

# ANNUAL REPORT 2014



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### Trade dispute

Although expectations were high amongst Danish pig producers that pig prices would rise in 2014, the trade dispute between Russia and the EU changed this. The Russian import ban on certain agricultural products led to an excess production of pork that was immediately reflected in decreasing pig prices. These falling prices also had an impact on the growing weaner export trade. This market now exceeds ten million pigs annually. In recent years, there was good business to be had from exporting weaners, a situation that was boosted even further as exports to Poland soared. The export of weaners is unlikely to diminish, but unfortunately this cannot be said of the prices.

### Structural development

The rising weaner export market has arisen because of structural challenges within Danish pig production. In the last ten years, investments in finisher production have dropped dramatically. Run-down pig facilities have become unsuitable for continued use. This has happened at a time when pig producers can no longer afford to invest in new facilities and so the consequence has been a drop in slaughtering. Since there has been a concurrent increase in litter size, the only solution has been to export more of these weaners. The Pig Research Centre keeps a very close eye on this situation and is working hard to secure the same business environment for Danish pig producers as for the rest of the EU, particularly in the area of environmental regulations.

### Disease and biosecurity

The presence of critical pig diseases close to the Danish border poses an increasing threat to the Danish pig industry. African Swine Fever is regularly seen in countries bordering Russia, and there is an increasing fear that the disease will spread further across Europe. In the US, pig producers are facing the challenge of PED, an intestinal disease that causes huge losses particularly amongst weaners. There is a risk that this

highly aggressive variant will spread to Europe at some point.

The risk of introducing this disease to Denmark via transport vehicles is heightened by the rising export of weaners to countries such as Poland. The Pig Research Centre therefore introduced an additional safety wash that all pig transport vehicles must undergo when crossing the border into Denmark. This procedure is currently being optimised even further. MRSA was once again at the centre of the attention in 2014. MRSA, which is a staphylococcus, is widespread in Danish pig herds; it is no more dangerous than other types of staphylococci, and can be treated with the right medication. Nevertheless, it forms part of the overall pool of resistant bacteria that is closely monitored by the Danish health authorities. Therefore, it is the responsibility of the pig industry to take every measure possible to minimise the risk of carrying the disease from pig herds to society at large.

### Animal welfare

The Danish pig industry is in the vanguard regarding implementation of improved animal welfare. Nevertheless, at the 'welfare summit' hosted by the Danish Minister for Food, Agriculture and Fisheries in 2014, representatives from the industry agreed on even more ambitious goals for pig welfare that were manifested in a declaration of intent.

Among these are the stopping of castration and tail docking and lowering piglet mortality, which are all areas that will be the focus of many research activities in the years to come.

The DANISH Product Standard is an audit tool used by the Pig Research Centre and its results are published to give an overview of the level of animal welfare in Danish pig herds. Audits show improvements in a range of areas, including the use of hospital pens.

### Genetics and productivity

DanAvl continue to increase their market share as the export of Danish genetics rises. For years, the export of genetics has developed rapidly, and the result is an in-

creasing income to the Pig Research Centre in the form of export royalties. These royalties will be used to further strengthen the breeding programme that now also includes genomic selection, which makes it possible to select breeding stock on the basis of DNA analyses. This accelerates the genetic progress, and the intent is to make DanAvl one of the largest global brands within its market sector.

In addition to pig breeding research, the Pig Research Centre conducts a wide range of other research activities reported here. The aim of these is primarily to enhance the productivity and the economy of Danish pig producers. However, activities relating to animal welfare, environment and food safety must also take account of present and future consumer concerns.

"Growth in balance" is the mission of the Danish Agriculture and Food Council, and also applies to the pig industry.

### Thank you

The work of the Pig Research Centre is based on close cooperation between pig producers, breeders and multipliers, pig advisors, commercial suppliers as well as universities and government departments. Without this collaboration, the activities reported here would not be possible.

Best regards

Erik Larsen & Claus Fertin  
The Danish Pig Research Centre



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## SEGES

In March 2014, it was announced that the Pig Research Centre would merge with the Knowledge Centre for Agriculture. From 1st January 2015, it was announced that the new organisation would carry the name of SEGES.

Within the agreement, the research activities of the Pig Research Centre will still be decided the Board of the Pig Research Centre, comprising twelve pig producers. It was also agreed that any profit or deficit of the Pig Research Centre will be regulated through a development account that is at the disposal of the board of the Pig Research Centre.

This means, for example, that the expected income from the increasing international sale of DanAvl breeding stock may be returned to the pig producers.

The possibility of developing better synergies through close co-operation between the different agricultural sectors (cattle, plants, pigs and so on) will be reviewed during 2015.

## Budget and sources of income

Following the good economy of recent years, the Pig Research Centre has been able to pay an annual bonus to the Danish pig producers.

However, a 2014 audit of the projects in which the Pig Research Centre received financial support from the European Agricultural Fund for Rural Development and the Danish Ministry of Food, Agriculture and Fisheries, revealed non-compliance with a series of formal requirements. Consequently, some of this funding will have to be repaid; the amount is still unclear as the audit is not yet completed and concerns projects conducted over a long period of time.

## Strategy

The Pig Research Centre's strategy includes the following main areas of activity:

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

Danish pig producers pay approx. DKK 4 per finished pig towards the cost of the work undertaken by the Pig Research Centre. Once a year, the board selects the key activities for the coming year from a range of interesting proposals.

The Pig Research Centre also handles a range of commercial activities, including the Laboratory for Pig Diseases and SPF Health Inspection.

Another essential business stream is DanAvl, which is owned and managed by the Pig Research Centre, thus representing Danish pig producers. DanAvl is the centre of cooperation where the interests of the Pig Research Centre, breeders, multipliers, AI companies and customers meet.

The aim is to achieve maximum genetic progress and implement state of the art technologies available from the work of the Pig Research Centre, in close co-operation with universities.

DanAvl operates full disclosure in terms of products and quality and access to purebred animals, but the terms of business are linked to specific requirements regarding resale and control.

The board decided to strengthen marketing and sales significantly to build market share in the years ahead, and a new DanAvl marketing strategy is currently being drawn up.

## New research activities in 2015

- Rye for sows
- Optimum feeding of lactating sows
- Reduction in stillborn rates
- Umbilical hernia
- Thriving weaners
- Stopping diarrhoea treatments
- Breeding for social interaction
- Breeding, micro/macro environment sensitivity
- Breeding, feed conversion version 2.0
- Toxins
- Effects of more expensive protein sources for weaners
- Use of Danish protein in pig feed
- Multivalent vaccines for lung disorders
- Optimum batch operation
- Air quality in pig units and emissions
- Slurry systems for rapid emptying
- Reduction in tail docking
- Improvement in feed conversion efficiency of outdoor and organic finishers
- Sustainable organic system (PECO SYSTEM)

### 'Knowledge for sale'

"Management of On-Farm Mixing" is the latest management tool from Development Pigs, which is a joint collaboration between the local pig advisory services and the Pig Research Centre. The tool was evaluated under practical conditions by a group of farmers using on-farm mixing and the response was positive.

The Pig Research Centre and an expert group on management of on-farm mixing have developed a new model for implementation and sale of knowledge to pig producers through local pig advisors. The intention is to use this as a tool for widespread sharing of best practice.

The adaptation of the model depends on the initiative of local pig advisors, combined with skills development, DISC personality profiling and good customer relations, which increased the implementation of "Management of On-Farm Mixing".

It is estimated that this implementation model may also be applied to other management tools or – in an adapted version – to individual advisory units.

To assess the extent of the implementation, a survey was undertaken of pig producers using on-farm mixing who either had obtained knowledge of "Management of On-Farm Mixing" or had implemented the tool on their own farm.

For a completed questionnaire to be approved, the respondent must have implemented a minimum three of the following tools:

- Appraisal and optimising of mixing system and feed computer (check list)
- Check of particle size (form)
- Check of accuracy of grinding (form)
- Level of feed hygiene (protocol for cleaning and work)
- Grain and ingredients (analysis strategy)
- Optimum number of ingredients and diets (impact analysis)
- Feedstuff legislation (e.g. HACCP, antibiotics, VetZink, industry requirements).

A total of 122 questionnaires were approved on "knowledge" of the tool and 51 were approved on "implementation". Approximately 1/3 of the replies were not approved. The demonstration of this model also resulted in learning points that can be used by other groups of advisors.

For more information, see "Publikationer" at [www.vsp.lf.dk](http://www.vsp.lf.dk) (Report no. 1410).

The project received financial support from the EU and the Rural Development Programme under the Danish Ministry of Food, Agriculture and Fisheries. Journal no. 32101-D-12-00515.

### Weighing of pigs

When the exact weight of a pig is known, it is possible to feed the pig the correct amount and to provide an optimum environment for growth.

Ten pig producers participated in a demonstration project on optimisation of daily gain in weaners based on weighing of the pigs. Research with finishers previously demonstrated that impacts during the growth period are often reflected in the pigs' overall daily gain. Correct weighing of pigs will therefore pinpoint irregularities in the production process and thereby present an opportunity for making suitable changes. The pig producers who participated in this demonstration project pinpointed the following common irregularities in their routines:

- Change in diet at a time when the new diet does not match the pigs' weight.
- Inaccurate treatment procedures, such as injection with a vaccine straight from the refrigerator rather than after first warming the vaccine before use.
- Inaccurate climatic environment, for example penning a batch of pigs in a cold pig house.
- Breakdown in feeding system which may cause negative growth for up to a week.

A spreadsheet is available for download from the Pig Research Centre website in which daily gain can be computed when a batch of pigs is weighed. Feed consumption also may be included on the spreadsheet – but this is not a requirement. Date, number of pigs, weight, feed consumption, culled pigs and log information are noted on the spreadsheet and subsequently a graph is produced showing:

- Average daily gain
- Average weight
- Feed units per kg gain (only if data on feed consumption is available)
- Feed units per pig/day (only if data on feed consumption is available).

The spreadsheet contains data for up to six batches of weighed pigs and can show graphs for all batches in combination with log information. Thus, it is easy to spot differences and similarities for each batch. Increases or decreases in the daily gain of a batch in one week can often be explained by consulting the log. However, one should never jump to conclusions regarding, for example, composition of diets or the transition between diets unless there is sufficient replication of data.

The project received financial support from the EU and the Rural Development Programme under the Danish Ministry of Food, Agriculture and Fisheries. Journal no. 32101-D-12-00515.

### The Pig Academy

Danish pig production faces a huge challenge in creating jobs that will attract qualified employees as well as future leaders. Successful succession planning requires immediate action.

Ensuring succession is a matter of joint responsibility, and the Pig Research Centre therefore hosted a workshop in May 2014, with the aim of generating ideas for how to improve the recruitment of skilled staff.

## 'THE PIG ACADEMY'

Representatives from primary production, the pig advisory services, universities, agricultural schools and students participated in the workshop and provided inputs about the type of staff, leaders and owners needed in the future. Ideas ranged from award schemes to identify the best employer in Danish pig production to a streamlined joint communication platform that generates knowledge of the training available as well as advertising attractive jobs available in the industry.

- In 2014, 14 students were enrolled in a course for management of pig production
- The average Danish pig producer is 54 years old
- Approximately 100 new "pig leaders" are required a year

To streamline education at the agricultural schools and to minimise the differences between the different institutions, the Pig Research Centre has prepared relevant and up-to-date educational material in collaboration with the agricultural schools.

In 2014, the material mainly focused on nutrition and feeding. The material included power point presentations, tests and assignments. In addition, a toolkit was delivered to all schools and included equipment for dissection of pigs, chemistry equipment and samples of more than 50 different ingredients.

The project also includes working with students enrolled in management courses to make them as well qualified as possible for managing pig farms in the future.

**'30 feed units less per finished pig'**

The aim of the demonstration project "30 feed units less per finished pig" is to demonstrate that the overall feed consumption

from when the gilt/sow is first inseminated and until the resultant offspring is slaughtered can in fact be reduced by up to 30 feed units per finished pig. Research has demonstrated the close link between management and feed consumption.

- The project started in January 2014 and is scheduled to finish in June 2016
- 50 integrated herds are participating in the project
- 32 pig advisors from across the country are also participating
- The herds have between 300 and 1,700 sows/year and jointly produce around 1 million finished pigs

The project started 31st January, 2014, and is designed with a Formula 1 motor racing theme. A total of 50 pig herds (teams) and 32 pig advisors (engineers) from across the country participated, and they all got off to a good start. Together with the engineers, the teams made action plans ('race' strategies) to pinpoint key areas and objectives in the herds.

Some of the areas are directly related to feed consumption: diet formulation, feed curves and feeding methods, but some are also indirectly related to feed consumption such as health, reproduction and ventilation.

To qualify for the next round of the project, teams must remain among the top 80% in the 'hit list' that is generated according to points awarded for feed consumption and other measurable improvements.

The first 'hit list' – which will also form the benchmark and the reference value for changes in feed consumption throughout

the project – ranked the teams according to feed consumption per finished pig and is based on 'DB check' values from the last half of 2013. Feed consumption per finished pig varied from 290 to 354 feed units per finished pig, averaging 314 feed units per finished pig for the 50 teams.

The second 'hit list' was based on figures from production E-control reports from the fourth quarter of 2013 and the first quarter of 2014. Each team was scored according to

- Feed consumption
- Numeric improvement in feed consumption compared with the reference value (in the first 'hit list')

A new 'hit list' is generated quarterly, and each time a lap winner is elected. One Grand Prix winner will be elected annually until a World Champion is declared at the end of the project.

Team Svenstrup was the first lap winner with an overall improvement of 16 feed units per finished pig compared to their reference performance.

The first qualification round will take place in March 2015.

Regional PitStop meetings are held where local pig advisors play a role of race marshalls. The meetings are adapted to regional requirements with meetings for both owners and staff. In future a minimum of two regional meetings will be held annually in each region.

The project received financial support from the EU and the Rural Development Programme under the Danish Ministry of Food, Agriculture and Fisheries. Journal no. 32101-D-13-00549.



### Number of pig farms

Information from Statistics Denmark, the central authority of Danish statistical records, shows a total of 3,861 pig farms in Denmark compared to 11,110 in 2003. If this trend continues, there would be about 1,900 pig farms in Denmark in 2020.

Danish pig farms can be divided into three categories:

- Integrated herds with both sows and finishers
- Finisher herds with no sows
- Sow herds

The degree of specialisation in the three categories was calculated on the basis of data from the official CHR-register. In the period 2012-2013, the number of sow farms increased from 670 to 672, while the number of integrated farms dropped from 1,394 to 1,216, which is a reduction of 12.7%. The number of finisher farms dropped from 2,051 to 1,970, which is a fall of 3.9%.

### Sows per farm type

Records show that there were roughly 650 sows per sow farm and 470 sows per integrated farm. In 2002, sow farms had about 83% more sows per farm than integrated farms. This development continued up to 2005 when the integrated farms started closing the gap. Nominally, over a period of years, integrated farms have had approximately 200 fewer sows than sow farms.

In 2003, 31% of the national sow population was housed on sow farms. By 2013, this had increased to 45%, as weaner producers have become more specialised.

### Pigs delivered to Danish slaughterhouses

The specialised finisher farms continue to increase their share of slaughterings,

which increased by around 0.5 million pigs from 2012 to 2013. However, as the number of pigs delivered for slaughter from integrated farms dropped by approximately 0.75 million pigs a year, the overall number of slaughterings in Denmark continue on a downward trend.

The average finisher farm delivered approximately 6,000 pigs for slaughter in 2013, and the average integrated farm delivered approximately 5,600 pigs.

The sale of weaners from integrated farms is increasing; in 2009, integrated farms finished approximately 48% of all pigs - in 2013 this had dropped to approximately 41% of all pigs delivered.

### Pigs delivered per farm

The number of pigs delivered for slaughter per farm registered in the Central Business Register (CVR) in Denmark continues to rise.

In 2013, 122 farms delivered fewer than 20,000 pigs to a Danish slaughterhouse, compared to 49 in 2009. This trend is also influenced by the competition for pigs between Danish slaughterhouses. For instance, Danish Crown pays an additional DKK 8/pig to producers who deliver more than 22,000 pigs per CBR number for slaughter.

The number of farms that deliver 1-2,499 pigs a year for slaughter dropped by almost 50% in the period from 2009 to 2013 i.e. from approximately 3,400 in 2009 to 1,700 in 2013.

### Production sites

The number of production sites with 500-999 sows/year peaked in 2010 at approximately 790 and then dropped to 740 in 2013. Only sites with more 1,000 sows manage to maintain a stable progress.

