rational pig production routines difficult.

pigs may actually compensate for some of the reduced gain.

The intervals investigated (10^5 - 10^7 and above 10^7 *Lawsonia* bacteria/g faeces) correspond to what is considered moderate and massive excretion in lab results from DTU Veterinary Institute.

This correlation between the level of *Lawsonia* in faeces and reduced daily gain in pigs suffering from diarrhoea may help evaluate the importance at herd level. In order to be able to use these results, samples must be taken when bacteria excretion peaks as it was done in this investigation.

Results also demonstrated that *Lawsonia* levels in faeces were lowest in normal faeces and highest in diarrhoea in the pigs examined (trial report no. 903).

Diarrhoea among newborn piglets

In September 2010, Pig Research Centre and DTU Veterinary Institute initiated the project "New type of diarrhoea among newborn piglets".

Finding herds suitable for the project turned out to be more difficult than expected as the problem has decreased on many pig farms, and problems are now mainly seen in gilt litters.

A total of 100 pigs from five farms were euthanized and subjected to bacteriological and virological standard analyses. Results revealed no differences in the prevalence of known bacteria or viruses between sick and healthy pigs.

Research on virulence factors on *E.coli* and toxin studies on clostridia was performed in 2011. It may turn out that toxins produced from these bacteria – despite low prevalence in terms of numbers – play an important part in the disease course.

Pigs from the first two farms were examined microscopically and show signs of inflammation with shortening of the epithelial villi. Specific colourings used for identification of *E.coli*, *Clostridium*



Approx. 1,250 pigs from 5 farms were clinically examined daily, and rectal swabs were taken in the first week of life.

perfringens and *Clostridium difficile* generally revealed few bacteria with adherence to mucosa and no significant differences between sick and healthy pigs.

In cooperation with Copenhagen University and DTU Veterinary Institute, Pig Research Centre investigated correlations between *Lawsonia* and daily gain in finishers. The project was financially supported by funds from the Innovation Act.

Yellow card

As a consequence of the increase in the use of antibiotics on Danish pig farms, the Yellow Card Scheme was introduced in July 2010. Consequently, 1,429 pig producers were notified that their use of antibiotics was close to or above the limit releasing a yellow card. They were given time to correct data errors before yellow cards were issued in December 2010 when approx. 1,100 farmers received a yellow card.

The yellow card reversed the trend

Following the introduction of the yellow card in July 2010, the consumption of antibiotics dropped by 6.2% in 2010. This drop continued in 2011 when consumption was 25% lower compared with the same period in 2010.

This reduction is in particular attributed to reductions in group medication (medication administered in feed or water).

Manual: Good Antibiotic Practice

In cooperation with a group of local pig advisors and practising pig veterinarians, Pig Research Centre has issued a practical manual on good antibiotic practice. The aim was to present pig producers

and their advisors with an easily accessible version of all available know-how and experience in how to lower the requirement for antibiotics.

Manual for Good Antibiotic Practice contains 24 pages of guidelines. These guidelines focus on prevention of diarrhoea in growing pigs and on correct and accurate handling of antibiotic for treatment of diseases. The Manual was presented in a series of meetings throughout 2011 with pig advisors and veterinarians.

17 demonstration farms

The instructions in the manual were implemented on 17 farms with high treatment frequencies among weaners. The aim is for these pig producers to reduce their antibiotic use by 10% over the course of ten months. An action plan was made for each farm by the herd vet often in cooperation with the pig advisor. Preliminary experiences reveal a multitude of problems to be solved.

Needle-free injection

In cooperation with Tican and a commercial company, Pig Research Centre is analysing pros and cons and economy of needle-free injections. A series of activi-



The Manual is also available in English and Russian at www.vsp.lf.dk.

ties will clarify injuries relating to the injection procedures during vaccination and reactions to pain. Practical experiences from Danish and foreign farms will also be analysed.