The number of sites that delivered fewer than 2,500 pigs for slaughter annually dropped by 3,500 from 2009 to 2013, which is a drop of approximately 33%. In that same period, the number of sites that delivered more than 10,000 pigs for slaughter rose from 126 to 210, and account for approximately 15% of all slaughterings made in Denmark.

Put differently, just 210 large pig production sites delivered the same number of pigs for slaughter as 3,500 small pig sites. This number will hopefully increase significantly, provided this is possible without incurring prohibitively high costs for air cleaning, which would effectively ruin the benefits of economies of scale.

The average number of pig farms in Denmark now drops by 50% every 6-7 years, compared to every 10 years previously as pig farms have become increasingly specialised.

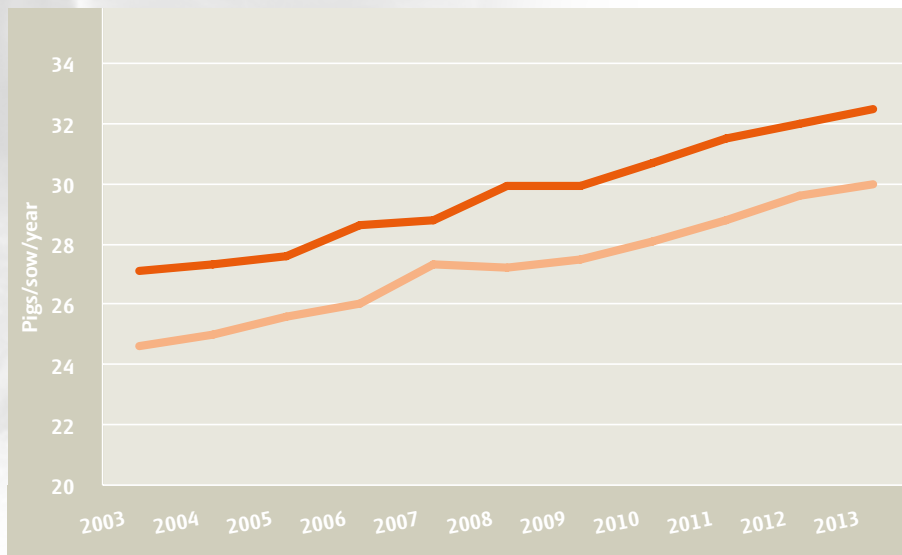
The number of pig production sites fell from approximately 19,000 in 2003 to approximately 8,000 in 2013.

Finisher farms with no sows account for approx. 62% of all pigs delivered for slaughter in Denmark.

Sow farms had on average 650 sows in 2013 whilst integrated farms averaged approximately 470 sows.

Integrated farms finished approximately 48% of the weaners they produced in 2009. By 2013, this figure had dropped to approximately 41%.

**Figure 1** - Pigs weaned per sow/year



### Development in productivity

The overall efficiency of Danish pig production is assessed once a year. Since 1980, records show an annual increase in the number of pigs weaned per sow/year and in the daily gain achieved by finishers.

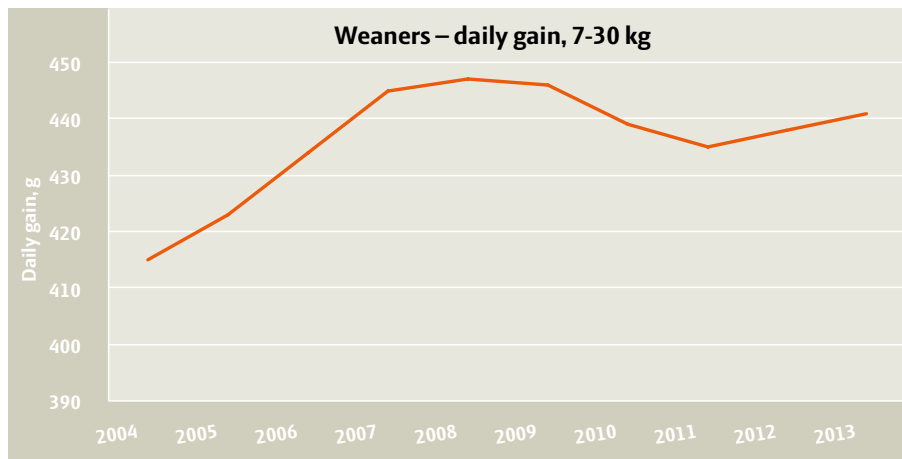
### Development on sow farms

The improvement in productivity on the best 25% farms follows the average for all farms. The best 25% sow farms wean approx. 2.5 pigs more per sow/year than the average of all farms. This difference is almost constant whereby the relative difference slowly decreases. Progress is driven by a constant increase in live born pigs/litter and enhanced management skills which play an important part in reducing piglet mortality.

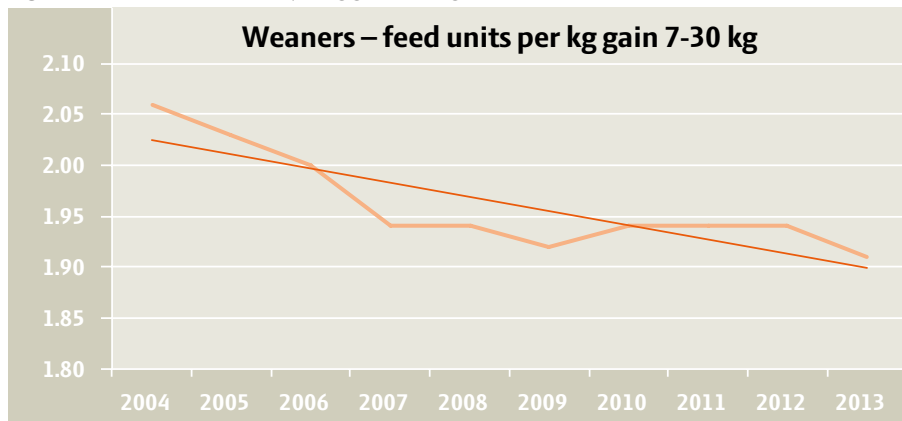
### Development on weaner farms

Daily gain in weaners has not increased in the last five years, which can most likely be attributed to the challenge of increased incidence of disease and the impact of consumer pressure to lower antibiotic use. In the last five years, feed conversion efficiency has remained largely constant; research activities are now aimed at improving this.

**Figure 2** - Weaners – daily gain, 7-30 kg



**Figure 3** - Weaners – feed units per kg gain 7-30 kg



**Development on finisher farms**

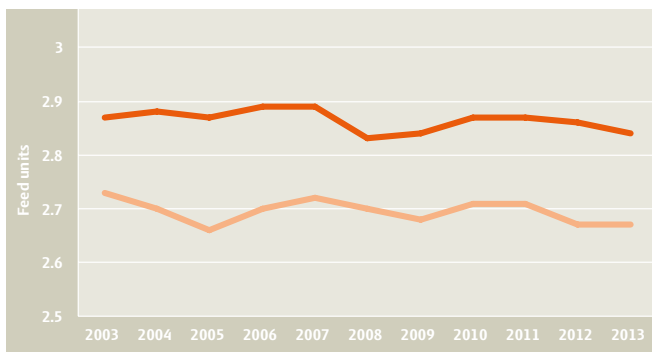
The feed conversion ratio (FCR) on finisher farms has failed to move in the right direction. However, if correction is made for the increase in slaughter weight, FCR has improved slightly. Research activities are now dedicated to improving FCR with the result that costs per kg gain will decrease, all other things being equal.

The best 25% farms have a daily gain that is approximately 75 g higher than the average for all farms. Put differently, the best 25% farms can produce 4.20 pigs per place per year versus 3.88 on the average farm.

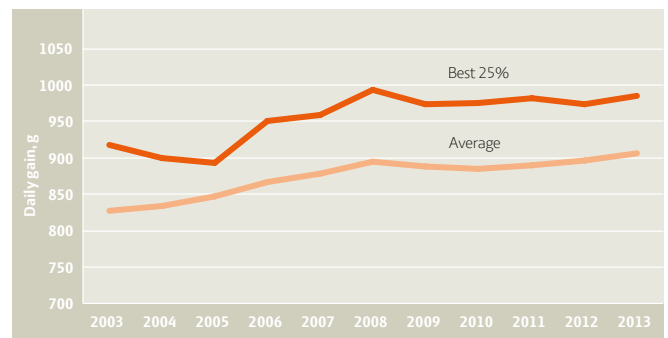
Mortality has decreased slightly as an average for all farms, and has remained largely constant on the best 25% farms.

- An annual increase in pigs weaned per sow/year of 0.45
- The improvement in daily gain corresponds to a drop in production time of one day per year.

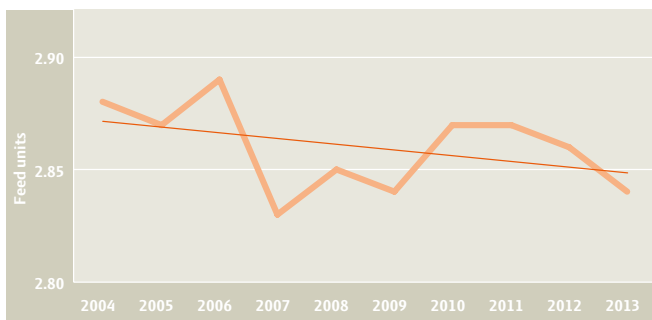
**Figure 4 - Finishers – feed units per kg gain**



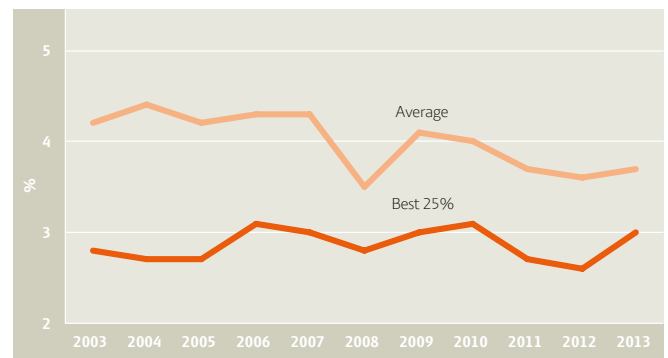
**Figure 6 - Finishers – daily gain 30 kg – slaughter**



**Figure 5 - FCR finishers 30-100 kg**



**Figure 7 - Finishers – dead and rejected, %**



### Export of weaners

The export of Danish weaners or pigs below 50 kg liveweight continues to increase: In 2003 approximately 1.8 million weaners were exported and by 2013 this had increased to more than 9.8 million.

### Increase in export

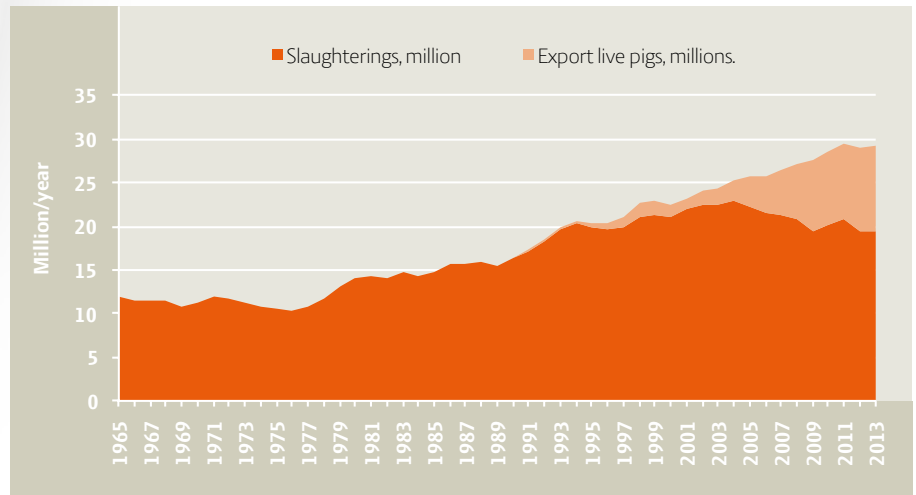
The sizeable export of weaners is mainly attributed to a decrease in the number of slaughterings in Denmark. This is boosted by the annual productivity increase of approximately 0.5 million weaners from a generally stable sow population (figure 1). When the market price is higher than the calculated weaner price, pig producers outside Denmark are able to pay more for weaners than domestic finisher producers.

### Export markets

Germany is the main destination for exports of Danish weaners, but in recent years Poland has become a more significant destination (figure 2).

Both countries are witnessing a drop in sow population. In Germany slaughterings increased, whereas in Poland both sow population and slaughterings dropped. This is attributed to differences in structural development since Poland has lagged somewhat behind. However, in recent years many, small integrated farms closed down, which created a vacuum that is now being filled by Danish weaners.

**Figure 2** - Development in production of pigs in Denmark, 1965-2013



### Four defining factors

Within the EU, only Denmark and the Netherlands export weaners in significant numbers. Competitiveness is influenced by the following four factors:

- Geography
- Health status
- Genetics in relation to the pig price
- Batch size

The Netherlands have a geographical advantage in being close to pig dense areas in Germany, whereas in terms of pig health Denmark has a lead on the Netherlands. The Danish SPF Health System provides a credible guarantee of healthy weaners.

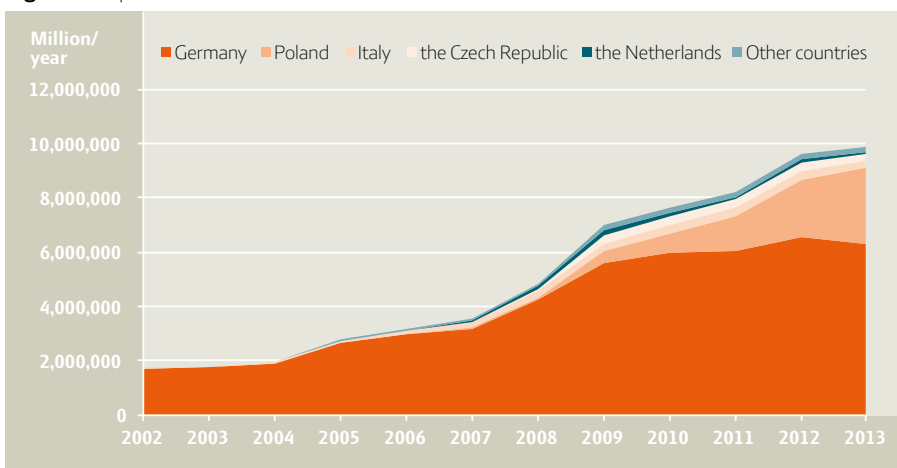
In Germany, Danish genetics are usually sold at the same price as the Dutch, but with a risk of a small loss. However, in Poland, the German AutoFom is not used for classification, and Danish genetics are sold at a slightly lower price because the benefit of additional lean meat is not measured.

On average, Danish pig producers export 42% more pigs per year than Dutch pig producers. In the Netherlands, annual average sow herd size is 480 compared to approximately 680 in Denmark, according to production records.

### Market shares in Poland

In 2009, Poland imported around 1.5 million Danish weaners but by 2013 this had increased to 3.8 million. In that same period, the percentage of weaners imported from Denmark rose from 28% to 68% thereby largely at the expense of weaners from the Netherlands.

**Figure 1** - Export destinations for Danish weaners. Source: DST.



- The export of weaners from Denmark increased from 1.8 million in 2009 to 9.8 million in 2013.
- The Danish market share of imported weaners in Germany is decreasing but is on the rise in Poland.
- Within the EU, Denmark and the Netherlands are the main source of exported weaners.

**Financial results**

Table 1 outlines the development in production economy on weaner and finisher farms over the last twenty years. The key financial figures are shown per production unit.

Gross margin per sow/year on weaner farms averaged DKK 3,931 in the last 20 years, while the best 25%, on average, achieved DKK 5,104.

The increase in pigs produced per sow/year in the last 20 years is remarkable – both on the average pig farm and the best 25%. An increase from 21.7 to 29.0 pigs/sow corresponds to an average increase of 33.6% in pigs/sow on the average farm.

Gross margin on finisher farms averaged DKK 122 per finished pig in the last 20 years compared to DKK 169 for the best 25%. Feed consumption dropped around 4% in that same period.

**Production ratio**

The index of the settlement price over feed costs per finisher has averaged 7.42 in the last 20 years varying from below 5 to close to 11.