New MRSA guidelines

MRSA is staphylococcus that has grown resistant to the drugs normally used. One type called MRSA 398 is found in pigs in particular and can transmit to humans. MRSA 398 is therefore considered a working environment problem. Under normal circumstances, humans will be healthy carriers of the bacterium – only those particularly predisposed will fall ill from MRSA 398.

Jordbrugets Arbejdsmiljøudvalg (the agricultural industry's working environment committee) has drawn up a set of guidelines on MRSA 398 in cooperation with the Danish Agriculture and Food Council. The guidelines briefly describe ways to prevent and handle MRSA 398 on pig farms, and are available at www.vsp.lf.dk.

Treatment without resistance

In cooperation with Copenhagen University and the Technical University of Denmark, among others, Pig Research Centre is investigating treatments with antibiotic where the risk of developing resistance is low while at the same time the antibiotic is effective in treatment of diseases. The project started in January 2011 and is called MINI-RESIST.

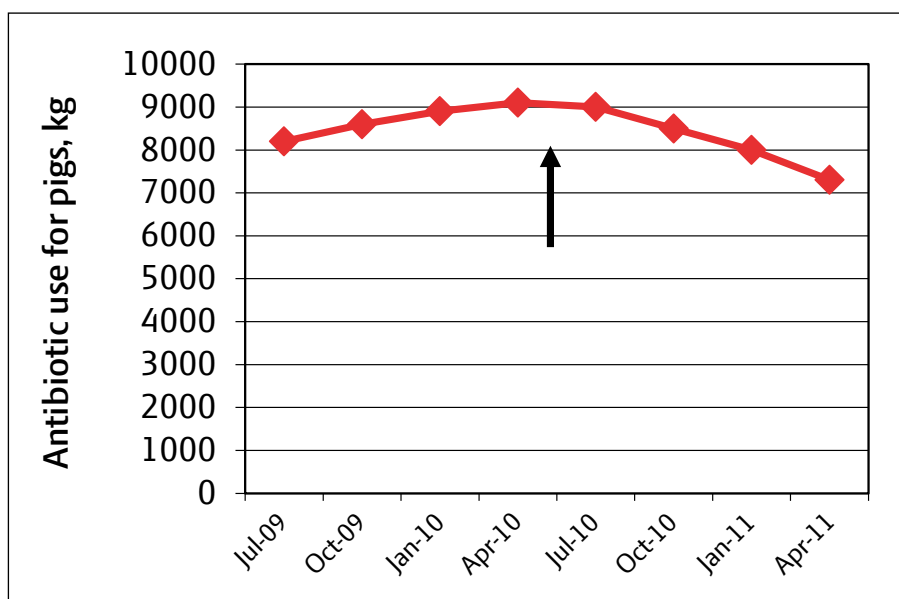


Figure 1. Antibiotic use (average of 9 months). The arrow indicates the introduction of the Yellow Card Scheme.

Infection protection

The increased trade in livestock in the EU and the export to non-EU countries requires increased attention to the veterinary alert system.

Any introduction of virulent infectious disease into Denmark would have dramatic consequences for the overall economy of Danish agriculture.

A dedicated and effective alert system is therefore a necessary insurance premium.

Cleaning and disinfection of transport vehicles and quarantine for humans are two key elements in the prevention of disease.

Danish Transport Standard

Consequently, Pig Research Centre established Danish Transport Standard, which includes all parties involved in the production of pigs in one preventive effort against infections.

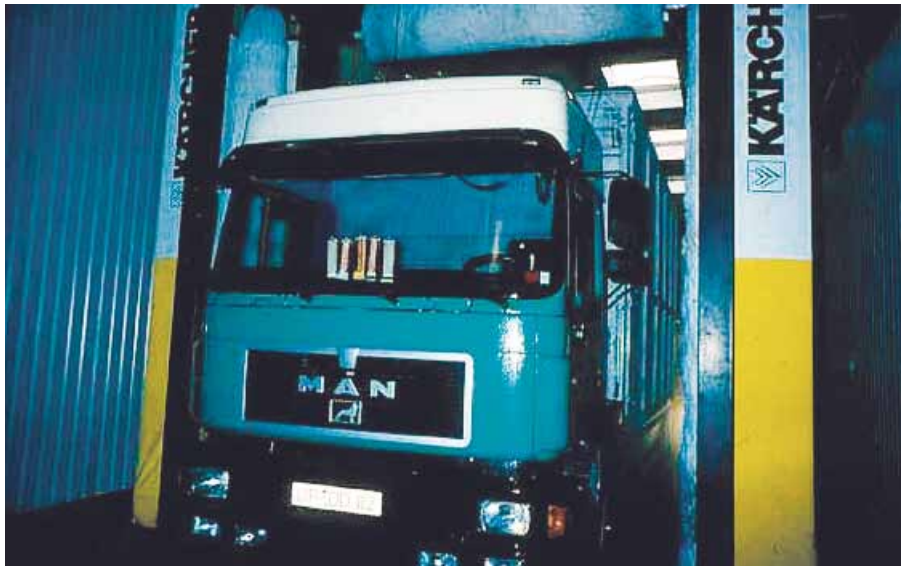
A central part is ensuring that all transport vehicles that were in contact with pigs in other countries are subject to wash and disinfection before loading pigs in Denmark. This takes place on one of four washing sites that are part of an agreement with Danish Transport Standard.

Upon arrival to these washing sites, the vehicles are checked for visible dirt; vehicles are subject to safety wash and disinfection; and a certificate is issued confirming completion of the procedure.

Through Danish Transport Standard, all producers are obliged to use hauliers with a Danish approval or ensure that the vehicle used has a valid washing certificate upon arrival to the farm.

At www.tjekvogn.dk, producers are able to check if the vehicle has a valid certificate. Alternatively, send a text message with the registration number of the vehicle to +45 5129 1070, and you will receive the most recent certificate.

All inspections of Danish Transport Standard are handled by an independent certification agency.



Transport vehicle in car wash.

Costs for completing the activities related to Danish Transport Standard are covered by the Pig Levy Fund.

Quarantine for humans

Through years of work with the SPF system, Danish pig producers are now well familiar with the concept of quarantine for humans. The aim is to prevent the introduction of infection via clothes or human skin and mucosa.

Transfer of disease through clothes is efficiently controlled by using an entry room where, as a minimum, hands are washed, and clothes and boots are changed. On some farms, visitors are required to shower before entering the actual pig facility.

Transfer of disease through skin and mucosa can be controlled if humans observe a period of quarantine from contact with animals carrying potential infections until entry on a Danish pig farm.

Traditionally, visitors arriving to Denmark were subject to 48 hours of quarantine before entering Danish farms. Recent scientific research was unsuccessful in documenting survival of Foot and Mouth Disease bacteria for this long. It was

therefore decided to reduce quarantine to 24 hours along with the introduction of a series of exceptions for visitors with whom the herd owner is familiar.

As a main rule, producers with fissioned animals must observe the following rules:

1. From the time of arrival at Danish borders, visitors must observe 24 hours of quarantine before entering a pig farm.
2. Upon arrival in Denmark, visitors must always change clothes and shoes and shower before entering pig facilities on Danish farms.
3. Food and hunting trophies brought into Denmark legally must not be present on the farm premises.

Exceptions:

1. Visitors arriving from low-risk countries must observe 12 hours of quarantine before entering a pig farm.
2. If the owner of the farm/herd manager is particularly familiar with the visitor, 24 hours quarantine beginning from the time of departure will suffice.
3. If the owner of the farm/herd manager is particularly familiar with the visitor arriving from a low-risk country, 12 hours quarantine beginning from the time of departure will suffice.