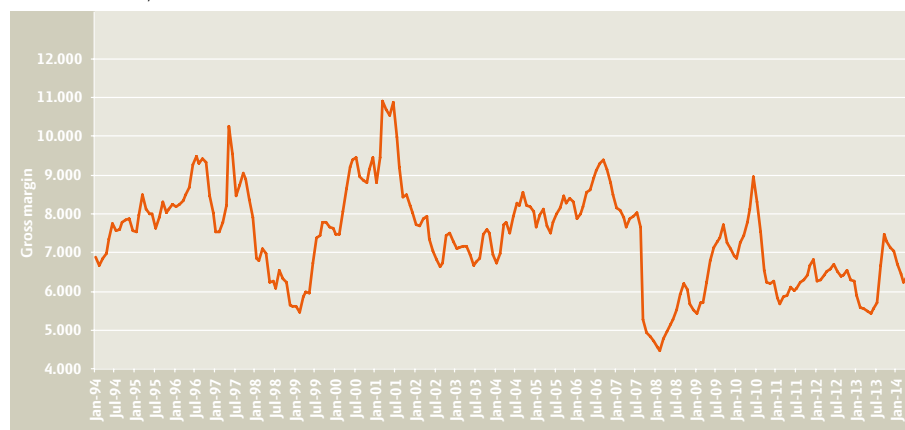
In 2013, the ratio was 6.23 based on a high pig price of DKK 11.93 per kg and a high feed price of DKK 1.94 per feed unit.

When the indices listed in table 1 are compared with that in figure 1, it is clear

that in years when the main production indices are favourable (for example in 1997, 2001 and 2006) the gross margin is high.

Rising export prices of weaners in the last three years resulted in an increasing gross margin on weaner farms even though that on finisher farms had decreased.

**Figure 1 - Production ratio: Settlement price per kg / Feed price, finisher feed, DKK/feed unit. 1994-2014 May**



**Table 1 - 20-year development in key financial indicators and gross margins (GM)**

		20-year development in key financial indicators and gross margins (GM)																			
		1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
		<b>DKK per production unit</b>																			
<b>Weaner farms</b>																					
GM/ sow/year	Av	3,460	4,230	5,016	5,220	2,645	2,429	4,612	6,135	3,801	2,853	3,624	4,033	4,811	1,893	2,828	3,398	4,077	4,153	4,784	4,612
Produced pigs/sow/year		21.7	21.7	21.4	21.8	22.4	22.4	22.8	23.1	23.7	23.6	23.1	23.7	24.9	26.1	26.3	26.8	26.6	28.3	28.5	29.0
GM/produced weaner		159	195	234	239	118	108	202	266	160	121	157	170	193	73	108	127	153	147	168	159
DKK/finished pig		335	367	410	420	291	272	370	447	352	309	338	351	368	327	333	354	363	358	412	418
DKK/feed unit, sow and weaner feed		1.51	1.48	1.48	1.51	1.42	1.33	1.33	1.46	1.40	1.38	1.38	1.35	1.31	1.63	1.95	1.72*	1.75*	2.04*	2.26*	2.35*
GM/sow/year	Best 25%	4,283	5,259	6,223	6,459	3,665	3,260	5,452	7,352	4,789	3,748	4,589	5,241	6,164	3,089	4,286	4,971	5,505	5,527	6,052	6,163
Produced pigs/sow/year		23.0	23.4	23.5	23.8	24.4	24.4	24.6	24.8	25.5	24.8	25.0	26.8	27.0	27.4	27.6	28.1	28.3	29.7	29.5	30.9
GM/produced weaner		186	225	265	271	150	134	222	296	188	151	184	196	228	113	155	177	195	186	205	199
<b>Finisher farms</b>																					
GM/finished pig	Av	136	134	162	174	78	85	152	188	111	79	93	134	149	97	86	83	135	132	130	99
FU/kg gain		2.97	3.01	2.98	2.97	2.95	2.90	2.94	2.98	2.95	2.90	2.91	2.82	2.96	2.96	2.88	2.86	2.87*	2.87*	2.86*	2.84*
DKK per kg, incl. bonus payment		10.17	10.49	11.47	11.84	8.37	7.86	10.16	12.09	9.62	8.34	9.25	9.38	9.83	9.15	9.83	9.41	9.93	10.79	11.99	12.07
DKK/feed unit, finisher feed		1.28	1.22	1.26	1.26	1.19	1.08	1.11	1.19	1.15	1.10	1.13	1.19	1.08	1.30	1.67	1.34	1.36*	1.71*	1.86*	1.95*
GM/finished pig	Best 25%	177	176	211	223	122	122	195	241	156	115	110	175	194	146	152	150	182	190	180	158

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

## On-farm mixing – sow units

The financial advantages of on-farm mixing of feed are confirmed in the software program DB Tjek ('Gross Margin Check'). Pig producers who practice on-farm mixing of feed for sows and weaners achieved a gross margin of DKK 417 per sow/year, which is higher than that of producers using purchased compound feed.

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

## Health status – sow units

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

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

Home-mixing SPF pig producers achieved a higher gross margin of DKK 1,060 per sow/year compared to conventional pig producers who bought in compound feed.

## On-farm mixing – finishers

Pig units with finishers only can also reap financial benefits from on-farm mixing of feed. On-farm mixing resulted in a higher gross margin of DKK 36 than finishing pigs with ready-mixed compound feed.

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

0.44 lower per kg gain. Compared to pig producers who buy in feed, mortality rates were also lower, lean meat percentage was the same, whilst daily gain was lower.

## Large finisher farms

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

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

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

- On-farm mixing was linked with a higher gross margin of DKK 417 per sow/year and DKK 36 per finisher.
- SPF health status achieved a higher gross margin of DKK 572 per sow/year.
- Large finisher farms had a higher gross margin of DKK 17 per finisher.

**Table 1** - Average difference with different types of sow units

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

**Table 2** - Average difference with different types of finisher production

	Feeding strategy		Produced pigs/year	
	Minerals	Vitamin supplement	0-4,999	5,000-7,999
	Compared with purchased		Compared with 8,000+	
FUgp/kg gain	0.00	0.04	0.08	0.04
Ref. daily gain 30-100 kg. g	-14	-17	-16	-1
Feed costs/kg gain, DKK	-0.44	-0.30	0.21	0.09
Gross margin/finisher	36	24	-17	-9

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

Breed	Year	Daily gain (0-30 kg), g/day	Daily gain (30-100 kg), g/day	FCR, FUp/kg gain	Lean meat %	LP 5, no.	Conformation, points	Killing out %	Longevity, %
Duroc, average	4 years	4.0	20.6	-0.048	0.15	-	0.04	-0.04	-
Landrace, average	4 years	0.1	10.5	-0.031	0.05	0.16	0.05	-0.08	-0.01
Yorkshire, average	4 years	1.1	12.1	-0.027	0.03	0.21	0.05	0.02	0.02
Average, 3 breeds	4 years	2.3	16.0	-0.039	0.10	0.19	0.04	-0.03	0.006

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

	Genetic progress	Economic weighting	Value of genetic progress, DKK (assuming 100%)	Dissemination in production, %	GM improvement in production, DKK/finisher
Gain (30-100 kg)		0.14	2.24	80	1.79
FCR	-0.039	-133	5.13	80	4.10
Lean meat %	0.10	8.6	0.85	150	1.28
LP5**	0.19	11.0	2.05	85	1.74
Conformation	0.04	12.5	0.53	100	0.53
Gain (30-100 kg)	2.3	0.09	0.21	100	0.21
Longevity**	-0.03	-4.9	0.16	100	0.16
Killing out %	0.006	42.5	0.27	100	0.27
Average of 4 years and all breeds			11.43		10.08

\*\* Yorkshire and Landrace 50% contribution each.

**Table 3** - Number of purebred and hybrid litters in 2013.

	Purebred litters		Hybrid litters	
	Code 100*	Code 200**	Code 100*	Code 200**
Duroc	3,800	1,699	61	182
Landrace	5,058	10,843	5,519	67,987
Yorkshire	5,255	14,248	11,111	85,305

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

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

**Table 4** - Purebred females in nucleus breeding and multiplication herds. August 2014.

	Purebred females		
	Nucleus herds*	Multiplication herds Denmark	Multiplication herds internationally
Duroc	1,786	-	-
Landrace	2,381	32,031	12,728
Yorkshire	2,367	27,689	15,387
Total	6,534	59,720	28,115

\* Sows on contract

### Genetic progress

Table 1 shows the genetic progress in each trait for the three breeds in the programme in the period 2010-2014 and the average progress in D(LY) (Duroc Landrace x Yorkshire) finishers for that same period.

Over the period of the year 2014 progress in feed conversion per kg gain was 0.039 (vs 0.038 in 2013), which is attributed to progress in all breeds. Daily gain, in the period 0-30 kg as well as 30-100 kg, has improved compared with 2013. In 2014 improvement in average daily gain was 2.3 g/day in the period 0-30 kg (vs 1.6 g/day in 2013) and 16.0 g/day in the period 30-100 kg (vs 12.9 g/day in 2013 for all three breeds).

In 2014 the progress in longevity for the sow breeds improved significantly compared to the previous year, the progress in 2014 averaged 0.006 vs -0.001 in 2013.

Table 2 shows the economic importance of genetic progress, which is based on the economic values used in the index calculations and on the dissemination of the traits in the production chain. Gross margin increased from DKK 9.59 per finisher to DKK 10.08 per finisher.

### Revision of the breeding objective

The economic and genetic parameters used for index calculations are currently being revised. This revision will impact on the calculated genetic progress and the expected progress. Once complete, the revision and the consequences will be published on the Pig Research Centre's website.

### Herd structure

Currently, 26 nucleus breeders have a contract with the Pig Research Centre, and in total they represent 40 herds with purebred animals: 12 Duroc, 14 Landrace and 14 Yorkshire. As of August 2014, 140 Danish multiplication herds were approved and of these 28 were in some way affiliated to a nucleus breeding herd.

In table 3, the number of purebred litters and hybrid litters the past year is shown.

and in table 4 the number of sows currently on contract with the Pig Research Centre (as at August 2014) is shown. The Pig Research Centre also has contracts with 77 international multiplication herds, and this number is continuously increasing.

## Production

In the past year, 5,509 boars were performance tested at Bølgildgård Boar Testing Station of which 2,681 were Duroc boars. The results of the performance tests are shown in table 5.

In nucleus breeding herds, 34,621 males and 44,524 females were performance tested. Tables 6 and 7 show the average production level in 2014 for males and females, respectively, in nucleus breeding herds.

## Litter size and live piglets day 5

Table 8 shows the litter size of purebred nucleus litters in 2014: live piglets on day 5 after birth (LP5) average 13.8 for Yorkshire, which is an increase of 0.4 piglets, and 12.4 for Landrace, which is an increase of 0.3 piglets.

## AI boars

The average index level for active Duroc boars has increased by 0.9 index points, and index levels for Landrace and Yorkshire boars have increased by 0.4 and 0.8 index points, respectively. Table 9 shows the current (August 2014) index for all three breeds and the number of active boars at Danish AI centres. In addition, table 9 also shows the number of boars entered at Danish AI centres and their average service time.

In total, 11 distributors have 2,659 boars in 68 AI centres internationally, which reflects an increase in both distributors as well as boars. Table 10 shows the distribution of breed and index for AI boars both in Denmark as well as internationally.

The number of AI boars internationally has increased from 1,811 to 2,659 in the

**Table 5** - Average production results from performance-testing at Bølgildgård Boar Testing Station (2013)

Breed	Number	Gain (0-30 kg), g/day	FCR, FUp/ kg gain	Lean meat %	Killing out %	Scanning objective, mm
Duroc	2,681	1,100	2.35	60.3	25.2	7.3
Landrace	1,414	1,045	2.41	60.4	25.5	8.3
Yorkshire	1,414	959	2.41	60.9	24.5	8.4
Total	5,509					

**Table 6** - Nucleus breeding herds – average production results for boars the past year.

Breed	Number	Daily gain, g/day		Lean meat %	Conformation, points	Scanning objective, mm	Scanning weight, kg
		0-30 kg	30-100 kg				
Duroc	6,152	394	1,140	61.2	2.91	7.3	95.2
Landrace	13,873	377	1,035	62.3	3.00	8.3	93.8
Yorkshire	14,596	360	986	61.8	3.09	8.4	93.2
Total	34,621						

**Table 7** - Nucleus breeding herds - average production results for females the past year.

Breed	Number	Daily gain, g/day		Lean meat %	Conformation, points	Scanning objective, mm	Scanning weight, kg
		0-30 kg	30-100 kg				
Duroc	8,312	399	1,082	61.5	3.00	7.0	95.0
Landrace	17,809	380	968	62.9	3.09	7.6	93.5
Yorkshire	18,403	363	949	61.6	3.15	8.7	92.9
Total	44,524						

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

Breed	Litter size	LP5	Per cent litters from first parity sows
Duroc	9.3	-	71.7
Landrace	15.8	12.4	77.1
Yorkshire	16.6	13.8	70.7



past year. The index level increased for Yorkshire boars only by 1.1 index point. Nevertheless, the index of Danish AI boars is still significantly higher than the international index. In Denmark, the index level is 11.6 points higher for Duroc, 17.4 for Landrace and 15.8 for Yorkshire (table 10).

**Sale of semen**

4,864,952 doses of Duroc semen were sold in Denmark in 2013, which is a slight increase on the previous year. Sale of Duroc semen outside Denmark continues to increase; in 2013, sales reached 1,116,687 doses, which is a 43.6% increase from the year before (777,711).

International sales of semen from the white breeds are not recorded in doses of semen; instead the number of on-farm replacement production sows is recorded. This has increased dramatically in recent years and continues to do so; in 2013, records showed a total of 424,519 on-farm replacement production sows internationally (table 11).

**Sale of breeding stock**

The sale of purebred animals in Denmark decreased from 2012 to 2013, whereas export of purebred animals increased.

The sale of hybrid females continues to increase nationally as well as internationally. The sale of hybrid gilts in Denmark increased by 3.6% from 2012 to 2013 and the export of hybrid gilts increased by 21.2% during the same period (table 11).

**Fees on genetic material**

The income from fees on sales of genetic material totalled DKK 109.9 million in 2013, which finances a large part of the research activities of the Pig Research Centre.

In 2012, approximately half of the fees originated from international sale of genetic products; in 2013 this had increased to 57% as illustrated in figure 1.

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

Breed	Boars entered, 2013	Active boars, August 2014	Index for active boars, August 2014	Months in service of boars departed in 2013
Duroc	2,391	2,581	113.4	12.4
Landrace	685	392	131.2	6.5
Yorkshire	797	459	133.9	6.3

**Table 10** - DanAvl AI boars sold in Denmark and internationally, August 2014.

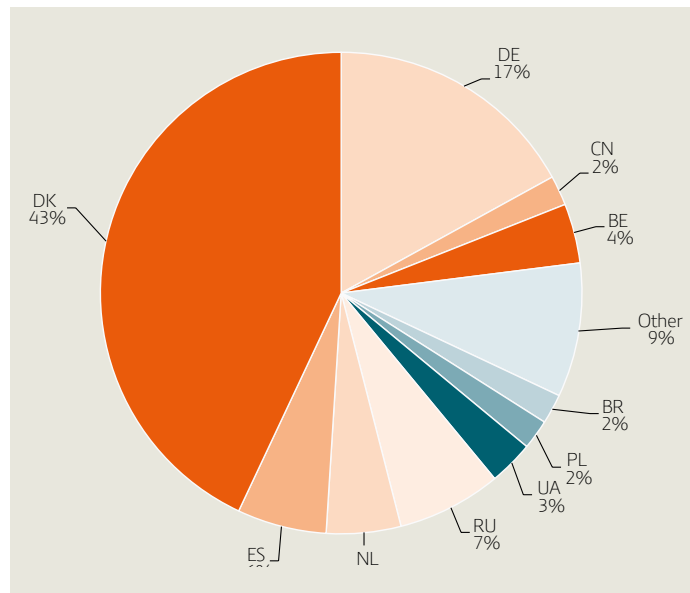
	Internationally		Denmark	
	Number	Index	Number	Index
Duroc	1,827	101.1	2,427	112.7
Landrace	439	113.9	351	131.3
Yorkshire	393	117.3	398	133.1
Total	2,659		3,176	

**Table 11** - Sale of genetic breeding stock from DanAvl in 2013, in Denmark and internationally.

	2012		2013	
	Denmark	Internationally	Denmark	Internationally
Purebred females	6,551	23,465	5,132	28,693
Hybrids	241,223	347,575	249,895	421,347
DD and XX boars	685	2,090	543	2,277
LL and YY boars	16	995	16	1,562
DD and XX semen, doses	4,678,582	777,711	4,864,952	1,116,687
LL and YY semen, doses	234,662	-	232,488	-
On-farm replacement production sows internationally*	-	290,896	-	424,519

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

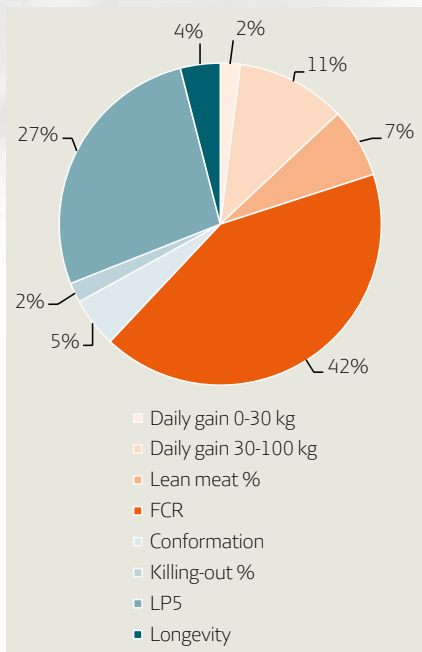
**Figure 1** - Fees on sale of genetic products in 2013 according to country (top 10)



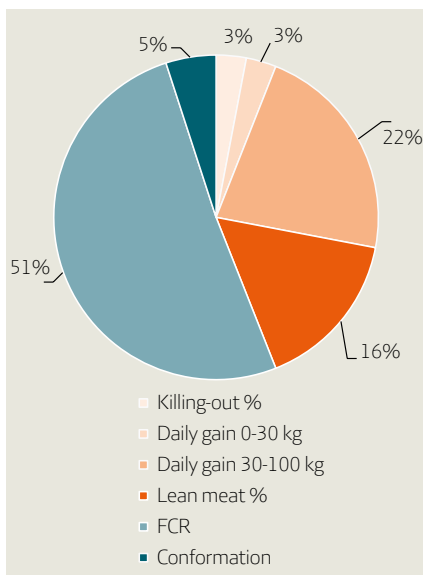
## Breeding objectives

The latest revision of the breeding objectives for Duroc, Landrace and Yorkshire was carried out in March 2011. The traits currently included in the breeding objective are shown in figures 2 and 3.

**Figure 2** - Breeding objective for DanAvl Landrace and DanAvl Yorkshire – economic contribution.



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



A new revision is currently underway and will be presented to the board in 2014. The revision will include a lower economic weighting of LP5 (live piglets on day 5 after birth) as a consequence of the increasing litter size.

## Social interactions

Selection that includes interactions between pigs is a method that takes into consideration that daily gain depends not only on the pig itself, but also on interaction with its pen mates.

Analyses based on data from performance tests of Duroc at Bølgårdgård confirm the assumption that socio-genetic effects are highly sensitive to data structure and environmental impacts. Preliminary results do not conclude whether a socio-genetic effect can be found on daily gain and feed conversion, and testing of more statistical models is therefore required.

Since March 2014, around 670,890 and 1,290 batches have been tested in which the pigs are of known origin of Duroc, Landrace and Yorkshire, respectively. This means that it will soon be possible to initiate analyses of data from all herds.

The project received financial support from the EU and the Rural Development Programme under the Danish Ministry of Food, Agriculture and Fisheries. Journal no. 32101-U-13-00238.

## EVA

In 2012, DanAvl implemented EVA, a new tool for reducing in-breeding within the Duroc breed. Since then, the increase in in-breeding has declined from around 0.5% to 0.1-0.2% (figure 4). This indicates that the method is working as planned, as a decline in in-breeding will guarantee continued genetic progress for many years to come. To enable nucleus breeders to select boars as early as possible. EVA was subsequently updated. Implementation of EVA in the white breeds will

be studied further during the autumn 2014.

Trials are underway to extend EVA to include limited in-breeding at DNA level. However, this requires research in and development of new methods and this is just one area of collaboration between the Pig Research Centre and Aarhus University.

## Breeding for reduced boar taint

In the EU, a voluntary agreement has been made to stop castration of male piglets in 2018 on welfare grounds. Trials are being undertaken to establish whether it is possible to reduce boar taint through breeding. Boar taint is primarily attributed to two chemical compounds: androstenone and skatole, while indole is less important. The first results of a three-year project, financially supported by the Danish National Advanced Technology Foundation, and of a two-year project, financially supported by the European Agricultural Fund for Rural Development, are now available.

One of the cornerstones of this work is the implementation of individual performance testing for boar taint. The trait boar taint is based on a combination of chemical analyses and the release of boar taint from the carcass during heating of a fat sample, which is evaluated on a scale from 0 to 2 (human nose score). On live animals, i.e. breeding candidates, boar taint is established with a biopsy where skatole and androstenone are determined, while slaughtered boars are also tested for boar taint with an odour test. Preliminary results show heritability of 55% for androstenone and 30% for skatole, which indicates that the biopsy method can be used in individual performance testing. Around 2,500 biopsies were taken across the three breeds – without indications of subsequent complications for the pigs, which is another criterion for the technology to be applicable in practice.

## Genomic selection IV

The hybrid D(YL) is the end product of the breeding programme, and breeding should therefore be based on information

from hybrids. However, this presents several challenges: data would often originate from offspring tests that are only available late in the life cycle of the candidate. For successful application of information from hybrids, genetic models must be capable of transferring this information to the nucleus. These models should be capable of handling heterosis where dominance is the most likely genetic basis of heterosis. The key is therefore the development of genomic prediction models that efficiently handle dominance effects (i.e. predict heterosis). It is therefore necessary to collect data for all production traits. In this respect, feed conversion is particularly important as it is the most important trait in the breeding objective and this is why hybrids are subject to individual performance testing at Bøgilgdgård. Data will be used for developing and testing the models as well as for evaluating the dissemination of breeding. 750 litters will be generated originating from 150 Duroc

sires and 750 YL dams of known pedigree. Results are expected by the end of 2015.

**Weaned pigs**

For a three-year period, data from standard commercial herds was collected and analysed to form a new trait, 14P that indicates a sow's ability to rear 14 piglets. The trait is measured by the number of live piglets on day 21 post-farrowing. Results showed that heritability is low and that it is a time-consuming task to record this information.

With the aim of finding another, less time-consuming method, a two-year project was initiated in 2013 in which it is being investigated if recordings of the number weaned pigs in multiplication herds may be used as an objective for a sow's ability to rear its own piglets. Results of a pilot study revealed that this was a much simpler method than recording 14P and that it generated a much more extensive database.

In the first year of the project, requirements and procedures for data collection were determined in three herds, where data was subsequently collected. However, preliminary analyses clearly demonstrated a much more extensive requirement for data collection than initially assumed, and as a result it will not be possible to obtain the amount of data necessary within the time frame of this project. Consequently, the project was terminated in 2014.

The project is part of the project "Genetic progress – three new traits in the Danish pig breeding programme" financially supported by the EU and the Rural Development Programme under the Danish Ministry of Food, Agriculture and Fisheries. Journal no. 32101-U-13-00238.

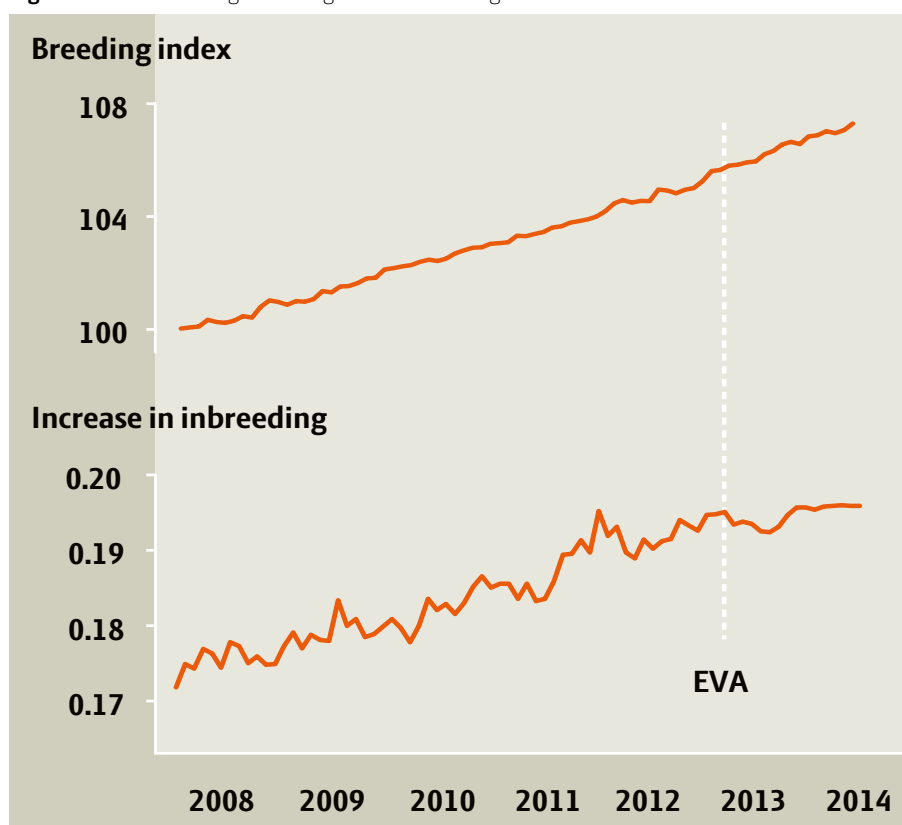
**F4 Yorkshire and Duroc**

Since 2003, pig breeding has aimed to increase the population of pigs that are resistant to the specific E.coli bacterium of the type 0149 F4ab/ac that causes diarrhoea in piglets post-weaning. An increase in the percentage of resistant pigs will reduce diarrhoea outbreaks among weaners, increase the daily gain from birth to 30 kg and reduce weaner mortality rates in the farrowing unit. Fewer outbreaks of diarrhoea and reduced mortality help improve welfare among weaners.

As of September 1, 2013, only resistant breeding stock are used in the Yorkshire nucleus. All Duroc breeding stock in the nucleus have been resistant since September 2012. From the beginning in 2003, the percentage of resistant Landrace breeding stock was lower than for Yorkshire and Duroc, and therefore the Yorkshire and Duroc are the first breeds to be declared resistant to 0149 F4 ab/ac.

Resistance to the E. coli bacterium is controlled by a single gene; resistant pigs have inherited this gene from both their mother and their father. A DNA sample

**Figure 4** - Trend in average breeding index for breeding candidates.



is required to establish whether a pig is resistant. Selection for increased resistance against post-weaning diarrhoea has happened alongside the normal index selection. A large part of the Landrace population is still not resistant, and it will be some years before the Landrace nucleus can be declared resistant to 0149 F4 ab/ac.

### Genomic selection III

In 2013, a two-year project on genomic selection, carried out in cooperation with Aarhus University, was concluded. The project, which concerned genomic selection for a breeding programme based on hybrids, was another comprehensive project related to genomic selection, and was financially supported by the Green Development and Demonstration Programme (journal no. 3405-11-0279). In this project, new techniques and methods for genomic selection were developed

with emphasis on two-way hybrids between Landrace and Yorkshire. Data and DNA samples were collected from several commercial herds for analyses of 14P (number of piglets in the litter on day 21 after farrowing in litters of 14 piglets), total number of piglets born, LP5 and sow longevity (time in production). Preliminary analyses subsequently revealed that the trait 14P has a fairly low heritability (0.06) and it is very time-consuming to record this trait in commercial herds.

Genomic data from the DNA analyses were used as test data in the theoretical part of the project to develop new genomic models and new breeding methods that were generated as a result of the project.

In terms of genomic prediction models for purebred and two-way hybrids, a single step method was developed based on

information from both purebreds and two-way hybrids that will now be tested.

The project also demonstrated that optimum contribution selection ensures greater genetic progress in the long run and lower in-breeding than the traditional breeding method. If only a small percentage of breeding candidates is genotyped (e.g. 5-20%), it is usually an advantage to use male breeding candidates. If a higher percentage of the breeding stock is genotyped, it is generally an advantage to focus genotyping on breeding candidates of both genders.

As a result of the project, genomic selection is now implemented for purebred pigs in the breeding programme. The Pig Research Centre invested significant resources in the implementation of genomic selection in the routine selection of breeding stock.

## Research and development

Research and development within AI is managed by the Pig Research Centre and Danish DanAvl AI centres through a joint steering committee that prioritises trials and projects.

## Quality control

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

## Number of sperm in semen doses

All Danish AI centres conduct in-house quality control of the number of sperm in the doses produced and they also monitor whether the doses contain bacteria. This quality control is performed in cooperation with the Pig Research Centre. The number of sperm per dose is also monitored through unannounced audits of the boar stations a couple of times each year. Results are published on the Pig Research Centre website. In 2013/2014, all AI centres complied with the guidelines for number of sperm per dose in the unannounced audits.

## Sperm quality index

The quality of sperm from Landrace and Yorkshire boars is monitored through a control programme in which sperm motility is recorded within a computer system. In this system, boars are ranked and the lowest-ranking boars marked for slaughter. There is still some scope for refining the programme as now more data has been gathered and this could facilitate recalculating the correlation between sperm motility and fertility. Results of the new analyses were presented as part of a PhD thesis published in autumn 2014. Cost-benefit analyses of implementation of the results still remain to be carried out before an effect will be seen of the results at Danish AI stations. Further analyses and

implementation are planned. In addition, the instrument ASQAS was developed for measurement of sperm dimensions. The instrument is being tested in practice in 2014/2015 with the aim of calculating a sperm quality index in which it will be possible to predict boar fertility on the basis of analysis of sperm motility and sperm dimensions.

## Boars with reduced fertility

In 2013, some Yorkshire boars were found to have reduced fertility. Further investigation surprisingly revealed normal sperm quality in a large percentage of the suspect Yorkshire boars. The opposite was the case with Landrace since boars with low fertility were often found to have a measurably poor sperm quality. The exact cause of reduced fertility in Yorkshire boars has yet to be established, but a PhD thesis published in autumn 2014 points to multiple factors.

## Returners

In spring 2013, some pig producers experienced problems with a higher percentage of 'returners' in certain weekly batches. Analyses showed that the problem was only seen in herds using semen from certain semen batches. It was not possible to confine the problem to certain AI stations or companies. The problem persists, and in another trial, samples of semen from

all production rounds are therefore being stored in a freezer: if, subsequently, a farm reports low farrowing rates in a certain batch, it will be possible to analyse the semen for bacteria, virus or inadequate dilution.

## Hygiene on AI stations

Semen doses must not contain live bacteria. Only a very small percentage of semen doses contain bacteria, but this is unacceptable. Therefore, a hygiene group was set up to discuss and implement a range of measures aimed at improving hygiene levels even further on Danish AI centres.

## Bacteria and AI boars

Semen doses must not contain bacteria and a project is currently analysing whether bacteria are transmitted between boars in AI centres and thus increasing the risk of sperm containing bacteria. Swabs from the prepuce will be collected from these boars and will be analysed for bacteria. The trial comprises boars from quarantine units i.e. before the boars arrive at the AI centres and boars at the AI centres. If results show transmission of bacteria between boars, the chain of infection must be investigated and intercepted.



*Semen collection.*

### Performance of nurse sows

The performance of nurse sows in terms of productivity was studied on the basis of data collected from 20 herds. The data analysis included 63,025 litters.

### Nurse sows save piglets

A preliminary analysis indicated that sows used as nurse sows weaned 0.7 more piglets before becoming nurse sows than sows that were not picked as nurse sows (see table 1). This indicated that the best sows had been selected to become nurse sows. These sows reared the nurse litter of piglets as well as their own piglets. Thus despite mixing of piglets and the disturbance that alien piglets caused the sow, the expected number of piglets were still weaned in the nurse litter.



*Nurse sows will save surplus piglets and produce more total-born piglets in their subsequent litter.*

### Subsequent reproduction

The lactation period of nurse sows was - as expected - approximately 12 days longer than that for sows not used as nurse sows (table 1). The nurse sow's subsequent litter increased by 0.6 piglets on average. A nurse sow on average entered oestrus after weaning at the same interval as sows that were not used as nurse sows. Results from these 20 herds indicated that the special management of nurse sows is the reason why the nurse sows perform as well in the subsequent reproductive cycle as the other sows in the herd.