ON-FARM

Cooperation = synergy

More cooperation between veterinarians and pig advisors will improve productivity, health and income for the pig producers!

This was the outcome of the project “Synergy in cooperation processes between herd veterinarians and pig advisors” that was completed in 2010.

The project

The project included the following activities:

- Joint herd visits with herd veterinarian and pig advisor
- Follow-up – either on another visit or via telephone
- Telephone interview with many of the farmers who participated
- Questionnaire for participating veterinarians and advisors

Dedicated advice

The project comprised 119 farm visits, and many different target areas were discussed. Most measures were characterised by the interdisciplinary situation that arose when herd veterinarian and pig advisor both participated in the visit.

Figure 1 illustrates the most frequent target areas on sow farms: reduction of piglet mortality by using, for instance, Guidelines for Farrowing Facilities.

Participants' reactions

When interviewed, the pig producers said that productivity had increased following the joint visits (Figure 2).

In most cases, improvement was seen for the areas specifically included in the action plans. 87% of all pig producers responded that they had implemented the action plan, which corresponds well with the effect shown in Figure 2.

Figure 3 shows that 85% of all pig producers in the project would be interested in another joint visit.

This is considered essential to success, and demonstrates that advice is more efficient when provided as a coordinated effort between veterinarian and advisor.

New relations for cooperation

Another criterion was to create new, improved relations in the cooperation between herd veterinarians and pig advisors. As shown in Figure 4, this criterion was fulfilled.

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

New project underway

A new project is now underway entitled “Competitiveness and improved health”.

The aim is to establish new guidelines for how to make the cooperation between

veterinarian and advisor work as a guarantee of success for the individual pig producer – each and every time!

A group will be set up consisting of pig producers to further develop the cooperation effort between veterinarian and advisor on their farm. The aim is to optimise productivity, health and welfare on these farms through coordinated efforts between owner, staff, veterinarian and advisor. The results are monitored via GM checks, the Vetstat database and questionnaires.

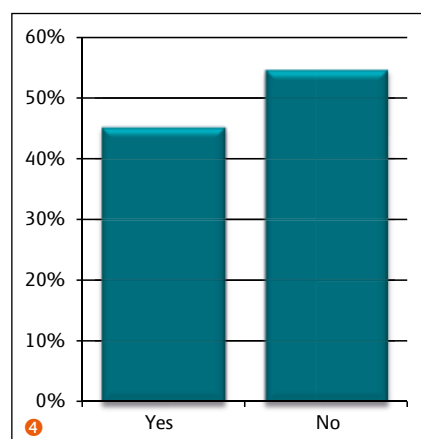
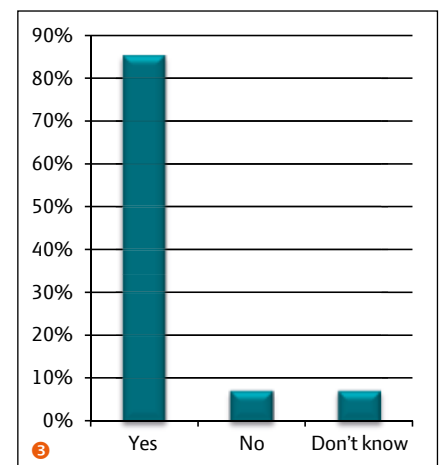
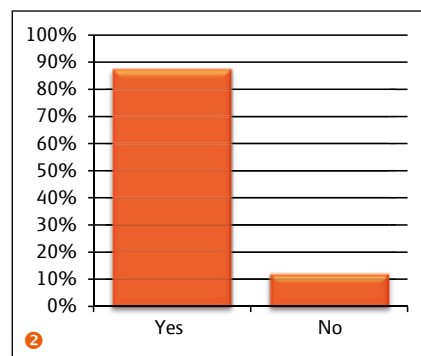
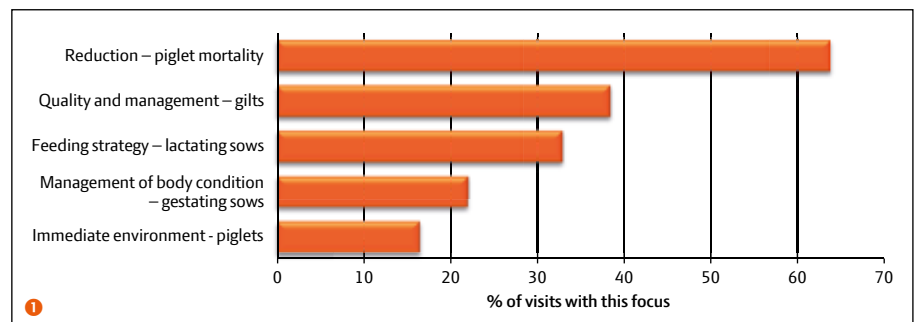