### Synchronised oestrus in gilts

If gilts would enter oestrus as predictably as sows, then planning of insemination, oestrus check, vaccination, transfer to farrowing pen, farrowing surveillance and cross-fostering would be easy. It is in fact possible to control time of oestrus in gilts if the gilts are acyclic when stimulation is initiated. Stimulation includes transfer to a new pen, mixing with new pen mates and boar contact every day. Gilts need a sufficient pen area and need to be allowed at least 3 feed units per day. A current trial compares the efficacy of correct stimulation with the effect of a medical product, Altresyn, for synchronisation of cyclic gilts. Medical synchronisation includes costs of the treatment, where each gilt need to be treated every day for 18 days. In return, a positive effect on litter size is expected, but this has yet to be confirmed. The trial started in the spring 2014, and will be conducted in four herds.



*Altresyn, used for synchronizing oestrus, is administered to gilts orally. Gilts learn to accept the treatment by receiving apple juice for 3 days.*

**Table 1** - Production results – nurse sows vs regular sows (preliminary results)

	Nurse sows	Not nurse sows
Lactation period (days)	39.8	27.6
Piglets weaned per weaning	12.4	11.7
Nursing piglets weaned	11.5	-
Weaning-to-insemination interval (days)	4.2	4.2
Return rate subsequent parity (%)	2.6	2.6
Total born subsequent parity	18.5	17.9
Sows culled between weaning and farrowing, (%)	15.5	17.8

## Danish vs Dutch feed

Both feed consumption and mortality of sows in the Netherlands are lower than in Denmark. The Pig Research Centre therefore investigated how productivity, feed consumption and longevity are affected when sows are fed according to both Danish and Dutch recommendations. The Dutch approach is based on a slightly different mineral profile and higher fibre content in gestation as well as lactation diets. In addition, recordings of backfat at farrowing and at insemination are a central tool in the Netherlands for management of feed curves during gestation as well as lactation.

The trial was conducted on two farms. Half of the sows were fed according to the Dutch recommendations and the other half according to the Danish recommendations. Data was compiled for a period of 18 months.

On the farm where the trial has already been completed, results indicated that, when gestating sows were fed according to the Dutch recommendations, significantly fewer sows were recorded as thin when entering the farrowing unit compared with those fed according to Danish recommendations. This arose even when feed consumption was identical in both groups. Results showed no difference in longevity or productivity in the trial period, which was of short duration.

In the lactation period, feed consumption was 12% lower in the Dutch group without adversely affecting the sows' body condition at weaning or their productivity. The low feed consumption was attributed to a combination of increased fibre content and strictly managed feed allocation, whereby feed curves matched backfat thickness. Sows with a backfat thickness above 15 mm in P2 at transfer to the farrowing unit, were fed a maximum of 8.5 FU/sow per day in the farrowing unit. Sows with a backfat thickness above 19 mm were fed up to 7 FU/sow/day.

The practice of using backfat measurement to allocate sows to the most appropriate feed curve and using diets with a higher content of fibre than regular grain-based diets were generally well received in the herds participating in the trial.

The project received financial support from the EU and the Rural Development Programme under the Danish Ministry of Food, Agriculture and Fisheries. Journal no. 32101-U-13-00239.

## Gastric health in gilts

The Pig Research Centre recommends feeding gilts according to appetite from approximately 65 kg liveweight. It is also recommended that they are fed a maximum of 2.7 feed units/day until insemination, which should take place when the gilts weigh 135-150 kg. The effect of feeding coarse meal vs pelleted feed to gilts at the time of insemination on the above feeding strategy was therefore investigated.

Results showed that gilts that were fed coarse meal from 65 to 140 kg had a gastric index of 0.6 compared to 4.4 in gilts fed pelleted feed. Lower gastric indices are associated with less ulceration. Gilts fed pelleted feed up to 100 kg followed by coarse meal had an average gastric index of 2.0 at 140 kg. Gilts fed restricted rations generally had better gastric health than what is considered normal for ad-lib finishing pigs. This demonstrates that restricted feeding affects gastric health positively. Furthermore, for gilts fed on coarse meal, additional gastric health benefits were detected at the time of insemination.

The project received financial support from the EU and the Rural Development Programme under the Danish Ministry of Food, Agriculture and Fisheries. Journal no. 32101-U-13-00237.



*Gilts should be fed on a restricted basis from a maximum of 65 kg to ensure optimum gastric health before they are moved to the sow unit.*

## Feed allowance and gastric health

The correlation between feed allowance and gastric health in sows was investigated on three farms where sows were fed home-mixed liquid feed. The investigation included recording of feed intake and gastric health in sows weaned after 21-28 days of lactation and slaughtered 0-5 days later.

The comparison comprised 20% of the sows on the highest average daily feed allowance and the 20% with the lowest average daily feed allowance.

Results revealed no difference in the percentage of sows with gastric ulcer between sows with high or low feed intake, respectively – neither in terms of scars from healed ulcers nor current ulcers.



*A sow's feed intake during lactation cannot be used as an indicator of the prevalence of gastric ulcers.*

Investigations were also carried out to ascertain whether sows that experience a day-to-day drop in feed intake of more than 30%, have an increased prevalence of gastric ulcers compared to other sows. However, results showed no correlation.

Overall, the trial did not find any clear correlations between feed intake during lactation and gastric health, hence feed intake is therefore not an appropriate indicator of gastric ulceration.

In order to make an assessment of the gastric health of a herd, pig producers should therefore regularly submit stomachs from sows in the herd to the Laboratory for Pig Diseases for extended analysis. As a guide, 20 stomachs are required for an extended analysis in order for the result to be meaningful.

The project received financial support from the EU and the Rural Development Programme under the Danish Ministry of Food, Agriculture and Fisheries. Journal no. 32101-U-13-00237.

### Valine for lactating sows

A literature review published in 2013 revealed large range in the recommended optimum valine:lysine ratio in studies made over the years. In 2013, when the Pig Research Centre revised the Danish nutrient standards, the recommendation for the valine:lysine ratio was 76% and there was a need to evaluate this recommendation under practical conditions.

In a dose-response trial made on one farm comprising six groups it was therefore investigated whether an increasing valine:lysine ratio may improve average daily litter gain and/or limit the daily weight loss of the sow.

Valine:lysine ratios varying from 76% to 97% were investigated. The diets used complied with all standards for lactating sows, and the valine content thereby presented the only difference between the six diets. The lowest valine concentration studied was 5.0 g standardised digestible valine per feed unit and the highest

concentration was 6.4 g standardised digestible valine per feed unit.

Preliminary results indicated identical average daily litter gain and identical average daily weight loss and backfat loss among the sows in all groups. Based on these preliminary results, there seems to be no reason to increase valine:lysine ratio beyond 76%.

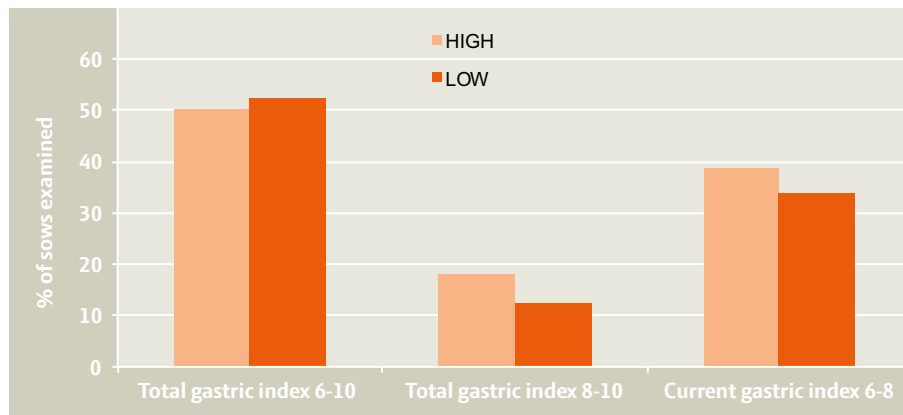
A comprehensive dose-response trial comprising six groups is currently being planned, in which increasing concentrations of ideal protein (fixed ratio between all amino acids relative to lysine) will be investigated. This trial is expected to determine whether increasing the amino acid profile beyond the Danish standards will lead to an increase in average daily litter gain and/or whether it would be possible to decrease sows' mobilisation from body reserves.



*Preliminary research results do not indicate improvements in production results when the valine:lysine ratio in the feed exceeds 76% in lactation diets.*

The project received financial support from the EU and the Rural Development Programme under the Danish Ministry of Food, Agriculture and Fisheries. Journal no. 32101-U-13-00239.

**Figure 1**





### Standards for gilts

The Pig Research Centre's Nutrient Standards have not previously included standards specifically aimed at the feeding of gilts. However, as a result of model calculations and a literature review, the Nutrient Standards now include recommendations for feeding gilts in the weight interval 30-140 kg. The overall aim is for gilts to:

- Be inseminated during their second heat
- Be 225-250 days old at insemination
- Weigh 135-150 kg at insemination
- Have a minimum backfat thickness of 12 mm at insemination

### The weight challenge

With previous recommendations for feeding strategies and diets in the growth period, gilts would often be somewhat too heavy at insemination. In addition they had a high lean meat content and a low fat content, both of which are undesirable for gilts with a long reproductive life ahead of them.

### Literature review

To ensure that the new standards do not jeopardise gilts' performance as sows, Danish and international literature was reviewed showing that:

- Heavy gilts often have a short longevity
- A higher level of backfat in gilts at the time of insemination is linked to greater longevity in the breeding herd
- Vitamin standards for finishers fully meet gilts' requirement until 105 kg,

whereas above 105 kg gilts need the same amount of vitamins per feed unit as gestating sows

- Restricted feeding and feed with low content of amino acids and protein will make gilts lighter. Due to increased backfat thickness these gilts will enter oestrus at approximately the same time.

### New standards for gilts

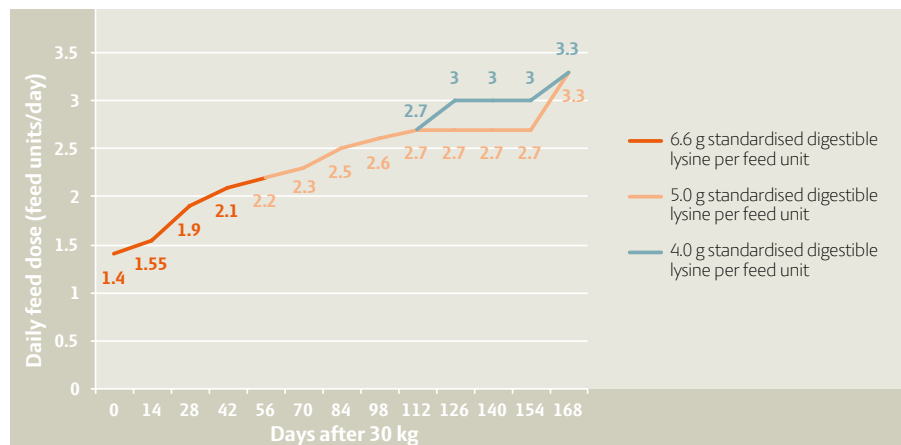
Marginal reductions in the content of crude protein and lysine in gilt feed alone will not affect gain and thereby weight.

This is reflected in the new standards shown in table 1. The new standards include a minimum of 10% more phosphorus per kg gain than for finishers in order to boost lifetime productivity of gilts selected for breeding.

### Use the correct feed curves

The new standards are closely correlated with the daily amount of feed. The guiding feed curve (figure 1) completes feeding of gilts and ensures that gain is neither too low nor too high.

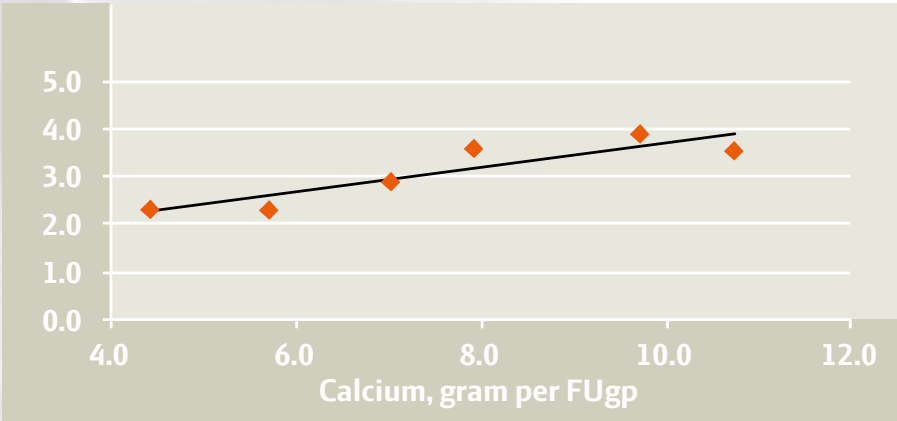
**Figure 1** - Recommended feed curves at phase-feeding using the nutrient standards shown in table 1. From 105 kg, feeding is assumed to include either 5.0 or 4.0 standardised digestible crude protein per feed unit.



**Table 1** - New standards for lysine, crude protein, calcium and phosphorus for gilts. For information on the remaining amino acids, see "Nutrient Standards" at [www.vsp.lf.dk](http://www.vsp.lf.dk).

	Gilts 30-65 kg	Gilts 65-105 kg	Gilts 30-105 kg	Gilts > 105 kg
Lysine, g st. dig. per feed unit	6.6	5	6	4
Crude protein, g st. dig. per feed unit	110	95	100	90
Calcium, g per feed unit	7.5	6.5	6.5	6.5
Phosphorus, g dig. per feed unit	2.7	2.3	2.5	2
Vitamins and microminerals	As for finishers	As for finishers	As for finishers	As for sows

**Figure 1** - Treatment for diarrhoea, days per pig.



### Calcium

A recent study of increasing calcium content from 4.4 to 10.7g per feed unit for weaners, given as calcium carbonate, showed that production results were largely unaffected by the calcium concentration in the trial period.

Each additional 2 g calcium per feed unit that was added as calcium carbonate resulted in the need for another half days' medication for treatment against diarrhoea.

An increase in the inclusion of calcium carbonate will tend to elevate pH of the acid-base balance in the gastro-intestinal tract, which may explain the effect on diarrhoea treatments. Other sources of calcium, such as calcium formate and calcium chloride, will likely have a weak and strong acidic effect, respectively, on the acid-base balance.

Previous research demonstrated that, when calcium formate constituted the calcium source, the additional cost was covered as compared with using calcium carbonate for weaners (Trial Reports no. 396 and 445). This also applied to pelleted feed for finishers (Trial Report no. 690).

On the basis of this study, the standard recommended calcium level of 8 gram is unchanged, but must be lowered to 6.5 g per feed unit in diets for pigs at increased

risk of diarrhoea in the weight interval 9-15 kg provided that phytase is added.

The project received financial support from the EU and the Rural Development Programme under the Danish Ministry of Food, Agriculture and Fisheries. Journal no. 32101-U-12-00228.

### Horse beans

To date, horse beans have been mainly used by organic rather than conventional pig producers, with the advice that only the petal-white varieties be used due to their low tannin content.



*Horse beans are a good alternative to soybean meal in feed for weaners (9-30 kg).*

The Pig Research Centre recently studied various varieties of horse beans including the tannin-rich varieties Fuego and Espresso. These varieties produce a much higher

yield and are therefore a competitive alternative to, for example, spring barley.

The addition of 25% horse beans of the varieties Fuego or Espresso to weaner feed for pigs weighing from 9-30 kg improved production value by 8 percentage points compared with a weaner diet based on soybean meal (control). Production efficiency of weaners fed Fuego or Espresso was 5 percentage points better than that of weaners fed a diet containing 25% Columbo horse beans. All the weaners fed Columbo, Fuego or Espresso had a higher daily gain and a better FCR compared with control pigs fed a soybean-based diet in the weight range 9-16 kg.

There were fewer outbreaks of diarrhoea in the group fed Espresso horse beans compared with the control group.

Results of a new trial with horse beans are expected in 2015.

The project received financial support from the EU and the Rural Development Programme under the Danish Ministry of Food, Agriculture and Fisheries. Journal no. 32101-U-12-00227.

### Synthetic amino acids

Routine analysis of mineral supplements recently pointed to the fact that, in some cases, free amino acids are not always fully retrieved in these analyses.

It is possible that analyses simply fail to retrieve all of the amino acids added to the diet. At the same time, tryptophan and valine are such fine grained ingredients that they may be lost due to sticking to the processing equipment, silo or transport equipment and will thus not be reflected in the analysis.

Results of a recent study showed that free lysine, methionine and threonine are fully retrieved in mineral feed. However, results revealed deficiencies of up to 20% of tryptophan and valine, even if trypto-

phan in granulated form was added or if another analysis method was used.

For more information, see “Publikationer” at [www.vsp.lf.dk](http://www.vsp.lf.dk) (Trial Report no. 997).

Analysis of free amino acids in mineral supplements

- If the result indicates 0-20% less tryptophan and valine then declared the diet is likely to be acceptable
- If the deficiency is larger than 20%, the mineral feed supplier should be contacted
- It is advisable to analyse mineral supplements for lysine, methionine and threonine as 100% of these should be retrieved
- Analyse 3 samples of each big bag

**Grinding of barley and wheat**

Studies have previously shown that the digestibility of starch in wheat remained the same regardless of particle size, whilst in barley it increased if particle size was fine.

This was investigated in a trial in which finishers were fed wheat and barley ground to a large and small particle sizes.

The aim was to establish whether it is more important to grind barley to a small particle size and less important for wheat.

Results revealed improved productivity when fine particle sizes were used regardless of whether barley or wheat was finely ground.

The project received financial support from the EU and the Rural Development Programme under the Danish Ministry of Food, Agriculture and Fisheries. Journal no. 3663-U-11-00181.

**Meal vs pellets**

Pelleted feed is known to improve FCR and daily gain compared with meal feed.

This was further investigated in a trial where diets based on the pig producer’s home-grown grain were used.

Preliminary results show that in pigs fed pelleted feed daily gain improved by 4.6% and FCR by 5.6%.

The pigs fed pelleted feed had a significantly higher prevalence of gastric ulcers as indicated by high gastric index values. More than 70% of the pigs fed pelleted feed had a gastric index of 6 or more. Among the pigs fed meal feed, approximately 20% had a gastric index of 6 or more.

The particle size of the feed was determined using wet sieving: results showed

that in the meal feed particle size averaged 77% particles < 1 mm. and in the pelleted feed, particle size averaged 82% < 1 mm, which is a satisfactory particle size.

**Efficiency of free amino acids**

Recent research shows that lean meat percentage improved by 0.5 when 135 g standardised ileal digestible (SID) crude protein rather than 122 g was added (see table 1), i.e. about 0.4 lean meat percentage units for each 10 g SID crude protein added per feed unit.

If the content of free amino acids (lysine, threonine and methionine) was raised by 30%, the result was an additional 0.2 lean meat percentage units. A high protein content was obtained by increasing the addition of soybean meal rather than grain.

Contrary to findings in previous trials, a slightly reduced daily gain and FCR and more liquid manure were observed in pens where the pigs were fed high-protein feed. The explanation may be that the pigs in this trial did not tolerate the elevated protein content, as all four diets also contained 12% rapeseed and sunflower meal, which in itself will lead to more liquid manure than soy-based diets.

This trial formed the first part of a project aimed at documenting whether large finishers may experience a fermentation loss of free amino acids in the stomach and thereby they fail to fully absorb the free amino acids. This may be, but, as yet, it is too soon to quantify. Consequently, the recommendations remain: and so the value of free amino acids is still calculated at 100% across the world. The only exception is the Danish recommendation for liquid feed where the recommendation is lowered to 75%.

Production efficiency was unaffected by the increase in protein content. The positive effect on lean meat percentage was neutralised in this trial by lower daily gain and poorer FCR.



Barley and wheat must both be ground to fine particle size to obtain optimum feed conversion.

Raising the protein content was not profitable. However, model calculations do show that there is a benefit in using approximately 126-132 g SID crude protein per feed unit on farms delivering pigs to Tican slaughterhouse or the UK market, and 124-125 g SID on farms delivering pigs at typical Danish Crown (DC) pig prices, provided that lean meat percentage averages around the 59% mark.

Results confirm that the 2013 revision of the amino acid and protein standards improves FCR and gross margin. It should be noted that group 1 in table 1 corresponds to the situation before the new standard was introduced and group 3 corresponds to the situation after introduction.

The project received financial support from the EU and the Rural Development Programme under the Danish Ministry of Food, Agriculture and Fisheries. Journal no. 32101-U-12-00228.

### Rapeseed

The Pig Research Centre studied the effect of feeding rapeseed to weaners and finishers, respectively, in two trials.

The aim of the first trial was to investigate whether pig productivity is affected by the quality of the rapeseed (high vs low glucosinolate content). Weaners were given 5% rapeseed in their feed and finishers were given 10%.

The aim of the other trial was to study whether weaners tolerate rapeseed better than finishers. One group was fed 7.5% rapeseed both as weaners and finishers, and the other group was given 12% rapeseed from the point when the average weight of the pen reached 62 kg. Pigs in both groups received the same amount of rapeseed, but at different points in their growth.

For both weaners and finishers, two different qualities of rapeseed resulted in:

- Identical feed intake
- Identical daily gain
- Unchanged FCR
- Identical lean meat % (for finishers)

7.5% rapeseed vs no rapeseed for weaners and 12% rapeseed vs no rapeseed for finishers resulted in:

- Lower feed intake
- Lower daily gain
- Unchanged FCR

7.5% rapeseed vs 12% rapeseed for finishers resulted in:

- Identical feed intake
- Identical daily gain
- Unchanged FCR

Preliminary results do not reveal any effect of a high glucosinolate content on productivity in either weaners or finishers. Likewise, results indicate no effect on productivity of either weaners or finishers, when the pigs started receiving rapeseed



*Feed intake among finishers is restricted by feeding 7.5% and 12% rapeseed from 60 kg.*

The project received financial support from the EU and the Rural Development Programme under the Danish Ministry of Food, Agriculture and Fisheries. Journal no. 32101-U-12-00227.

### Restricted dry feeding

To date, no feeding systems have been capable of releasing a uniform distribution of dry feed into the trough of a traditional finisher pen. The Spotmix system from Bopil manages this to some extent in short troughs. Consequently, as far as dry feeding is concerned, ad lib has been the most common feeding principle.

Female pigs may be fed dry feed ad lib in the entire growth period without any significant adverse effect on feed conversion. Among castrates, however, feed conversion efficiency is often seen to deteriorate when they are fed ad lib during the whole of the growth period.

Investigations made in the past mainly focused on comparing ad lib dry feeding with liquid feeding in long troughs. No trial

**Table 1** - Effect of crude protein and 30% extra amino acids.

Group	1	2	3	4	Factor effect	
SID crude protein, g/FUgp	134	137	121	122	+13 g SID	+30% free
Inclusion, free amino acids	Normal	+30%	Normal	+30%	crude protein	amino acids
SID lysine, levels reached, g/FUgp <sup>1)</sup>	7.5	-8.1	7.7	-8.8		
Daily gain, g	1021	1031	1037	1047	-16	10
FUgp/kg gain	2.75	2.72	2.72	2.70	0.03	-0.03
Lean meat %	60.3	60.5	59.8	60	0.5	0.2
Production value, per place unit/year, index <sup>2)</sup>	99 a	105 b	100 a	106 b	-	6
Gross margin, per place unit/year, index <sup>3)</sup>	95	99	100	102		

<sup>1)</sup> Additional free lysine, methionine and threonine only in groups 2 and 4. Thereby the full amino acid profile does not follow the lysine level.

<sup>2)</sup> Different superscripts (a,b) indicate significant differences

<sup>3)</sup> Gross margin including manurial value

has ever before compared ad lib dry feeding with dry feeding in long troughs. This is now possible with the new dry feeding wall developed by Techno com and sold by Vissing Agro. In terms of set-up costs, the dry feeding wall is competitive with the costs related to investing in liquid feeding.

A high feed intake and a high daily gain at the beginning of the growth period are prerequisites for efficient feed conversion in pens where pigs are fed in long troughs. A dry feeding wall like the one shown in the photo was therefore used in a trial in which the aim was to determine the feed dose that would be a competitive alternative to ad lib feeding until 65 kg and that did not lead to overfeeding of the pigs and staff having to subsequently adjust the feed dose. As is normal practice with liquid feeding in long troughs, the feed dose ensured that about 30% of the pens in the section needed to be down-regulated compared with the feed curve.

Results showed that the pigs' performance by the dry feeding wall in the first half of the growth period was competitive with ad lib dry feeding. In fact, it was possible to achieve a slightly higher feed intake

**Table 2** - Preliminary production results for restricted feeding until intermediate weighing (32-111 kg).

	Dry feed ad lib, female	Dry feed ad lib, castrates	Dry feeding wall, female	Dry feeding wall, castrates
Daily gain, g, 32-65 kg	799	842	842	869
Feed dose, FUgp/day, 32-65 kg	1.92	2.07	2.04	2.12
FCR, FUgp/kg, 32-65 kg	2.41	2.47	2.42	2.44
Daily gain, g, 65-111 kg	944	981	944	939
Feed dose, FUgp/day, 65-111 kg	2.50	2.80	2.55	2.65
FCR, FUgp/kg, 65-111 kg	2.65	2.86	2.71	2.82
Lean meat %	61.4	59.1	61.5	59.6

and a slightly higher gain in the period up to approx. 65 kg liveweight by using the dry feeding wall compared with ad lib feeding in a tube feeder (Ergomat XL).

Unfortunately, the positive results did not last throughout the whole of the growth period: the restricted feed supply toward the end of the growth period adversely

affected daily gain of pigs by the dry feeding wall, which also impacted on the feed conversion ratio.

To obtain a high feed intake, the pigs using the dry feeding wall were fed ten times a day, as a pilot study had previously demonstrated a low feed intake when pigs were four times a day.



*The dry feeding wall consists of a flex auger mounted on a pipe at the pen partition above the trough. Downpipes are installed for every 33 cm trough. The flex auger fills the pipe, which has two positions: one for filling and one for releasing feed through the downpipes. Flex auger and pipe are operated by a servo-motor.*

### Welfare Summit

At the Welfare Summit held in Copenhagen in spring 2014, the Danish pig industry voluntarily signed an agreement to end castration without anaesthesia by the end of 2018 on welfare grounds. In future, pig producers must either produce entire males or use anaesthesia during castration of piglets. Production of entire males requires reliable methods and equipment for analysis of taint incidence and agreed acceptance limits so that consumers are assured of a high-quality product. In Denmark, multiple research activities are investigating analytical methods and ways to reduce boar taint through production methods and genetic work.

### Boar taint

Boar taint is primarily caused by skatole and androstenone. Skatole is produced in the digestive tracts and can be affected by feeding. Androstenone is a pheromone that contingent primarily on maturity.

### Screening

Results of a screening of entire males on nine farms showed that 37% of the entire males would be rejected if the following rejection criteria were applied

1. Skatole: 0.25 ppm
2. Human nose: 2 (on a scale 0-2)
3. Androstenone: 1.00 ppm

Results revealed large variations between farms, and rejection rates found on conventional farms were considerably lower than on organic farms. For more information, see "Publikationer" at [www.vsp.lf.dk](http://www.vsp.lf.dk) (Trial Report no. 996).

### Weight

Preliminary results from a trial with entire males where biopsies were taken from pigs in the weight interval 60-120 kg demonstrate that androstenone concentrations in fat increase as weight increases (see figure 1).

The project received financial support from the EU and the Rural Development Programme under the Danish Ministry of Food, Agriculture and Fisheries. Journal no. 3663-U-11-00182.

### Nutrition

Current research activities are analysing whether a higher content of protein/amino acids and energy may enhance the growth rate of entire males: thus the pigs will be less mature at slaughter and boar taint contingent on androstenone will decrease.

Research activities also include the effect on boar taint of feeding entire males different types of fibre such as chicory, palm cake, Jerusalem artichoke and sugar beet pellets for a short period before slaughter. These activities investigated the effect on boar taint and productivity of feeding a grain mix 3 days before slaughter and feeding chicory 4 days before slaughter.

The project received financial support from the Green Development and Demonstration Programme. Journal no. 3405-10-OP-00134.

A pilot study investigated the effect of adding 5% activated coal to the feed for entire males for the last 14 days before slaughter, but results showed no effect on boar taint.

### Liquid feed or dry feed

Entire males perform better than castrates, and this may affect choice of feeding system.

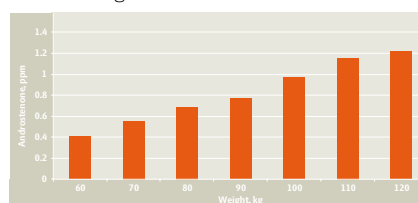
Research showed that castrates perform best when they are fed liquid feed restricted as opposed to dry feed ad lib, which is not the case with entire males.

When entire males are fed liquid feed on a restricted basis, it is essential to pay close attention to the feed curve throughout the entire growth period to avoid restriction of the growth of entire males. Adjusting the feed curve makes it possible to achieve the same production efficiency as with a dry feed ad lib regime.

Investments and operating costs are typically higher for liquid feeding systems than dry feeding systems. This increase in costs must be assessed in the light of the general productivity improvements in producing female pigs and entire males in systems where pigs are restrictively fed liquid feed rather than dry feed ad lib.

The project received financial support from the EU and the Rural Development Programme under the Danish Ministry of Food, Agriculture and Fisheries. Journal no. 32101-U-12-00195.

**Figure 1** - Androstenone concentration in fat in relation to age.



Feed pellets (and pigs) turn black when 5% activated coal is added to the diet, but boar taint is not affected.

**Test of commercial diets**

Commercial diets comprising starter feed and weaner feed from three different companies - DLG, ATR and Danish Agro (DA) - and a control diet formulated by the Pig Research Centre were compared in a trial at Grønhøj experimental farm. Results showed that the production efficiency achieved with the diets from DLG was identical with the control diet and significantly better than that obtained with the diets from ATR and DA.

The feed from DLG therefore is actually worth DKK 21 more per 100 kg feed than the other diets, but did in fact cost DKK 130 more per 100 kg.

With the exception of a methionine deficiency of on average 8.3% in the weaner feed from DA, analyses showed little variation between the declared and the analysed nutrient content in all the diets.

For more information, see "Publikationer" at [www.vsp.lf.dk](http://www.vsp.lf.dk) (Trial Report no. 1003).

The project received financial support from the EU and the Rural Development Programme under the Danish Ministry of Food, Agriculture and Fisheries. Journal no. 32101-U-12-00227.

**Control of finished feed**

The objective was to establish whether pig feed manufacturers actually meet the guarantees given on product labels. The Pig Research Centre sampled commercial diets from the following feedstuff producers:

- DLG
- Danish Agro
- Brdr. Ewers
- Møllerup Mølle
- Himmerlands Grovvarer
- Vestjyllands Andel

Following completion of the analyses, the results will be published on the Pig Research Centre website.

The project received financial support from the EU and the Rural Development Programme under the Danish Ministry of Food, Agriculture and Fisheries. Journal no. 32101-U-12-00227.

**Dutch feed**

A review of the international competitiveness of the Danish pig production industry made by the Pig Research Centre indicated that the feed efficiency may be better in Dutch than in Danish pig production. This may be attributed to a higher nutrient content per feed unit in Dutch feed or to better productivity due to ingredient composition or processing techniques used in the Netherlands.

The Pig Research Centre therefore analysed 20 finisher diets purchased in the Netherlands for Danish feed units for specific nutrients.

Analyses revealed a higher energy content in the Dutch feed than in typical Danish feed – this was especially apparent in the diets used from 50 kg onwards. In addition, the energy concentration declared was typically higher. On average, energy content was 4 feed units per 100 kg higher than that retrieved in the analysis. This exposes the limitations of a feed evaluation system that is not verifiable.

Finally, the preliminary results revealed a tendency to a higher content of digestible amino acids per feed unit analysed in the Dutch feed, which was also observed in particular in the diets used from 50 kg onwards.

Dutch feed is also being studied under practical conditions where a typical Dutch finisher diet practicing two-phase feeding is compared with a typical Danish single phase diet. Results are expected by the end of 2014.

**Feeding value of protein ingredients**

A digestibility trial was recently undertaken at the University of Illinois with weaners between 9.3 to 19.5 kg liveweight that were surgically equipped with a T-cannula in the end of ileum. The outcome was the updating of the digestibility coefficients for soy protein and rapeseed protein products listed in the feedstuff database (see table 1). With the exception of de-hulled soybean meal and rapeseed cake, the digestibility coefficients for the tested products needed to be lowered.

As a consequence of the new digestibility coefficients, feed formulations now require slightly higher inclusion rates of soy protein products and EP 100 to reach the desired level of standardised digestible crude protein per feed unit.