Figure 1. Most common target areas on 91 visits to sow farms.

Figure 2. Pig producers were asked whether they experienced productivity improvements after the joint visit and the follow-up to this.

Figure 3. Pig producers were asked whether they would be interested in another joint visit.

Figure 4. Herd veterinarians and advisors were asked whether the project created new relations in terms of cooperation.

Pig Tracker

The Pig Tracker project was initiated by Pig Research Centre on January 1, 2009.

The aim is to develop a new electronic ear tag based on ultra high frequency (UHF) radio waves as an alternative to today's ear tags that use low frequency (LF) radio waves. The advantage of UHF is that ear tags can be read from a distance (>2 m under favourable circumstances) and that several pigs can be read at once, for instance, when moving an entire batch.

The ear tags are delivered by Tracecompany that is in close contact with the project group. The project ends December, 2011, when the aim is for the technology to be implemented on the first farms.

Development and testing of the technology

Preliminarily, a series of practical tests were made with handheld scanners and stationary scanners in passageways.

The results demonstrated that the technology is applicable under practical conditions with a reasonable accuracy and reading distance. However, results also demonstrated that the ear tag still needs improvement. The ear tag was developed over a relatively short period, and it is therefore believed that these challenges can be overcome too.

Different types of scanners were also tested. It is essential to find the scanner with the highest reading accuracy at the lowest cost. As with the ear tags, durability of the scanners in a moist and ammonia-rich environment is also an important factor. A series of tests were made at the slaughterhouse to connect the ear tag with slaughter number, which will make it possible to access individual slaughter data and attach this to recordings from the pig's productive life.

All must form a synthesis

Even though the technology was proven to work in the preliminary tests, it will still be a while before the pig producer will be able to use it in practice.

Electronic identification presents a multitude of possibilities. Many of the breeding/multiplication farms currently enrolled as test farms have expressed a desire to be able to use the technology for immediate and accurate identification of sales animals. This naturally requires that the technology be integrated with existing on-farm management systems.

It is also important that the staff finds it a positive experience to use the technology. For instance, handheld scanners must be easy to operate when reading and entering data, screen images must be easily understandable – also for those not used to working with electronic handling of data.

The introduction of electronic identification will also affect many of the routines on farms just as the implementation of bar codes did in connection with, for instance, traditional management of stock.

The project was financially supported by the Innovation Act and Prosign RFID, RF-LabelTech and the Danish Meat Research Institute.

Perspectives

The use of electronic identification in pig production has the potential to generate benefits of a scale seen in other industries in the form of, for instance, optimised stock control, trouble shooting and documentation.

Once the infrastructure for data collection is in place, it may also turn out to be possible to use the technology in connection with e.g. automatic weighing and monitoring of pigs' feeding patterns, recording of time spent by the staff etc. In terms of data collection, we are currently witnessing a dramatic development in the smart phone industry; today, smart phones have a wide range of use in agriculture.