**Table 1** - Standardised ileal digestibility of soy and rapeseed products for weaners.

	HP 300	Vilosoy	Alpha-Soy PIG 530	Imcosoy	De-hulled soybean meal	Scanola rapeseed cake	EP 100
Protein digestibility, %	89.9 <sup>a</sup>	85.2 <sup>abc</sup>	86.2 <sup>ab</sup>	82.2 <sup>bc</sup>	88.0 <sup>ab</sup>	79.5 <sup>c</sup>	70.6 <sup>d</sup>

<sup>a-d</sup> Means with different superscripts are significantly different (P<0.05).

### “Wet is best”

The project “Wet is best” demonstrates the effect of sound advice in a one-year progress development course. The aim was to improve the productivity of the finisher units participating. This involved two steps:

- Step 1: Checking mixing and feeding processes to ensure that the amount fed and the quality of the feed are just right.
- Step 2: Deciding on the optimum feed curve for each herd and the best method for daily adjustment of the feed amount.

### “Wet is best”

The Pig Research Centre demonstrated liquid feed management in cooperation with

- 9 pig advisors from the expert group on liquid feeding and
- 18 finisher producers.
- The project also involved the delivery of a targeted and co-ordinated advisory programme and a series of seminars held across the country with participation from both advisors and producers.

Step 1 focused on optimising the function of the liquid feed systems and validating data used for analysing the effect of the project. This step also provided the pig producer with an assurance that the system was running correctly. In step 1, most participants improved routines such as silo checks, cleaning and particle size analysis or they optimised the number of mixes used in order to reduce wastage of residual feed etc. On 75% of the farms, errors were pinpointed during step 1. Some of the participants claimed that the greatest benefit for them lay in step 1.

Step 2 was based on the participants’ objectives for better feed conversion efficiency, daily gain and lean meat percentage. The impact on gross margin per place unit was also recorded. All pig producers who participated were routinely benchmarked enabling them to compare progress with each other. Results showed that on more than 90% of the farms feed curves needed revision.



*Finisher producers and pig advisors evaluate the effect of the project and exchange experiences obtained in the project.*

In the course of the project, all pig advisors helped each other, and thus the pig producers got “a second opinion” on the challenges they each encountered on their farms.

The project received financial support from the EU and the Rural Development Programme under the Danish Ministry of Food, Agriculture and Fisheries. Journal no. 32101-D-12-00515.

### Loss of synthetic amino acids

In typical liquid feeding systems, where wet feed remains in the pipelines between feeding, the synthetic amino acids lysine and threonine are decomposed by microorganisms. This must be taken into consideration when liquid feed diets are formulated to prevent amino acid deficiency in the pigs.

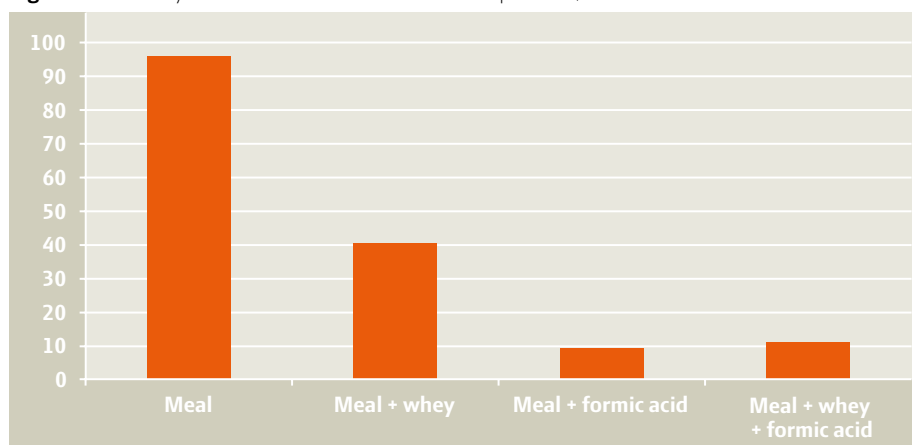
A loss of 25% of the synthetic lysine and threonine in liquid feed should be allowed for in all categories of pigs. Results from a recent trial, made in cooperation with Aarhus University, Foulum, revealed no significant loss of synthetic methionine, tryptophan and valine in liquid feed. Synthetic lysine in particular decomposes in liquid feeding systems; this decomposition is also observed in home-mixed meal as well as in pelleted, purchased feed.

This decomposition can be substantially reduced by adding 2‰ formic acid. When formic acid is added to liquid feed, it is no longer necessary to compensate for this loss of synthetic amino acids in feed formulations. However, adding formic acid instead of extra amino acids is not a profitable solution as 2‰ formic acid costs roughly six times as much as the addition of extra amino acids to a finisher diet.

Whey also limits the decomposition of these amino acids, but not to the extent seen with formic acid. Therefore, even when whey is used in liquid feed, additional amino acids will be required.

The project received financial support from the EU and the Rural Development Programme under the Danish Ministry of Food, Agriculture and Fisheries. Journal no. 32101-D-12-00515.

**Figure 1** - Loss of synthetic amino acids in fermented liquid feed, %





**New regulation of livestock and land**

In August 2016, new regulations aimed at livestock production and minimum land area requirements will come into force, as laid down in a comprehensive Growth Plan for the agricultural industry published in April 2014.

It has been a longstanding position of the industry that regulation should be based on the actual level of emissions to nature and the surrounding environment, which corresponds with the EU directive.

Consequently, environmental approvals should be based on emission limits on significant impacts on nature and environment rather than on limits on the number and type of livestock. The use of fertiliser on these areas will also be regulated separately from the livestock approval.

The aim is for owners of livestock production sites to be able, under a number of conditions, to boost production and increase the range of production, without being required to report this or to obtain renewed permission or approval, provided that they comply with emission limits for ammonia, odour and so on.

It is hoped that the outcome will result in more efficient use of pig production sites.

The Growth Plan also introduced a target of a maximum time frame for reviewing of individual livestock approvals of six months from the date when application is made.

**1.4 → 1.7 Danish livestock unit (LU)**

Under the EU Nitrate Directive, farm owners can apply a maximum of 170 kg nitrogen/ hectare/year in the form of livestock manure to land and this corresponds to 1.7 livestock units.

With the Action Plan for the Aquatic Environment II in 1998, Danish politicians agreed to tighten the ‘harmony area’ requirement’ for pigs, poultry and mink animals to 1.4 livestock unit per hectare. Within the EU, this restriction is unique to Denmark.

Danish pig producers cultivate approximately 75% of the ‘harmony area’ themselves and thus need slurry agreements for the remaining 25% of the livestock manure. They will be particularly disadvantaged by the lack of equality with all other EU countries.

The objective is to obtain equality with the EU rules, which allow application of up to 170 kg nitrogen per hectare.

EU equality of ‘harmony requirements’:

- 1.4 LU/ha -> 54.6 pigs/ha
- 1.7 LU/ha -> 66.3 pigs/ha
- +21% pigs for the same area, or
- 18% reduction in ‘harmony area’

Equality with EU rules would thus allow for a 21% increase in the production of finishers with the current ‘harmony

area’. The economy of finisher production would potentially improve resulting from better utilisation of livestock manure, lower transportation costs, lower requirement for purchasing land and reduced fertiliser costs.

**Phosphorus emissions**

Given the 1.7 LU per hectare restriction, standard figures currently allow spreading of up to 41 kg phosphorus per hectare. About 25-28 kg phosphorus/hectare will be removed by crops in good clay soil; this figure will, however, drop significantly in other types of soil.

Special attention must therefore be paid to low-lying land at great risk of phosphorus loss to the aquatic environment and to land that already contains high levels of phosphorus. Future regulation of land is expected to introduce a new phosphorus regulation similar to the current nitrogen standard.

With phosphorus included in the future regulation of land, it will be possible to ensure that the spreading of phosphorus through livestock fertiliser takes into consideration the environmental impact. This will make it possible to spread livestock fertiliser up to 170 kg nitrogen per hectare. Under the current requirement for 1.4 livestock unit per hectare, it is likely that soil phosphorus values will diminish.

**Phosphorus content in soil**

The ploughing layer typically contains 2,000-3,000 kg phosphorus per hectare of which only a small percentage is accessible to crops. It will be years before a deficiency or an excess supply of 10-20 kg phosphorus/year affects the overall phosphorus content. The accessible phosphorus content is measured as the phosphorus value in soil and this is the baseline for determination of the phosphorus requirement of the field. Consequently, an increase or a decrease in phosphorus supply will only slowly affect the phosphorus value, as there is a continuous shift in the balance with low-soluble phosphorus reserves. Soil samples, collected with only a few years’ interval, will be unable to indicate deficiency or excess supply of phosphorus than what was removed by crops, which will take many more years.



## The Technology List

The Pig Research Centre tests new environmental technologies for pig housing with the aim of these being accepted on the Technology List. The Technology List is a list of well-documented and efficient environmental technologies under the Danish Environmental Protection Agency, and is therefore often used by pig advisors and local authority caseworkers as a reference, when preparing and reviewing applications for environmental approvals.

The Technology List is routinely updated. In the summer 2014, three more technologies were accepted on the List: JH Forsuring NH<sub>4</sub><sup>+</sup> for manure acidification; MAC 1.0 for chemical air cleaning; and point extraction ventilation in finisher units.

### JH Forsuring NH<sub>4</sub><sup>+</sup>

JH Forsuring NH<sub>4</sub><sup>+</sup> is a slurry acidification system by Jørgen Hyldgaard Staldservice A/S and it is accepted on the Technology List on account of a 64% reduction in ammonia emissions. This is based on two trials made by the Pig Research Centre in commercial finisher herds. With this system, slurry is discharged daily from the pig house to a processing tank in which concentrated sulphuric acid is added until pH in the slurry has decreased to 5.5. A small amount of the slurry is then discharged to

the slurry tank, and the remaining part of the slurry is returned to the slurry pits in the pig house.

The Pig Research Centre also investigated the effect of the system on odour emissions. However, research showed no significant reduction in odour emissions by acidifying slurry. On average 6.5 kg of sulphuric acid was used per finished pig and electricity for operating the system averaged 1.5 kWh per finished pig.

### MAC 1.0

The chemical air cleaner MAC 1.0 from Munters A/S was accepted on the Technology List with an ammonia reduction of 89%. This was based on two one-year trials made on two different sites with both partial and full air cleaning.

Costs for operating the air cleaner at 60% partial air cleaning amounted to DKK 9.40 per finished pig, and to DKK 17.90 per finished pig for full air cleaning. Odour emissions were not affected.

Munters A/S subsequently launched a version 2.0 of the MAC where the air cleaner is horizontal instead of vertical. It is now possible to pull out the mist eliminator, which makes cleaning easier. The Pig Research Centre is carrying out

further tests to document the efficiency of the MAC 2.0, with the aim of securing acceptance on the Technology List.

### Point extraction

The ventilation principle 'point extraction' is approved for finisher units in combination with air cleaning and is thereby represented on the Technology List. With point extraction, 10% of the maximum ventilation capacity is directed through extraction points located in the slurry pit below the lying areas. This air is directed through an air cleaner, while the remaining part of the ventilation air passes unfiltered through ceiling outlets.

When 'point extraction' is combined with air cleaning, the air that passes through the air cleaner contains higher concentrations of ammonia and odour than that passing through the ceiling outlets. At 10% partial cleaning, the air cleaner is used much more efficiently when combined with 'point extraction'. Additionally, there are savings on installation and operation. For example, using 'point extraction' leads to a 51% reduction in ammonia emissions if combined with an air cleaner with 90% efficiency in ammonia reduction. Correspondingly, a 36% reduction in odour emissions will be possible when combined with an air cleaner with a 70% efficiency in odour reduction. Total costs, including installation and running for the installation of 10% 'point extraction' with air cleaning for 500 Danish livestock units (LU) amount to DKK 7.30 per finished pig.

The Technology List is available at [www.mst.dk](http://www.mst.dk).

### Acidification of slurry by Infarm A/S

The efficiency of acidification of slurry in terms of reducing ammonia emissions is currently being documented with the aim of permanent acceptance on the Technology List. At the time of reporting, this technology has been provisionally accepted but permanent approval is anticipated in 2015.



*JH Forsuring NH<sub>4</sub><sup>+</sup> is accepted on the Technology List with 64% ammonia reduction.*

**Frequent emptying of slurry**

Based on positive research results, the Pig Research Centre has applied for frequent emptying of slurry to be accepted on the Technology List as an odour-reducing technology. Throughout summer 2014, further documentation was compiled, demonstrating the effect under summer conditions.

**Point extraction in farrowing facilities**

For a one-year period, the Pig Research Centre tested 'point extraction' in a farrowing facility that consists of traditional farrowing pens and partly solid floor. Extraction points were placed below the sows' lying area in each pen. The point extraction system ventilated 45 m<sup>3</sup>/hour/sow, which corresponds to around 10% of maximum ventilation capacity.



*Point extraction in a farrowing facility with partly solid floor.*

Results show that the ventilation air that passed through the 'point extraction' system contained 53% and 41% of the ammonia and odour emissions, respectively, from the pig house. This corresponds to the effect found in finisher facilities.

**Ceiling inlets and point extraction**

During summer, additional air intake through ceiling inlets helps improve air flow and this helps to keep the pigs cool-

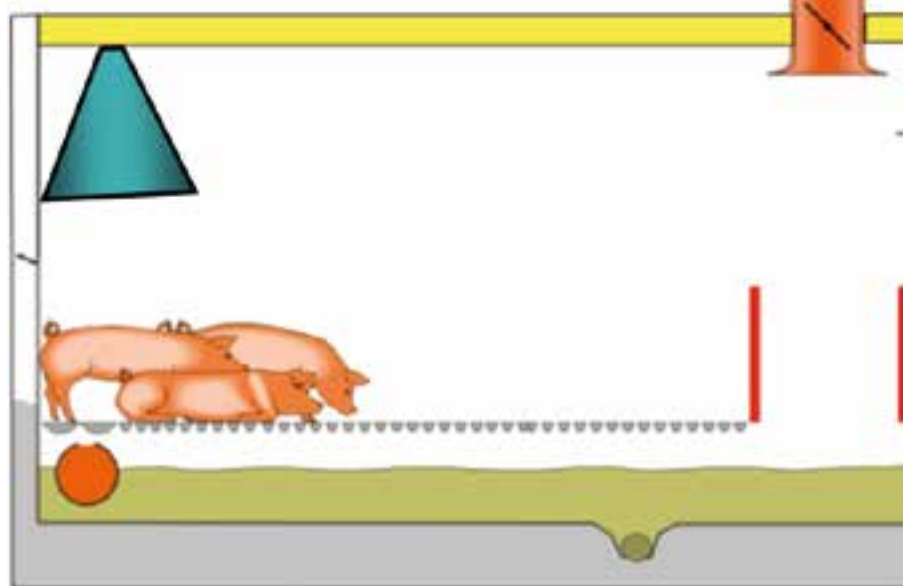
er. However, research shows that ceiling inlets placed just between the dunging area and the activity area adversely affect the 'point extraction' system, because the air flow is led directly below the pigs' lying area where the extraction point is located.

To solve this, the Pig Research Centre tested point extraction in combination with a new design of ceiling inlet. The inlets were kept totally opened and placed by the back wall of the finisher pen. This

are generally higher when air is passed through point extraction. In addition, the air cleaners are dimensioned to 10% of the maximum ventilation capacity of the pig house and will therefore operate on full capacity all year round.

The project received financial support from the Green Development and Demonstration Programme. Journal no. 34009-13-0650.

*Ceiling inlet placed by the back wall held in 100% open position in a finisher facility ventilated via point extraction.*



improved the efficiency of the point extraction, compared to a system where inlets are placed between the boundaries of the dunging area and the activity area.

**Cleaning of point extraction air**

The Pig Research Centre is currently testing whether air cleaners are in fact capable of handling the high concentrations of ammonia and odour contained in the air passing through the point extraction. Ammonia and odour concentrations

**Alkaline for odour reduction**

Research previously revealed that alkaline compounds may reduce odour by binding sulphur compounds in the pig house air. This was tested in a trial where alkaline (NaOH) instead of acid was added to the processing water in the MAC 1.0 chemical air cleaner from Munters A/S. Results from tests undertaken during the summer in two finisher batches indicated an average reduction in odour of 41% and in hydrogen sulphide emission of 53%. The

Pig Research Centre sees many long-term possibilities in adding alkaline in air cleaners for odour reduction. Odour problems are typically most prominent during summer. In theory, a chemical air cleaner may therefore operate with alkaline in the summer for odour reduction and with acid in the winter for reduction of ammonia emissions.