Scanners are now also available for smart phones. This technology may prove to be a fast and cheap way to implement electronic identification.

Today, the electronic ear tag can replace the conventional ear tag so that pig producers do not have to use two ear tags. This obviously requires that the ear tag comply with the authorities' requirements in terms of visual printing of, for instance, CHR number.



Close-up of electronic ear tag.

Productivity must improve

The programme “Speeding up finisher production” contains a range of activities aimed at demonstrating how to improve productivity with the use of and further development of existing know-how.

The programme includes:

- Management of the daily production
- All in-all out at site level
- Lower feed costs (for more information, see the section on nutrition)
- Quality of weaners
- Management of production

In “Management of the daily production”, know-how is implemented in practice, while the other activities generate new knowledge and tools that will be implemented and tested on the farms participating in “Management of the daily production”.

Manage the daily production – it actually works!

In the summer 2010, the first farms were started up, and at the time of writing 40 farms were participating. The advisory process differs from farm to farm, but the general concept is to form an outline of the challenges facing the production and prepare a plan for how to meet these challenges. Some problems are recurrent on several farms:

- Preparing the pens before transfer of pigs
- Optimising climate systems
- Strategies for weighing out pigs and pick-up of pigs for slaughter
- Trouble shooting in feeding systems
- Optimising diets
- Inspecting feeders and water supply
- Strategy for sorting of pigs and for the use of hospital pens
- Is a new supplier of weaners required?

Some target areas mainly concern trouble shooting (climate and feed) and purchasing weaners that will thrive in the accommodation available. Other areas concern routines – daily as well as periodic – that are essential when running an efficient production.

Changing one’s routines is a major challenge. Pig advisors, owners and staff are therefore working with both their trade and with how to maintain the motivation to perform routines correctly and stay on that road.

Advice and results

Participants evaluated the process half-way through, and pig producers responded that they appreciated the focus on work routines, and that they found joy in seeing how even minor adjustments have a positive effect. This is reflected, for instance, in the payment at slaughter or in the fact that the pigs thrive and grow faster. All participants agree that they now spend their time differently and more intelligently.

Results in “Management of the daily production” are monitored closely in terms of efficiency as well as economy. Participants are benchmarked against each other, and Figure 1 shows the development seen on one of the farms (figures in current prices).

The second half of 2010 was characterised by very poor terms of trade, and gross margins generally dropped in this period. The farm in this example went through a highly positive development with increasing gross margin and a drop in overheads and capital costs due to a significant improvement capacity utilization. Daily gain increased, and feed units per kg gain and mortality rates dropped.

Experiences obtained so far demonstrate that:

- Dedication and joint efforts from advisors, owner and staff do pay off,
- There is a huge potential for improvement, also on large, well-run farms.
- Motivation, persistence and good training are essential elements.

All in-all out

In this project, comparisons are made between finishers that were accommodated under all in-all out practice at section or site level. The pigs come from the same sow batch infected with pleuropneumonia, pneumonia and PRRS.

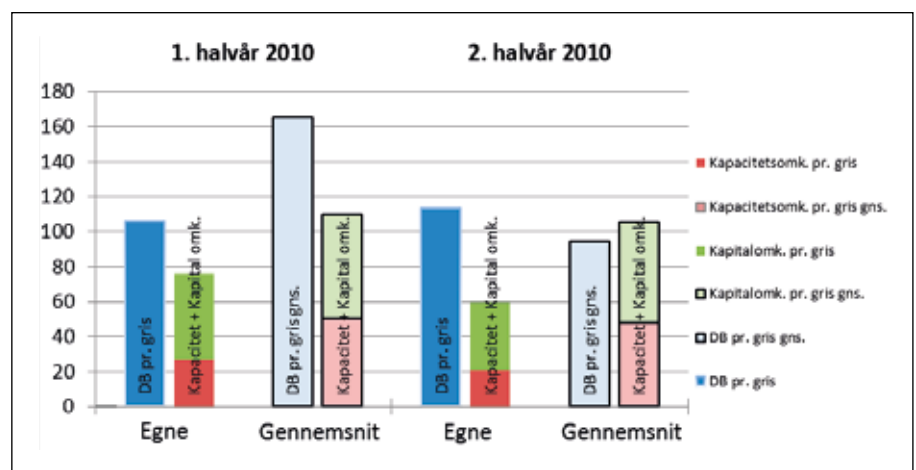
The expected outcome is fewer respiratory disorders and improved productivity among the finishers housed in accommodation that was completely emptied before a new batch of pigs is transferred.

Other activities

Other activities include:

- Weaner passport promoting communication between buyer and seller
- Stock exchange for renting out pig facilities where tenants and letters can connect across Denmark
- Analyses of experiences with feed dose by the end of the growth period.

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



Financial result per pig (DKK) – in comparison with average.

Farrowing huts

In 2009-2010, a new type of farrowing hut was developed in a joint venture between Pig Research Centre, Organic Denmark and the Danish Animal Welfare Society.

Experiences with the new hut were analysed (Report no. 1103), and results demonstrated that the function and working environment of the hut had improved significantly compared with the traditional A-huts. Productivity data are still being compiled.

In 2011, the farrowing hut was further developed in cooperation with Organic Denmark. In cooperation with Vissing Agro it is being attempted to reduce production costs and ensure that the steel huts are suitable for transport.

The huts were originally made of steel, but fibreglass presents brand new opportunities in terms of design and colour to make the huts blend in with the surroundings. The fibreglass hut (Poca Pig) is based on the positive experience with the new steel hut in terms of size and layout. It has two entries: one for humans and one for pigs. The first prototypes were produced and tested in 2011. The huts are designed in cooperation with industrial designer Kent Laursen and produced at Poca Glasfiber.



New farrowing hut in fibre glass (Poca Pig).



The working environment of the new steel hut has improved; sow and piglets now have more room, and the ventilation hatch opens automatically.

Treatment of diarrhoea without antibiotics

In 2009-2010, research revealed that Lawsonia was not the primary factor to

trigger diarrhoea (Report no. 1105) on organic farms. Consequently, treatment of diarrhoea without antibiotics was investigated in cooperation with Organic Denmark.

Two organic farms with post-weaning diarrhoea were visited by a team of experts within feeding, climate, pen design and health in 2010.

The aim was to increase the overall immune status of the pigs and thereby reduce diarrhoea through:

- Correct immediate environment
- Correct nutrition and feeding strategies
- Optimum vaccination routines and correct treatment of sick pigs.

After the visit, an action plan was prepared including the below main points:

- Optimisation of hospital pens and treatment strategy
- Accommodation of the 10% smallest pigs in a separate pen + weaning feed
- Restricted feeding the first 6 days post-weaning
- Optimisation of the immediate environment in weaner pens (large pens)
- Wash and disinfection of pens between batches.

The effect of the action plans on diarrhoea frequency is expected by the end of 2011.

Organic male pigs

Friland A/S and the Danish Animal Welfare Society have entered into a voluntary

agreement on phasing out castration of organic pigs beginning in 2011 and ending in 2014 provided that a suitable method for analysis of boar taint is available and rejection rates are below 5%.

A joint venture between Aarhus University, Copenhagen University, Development Centre for Organic Livestock, the Knowledge Centre for Agriculture and Pig Research Centre will in this period clarify methods for reducing boar taint and the outcome will hopefully be recommendations for feeding, accommodation and slaughter of organic male pigs without jeopardising animal welfare and productivity.

Pig Research Centre is also screening six organic farms with male pigs to establish the causes of variations in rejection rates between farms.



Organic male pig.

The project is financially supported by GUDP.

Reports

- No. 1019: Nutrient content in grain harvested in 2010
- No. 1020: DKK +25 per finisher, phase 2
- No. 1101: Optimised climate control and the use of ceiling inlets in diffuse ventilated finisher facilities with part-solid floor
- No. 1102: New equations for calculating amino acid content in wheat
- No. 1103: Development of farrowing huts for outdoor sows
- No. 1104: Outdoor area with combined solid floor and slatted floor for finishers
- No. 1105: Diarrhoea in growers and finishers on organic and outdoor farms
- No. 1106: Regular liquid feeding vs liquid feeding with no residue – feed quality does change in systems with no residue
- No. 1107: Phytase and phosphorus in feed for pigs on farms with behavioural or leg problems
- No. 1108: PCV2 status on two Danish farms – one year follow-up
- No. 1109: Bedding in hospital pens for sows
- No. 1110: Nutrient content in grain harvested in 2011

Trial reports

- No. 879: Pit ventilation capacity of 60 vs 15 m³/h per place unit in a finisher facility
- No. 880: Lysine for weaners
- No. 881: Valine for weaners
- No. 883: Different floor types in finisher pens with and without pit ventilation in the summer
- No. 884: Development and consequences of ear necroses on two farms and antibiotic treatment of ear necroses
- No. 885: Treatment of umbilical hernia with a latex ring (Elastrator®)
- No. 886: Sow mortality in the farrowing facility
- No. 887: Effect of reduced stimulation of the sow during insemination

- No. 888: Enrichment material for finishers; welfare and practical solutions
- No. 889: Effect of fibre and reduced sulphur on odour from finishers
- No. 890: Weaner feed with 15% rapeseed cake or meal
- No. 891: Zinc gluconate does not reduce tail biting
- No. 892: Ronozyme WX and Porzyme 9302 for finishers
- No. 893: Tube feeders for weaners
- No. 894: Floor heating under the sow at farrowing in farrowing pens for loose sows
- No. 895: Fermenting grain only increases energy value slightly
- No. 896: Summer recordings of Farm AirClean 3-step BIO FLEX from SKOV A/S
- No. 897: High inclusion rates of corn make fat more soft
- No. 898: Additional air intake and increased air flow in finisher facilities with part-solid floor
- No. 899: Reduced odour emissions from finisher pens through frequent emptying of slurry
- No. 900: Addition of organic micro minerals to sow feed
- No. 901: Commercial diets for weaners – Jutland 2010/2011
- No. 904: Feeding strategy and distribution according to gender with liquid feeding in WTF pens
- No. 905: High recovery rates of free amino acids in mineral diets
- No. 906: Socialisation of gilts in the gilt facility
- No. 907: Effect of sulphur in feed and inulin on odour from finishers
- No. 908: Effect on milk production during lactation when the teat was inactive during the previous lactation
- No. 909: More Vitamin D3 for gestating sows
- No. 910: Addition of coconut oil to feed for gestating sows

Other information material

- Guidelines on requirements for pick-up trucks
- Basic package for self-audit of animal welfare
- Manual: Gestation Management
- Manual: Service Management
- Manual: Growth Management
- Guidelines on good antibiotic practice
- Datasheet on hospital pens – soft rubber mats
- Animal welfare in the pig industry
- Product standard for UK pigs
- Increases in the audits and new rules for participation in Danish Product Standard, January 2011
- DANISH Product Standard, December 2010
- DANISH Transport Standard, version 1.0
- DANISH – 8 tips & tricks

Guidelines in three languages

- Handling of sick, injured or aggressive animals
- Clean and dry facility
- Thermal environment for the smallest pigs
- Ear necroses – fit for transport?
- On-farm feed hygiene
- Transfer and sorting of weaners
- Hospital pens for growing pigs
- Antibiotics and pick-up for slaughter
- Danish biosecurity rules
- Self-audit scheme for animal welfare on Danish pig farms, July 2011

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