### Separation of slurry

Natural separation of slurry by sedimentation for 1-2 weeks may reduce transport and processing costs of slurry treatment in a biogas system. It may also improve the distribution of phosphorus during slurry application.

The effect of leaving slurry to sediment was investigated in two trials with 'thin' slurry in the summer period and 'thick' slurry in the winter period.

The trial took place within in 3 m high tanks. The bottom fraction constituted 25% of the slurry in the tanks, and the fractions were analysed after standing for 0, 6, 10, 16 and 24 days. Results showed that standing for 6-10 days doubled the dry matter content of the bottom fraction that can be used for biogasification (volatile solids, abbreviated VS). Phosphorus

concentrations increased by approx. 60%. The content of VS and phosphorus did not concentrate further when standing for longer than 6-10 days.

In a weaning-to-finish herd, the period of standing is now being studied in an ante tank of 600 m<sup>3</sup>. The content of VS and nutrients will be analysed in the bottom 35% of the slurry after standing for one and two weeks.

### Acidification and separation

Tests have confirmed that acidification of slurry may reduce ammonia emissions and that separation of dry matter from the slurry may reduce odour emissions. However, a combination of the two technologies has not been tested.

In co-operation with Infarm A/S, the Pig Research Centre investigated and documented odour reduction from the pig house by daily separating dry matter from the slurry as part of the slurry acidification process. The investigation was made at the Pig Research Centre's experimental farm Grønhøj.

Data was compiled for a one-year period, and results revealed a 43% decrease

in odour emissions from the climate chambers where slurry was acidified and separated compared with the control unit, where slurry was not treated. Ammonia emissions were not affected by separation, and so it is therefore possible to combine slurry acidification and separation.

The project received financial support from the EU and the Rural Development Programme under the Danish Ministry of Food, Agriculture and Fisheries in cooperation with Infarm A/S. Journal no. 3663-U-10-00150.

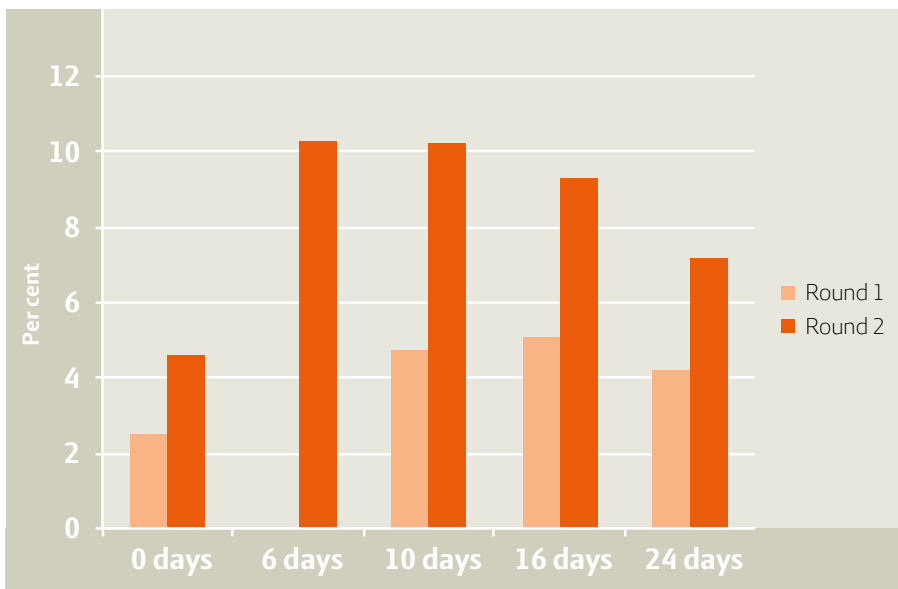
Full-scale investigations of slurry acidification and separation in finisher herds will be launched in 2014/15.

### Chemical analysis of odour

In co-operation with scientists at Aarhus University, olfactometry and chemical odour data were compiled from four finisher herds using different types of environmental technologies. At Aarhus University, scientists have developed a chemometric model for estimation of odour concentration, based on a series of chemical compounds in the air. The aim is to obtain the authorities' acceptance that the odour-reducing effect of environmental technologies can be documented with chemical recordings and not just olfactometry.

The project received financial support from the Green Development and Demonstration Programme. Journal no. 3405-11-0302.

**Figure 1** - Level of biogasification (VS) in the bottom fraction of the slurry after being left to sediment for 0-24 days. Data from one tank (6 days) was discarded in round 1 due to a leak.



### Gilts in groups with sows

Leg injuries and failure to integrate in the group are the two main challenges when grouping gilts and sows.

The Pig Research Centre recently conducted a trial with sows and gilts housed in static and dynamic groups in pens with electronic sow feeding (ESF). For more information, see "Publikationer" at [www.vsp.lf.dk](http://www.vsp.lf.dk) (Trial Report no. 1011).

In the static groups, gilts were transferred to the pen two days before the sows. Observations showed that the gilts used the bedded lying area, until the sows were transferred to the pen and then had to retreat to the activity area. The reason for this may be that there are normally fewer lying areas in pens for static groups than in pens for dynamic groups.

However, this and other trials demonstrate that gilts and young sows are at a great risk of suffering leg injuries, which primarily occur in the first few weeks after grouping.

The current trial revealed no effect of grouping strategy on the percentage of gilts that were inseminated for their second litter. There were no differences in the percentage of pigs that had to be moved to a hospital pen or became lame.

The recommendation to house sows in static groups where they only need to be grouped once and where it is easy for the staff to form a general view of the pen remains.

### Design of lying area

In a herd where gestating sows are fed in ESF, the pros and cons of various designs of sows' lying areas are being studied. The aim is to find a design that minimises dunging in the lying areas.

Preliminary results indicate that sows are discouraged from defecating in the lying area, when the feeding station is placed in the middle of the pen and surrounded by the lying areas or when low lying walls are placed halfway into the lying area.



*Pigs can be discouraged from dunging in the lying area with different methods. Top: Feeding station (ESF) placed in the middle of the pen. Bottom: Low lying walls placed away from the dunging area and halfway into the lying area.*

The lying area walls are approximately 40 cm high; 5 cm thick; and 2 m long, which corresponds to the length of a sow.

### Roughage as supplement

Only few pig producers have experimented with feeding roughage to gestating sows as a supplement to the regular feed allocation.

In 2010, a Working Group under the Danish Ministry of Justice recommended feeding sows roughage five times a day to give the sows a feeling of satiety.

The Pig Research Centre therefore analysed the consumption of different types of roughage and sows' eating habits, when roughage was supplied for 5 hours or 24 hours. For more information, see "Publikationer" at [www.vsp.lf.dk](http://www.vsp.lf.dk) (Report no. 1415).

Estimated consumption of roughage:

- Corn silage (5 hours): 2-2.5 kg/sow
- Wrapped grass (5 hours): 1.2-1.5 kg/sow
- Beet pellets or green pellets (24 hours): 0.3 kg/sow
- Pectin (24 hours): 4.5 kg/sow
- HP pulp (24 hours): 3.1 kg/sow

The percentage of sows eating roughage varied greatly depending on sow age, type of roughage and where roughage was placed.

Recordings show that 75-90% of the sows were observed eating roughage when corn silage or 'wrapped hay' were supplied for 5 hours in the lying area or when beet pellets were supplied in a dispenser for 24 hours.

Roughage consumption was highest in the older sows.

Future trial activities include a comparison of corn silage and beet pellets with no roughage. Straw will be used as bedding in all pens in these trials.



*Sows are fed supplementary roughage in ad lib feeders (beet and green pellets) or on the floor for five hours (corn silage).*

The body condition of the sows, the percentage of sows sham-chewing and culling rates will be recorded for evaluation of the effect on behaviour and production of feeding roughage in terms.

The project received financial support from the EU and the Rural Development Programme under the Danish Ministry of Food, Agriculture and Fisheries. Journal no. 32101-U-12-00197, 32101-U-13-00234 and 32101-U-13-00235.

### AND TECHNOLOGY

#### Radiant heat in the covered creep area

It is assumed that more even distribution of radiant heat than that achieved with traditional heat lamps will improve the immediate environment of the piglets in the covered creep area. The Pig Research Centre therefore compared the following heat sources with the traditional, cone-shaped heat lamp (100 W):

- e-Heat (150 W, curve-controlled)
- Aniheater (150 W and 100 W, respectively, energy saving switch)
- Little Flat (heat panel, 95 W)

All of the above have a rectangular heating surface and a larger spread than a traditional heat lamp.



The Aniheater is placed below the cover (left-hand side). E-heat is installed in the cover (right-hand side).

The trial was conducted in a herd with traditional farrowing crates, partly solid flooring and floor heat in the covered creep areas.

Data was insufficient for statistical analyses, but numerically, there was no clear correlation between piglets' lying behavior in the creep area and source of heat. Consequently, no source of heat could be recommended over another, under the conditions that applied in this trial.

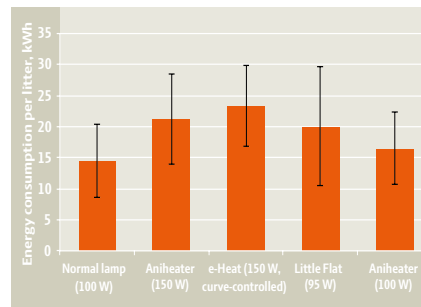
The heat sources were used according to the accompanying 'concept': curve control (e-Heat); "50% reduction in heat" (Aniheater); or on/off (Little Flat). Under practical

conditions, piglets' lying behaviour is the determining indicator of the temperature in the creep area, and was therefore used in this trial to determine when to turn off the radiant heat in the creep.

The traditional heat lamp (cone-shaped) was turned off on day 7 day after farrowing. e-Heat was turned off on day 12 day as recommended in a preset curve. Aniheater 150 W and Aniheater 100 W + LED light were turned off on day 7.5 and 8.5. respectively. Little Flat was turned off on day 9. For all heat sources, the usage of the heat lamp varied by three days, which is not unexpected as heat requirement varies between litters.

The highest demand for electricity was recorded in the new types of heaters, reflecting the number of days the heat lamps were used.

**Figure 1** - Energy consumption of one litter (from farrowing to "lamp off") with different sources of radiant heat in the creep area.



e-Heat and Little Flat were subsequently modified after this trial.

#### Air quality in covered creep areas

On many farms, the front of the covered creep is blocked with a board, with just a small opening for the piglets, in order to contain the heat in the creep area during the first couple of days after farrowing. However, this is assumed to lower the air flow in the creep and thus the air quality in the creep area deteriorates.

The quality of the air in creep areas in a farrowing unit with partly solid flooring

was therefore studied in a pilot study. Carbon dioxide concentrations and temperature in the creep were recorded in the study. The creep area was blocked by a board throughout the first five days after farrowing in the trial group. In addition, a heat lamp (100 W) and floor heat were used in all creep areas in both control and trial groups.

Results showed:

- A marginal increase in the temperature in the creep area of 0.9°C on average, when the entrance was blocked by a board.
- Carbon dioxide concentrations in the creep areas below 3,000 ppm for 80% of the time, which is the CIGR standard, and this is deemed acceptable.
- No significant difference in air quality whether a board was used or not.

Many pig producers use a board even when other sources of heat are installed. In such cases, it may be worth considering whether this in fact improves productivity or whether it simply adds to labour and restricts the supervision of the piglets when they are in the creep.



Creep area covered by a board the first few days post-farrowing. Ventilation in the creep is ensured by an opening between the upper front edge and the board.

#### Free-access, lactating sows

Currently only about 1% of all sows housed indoors in Denmark are loose-housed during lactation. Loose housing in the farrowing unit is associated with increased investments and increased piglet mortality. It is a challenge to balance its

HOUSING

welfare benefit with competitiveness and efficient pig production.

Nevertheless, an increasing number of pig producers opt for farrowing pens which allow sows free-access.



SWAP farrowing pen with sow and piglets.

They choose between pens in which the sow has free movement all the time and pens where the sow can be confined for the first days after farrowing, when piglet mortality peaks. Research shows that in pens where the sow has unlimited free-access, piglet mortality increases by up to 5 percentage points compared with traditional farrowing crates. However, if the sow is confined for the first few days post-farrowing, there is the potential to achieve results comparable with those achieved with traditional farrowing pens. Sows kept in loose-housed farrowing systems demand a high standard of management input.

**Farrowing and the first few days**

The Pig Research Centre and University of Copenhagen investigated the effect of confining the sow the first few days after farrowing on sow welfare. As well as piglet survival rates, records of stress levels and pig behaviour were also recorded. The investigation ran for a year in a herd with an average number of 1,200 sows. The project covered around 2,000 farrowings; parity averaged 2.2 and the total of piglets born averaged 17.8 per litter. The herd had only recently been established, and this was reflected in the parity structure.

The sows were randomly assigned to three groups:

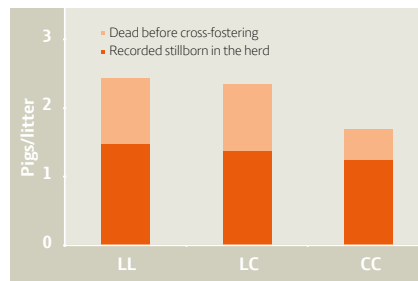
- LL: Loose during farrowing and loose afterwards
- LC: Loose during farrowing and confined until day 4
- CC: Confined from day 114 of gestation and confined until day 4

Cortisol levels were recorded in saliva samples from 48 sows from each group to indicate stress levels. Unexpectedly, preliminary analyses revealed the highest cortisol levels in saliva from loose sows (LL) and lowest levels in saliva from confined sows (CC). The final analysis of the effect of confinement on sows will also include recordings of the sows' pulse and video recordings.

The farrowing progress of the sows in each group was also compared and preliminary analyses indicate no differences in farrowing progress or birth intervals between the three groups.

Preliminary analyses of the producer's recordings revealed 17.7, 18.0 and 17.9 total-born piglets for LL, LC and CC, respectively. Before cross-fostering, piglet mortality was higher for LL sows and LC sows than CC sows.

**Figure 2** - Dead pigs per litter before cross-fostering and the percentage of pigs estimated as stillborn by the pig producer – for sows loose during farrowing (LL) or confined during farrowing (CC)

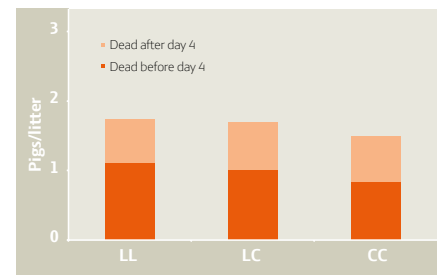


Litters were cross-fostered to make litters up to 13-14 piglets in all groups.

From cross-fostering and 4 days onwards, preliminary analyses revealed the highest piglet mortality in the LL group. From day

4, when all sows were housed loose, no differences were found in piglet mortality between the three groups.

**Figure 3** - Dead pigs per litter after cross-fostering - for sows housed loose all the time during farrowing (LL); confined from birth of last piglet and until day 4 after farrowing (LC); or confined during farrowing and until day 4 (CC).



Around 9,300 piglets died during the trial period and all were subject to post-mortem examination. Stillbirths accounted for 25% and 75% died after birth. Post-mortem examinations revealed that, of the piglets that died after birth, 77% had empty or partly empty stomachs, and 57% were crushed.

**International cooperation**

The Pig Research Centre remain in close contact with interested parties in other countries where market-driven animal welfare is in focus, including development of hospital pens for loose-housed sows as a competitive alternative to traditional farrowing crates.

The project received financial support from the EU and the Rural Development Programme under the Danish Ministry of Food, Agriculture and Fisheries. Journal no. 32101-U-13-00240.

## Growth potential

There is still untapped potential for enhancing growth rates of both weaners and finishers, some of which may be gained by not moving pigs at weaning. In this case, the pigs will not need to adapt to a new environment and they will remain in the same group of littermates as during suckling. This is expected to make the weaning process less stressful and, thus, improve production results, lower use of medication and reduce mortality rates later in life. Multiple activities are focusing on the concept of 'weaning in the farrowing pen' (FIF) to further study the growth potential of weaners and how this might be utilised to the full.

The growth potential of pigs weaned in the farrowing pen was previously investigated and results confirmed that housing is likely to provide the basis for high weight gain. The study was made in two herds. In the one herd, daily gain averaged 556 g in the period 7-30 kg, as recorded in 42 litters weaned in the farrowing facility. Daily gain varied from 240 g to 673 g between litters. In the other herd, daily gain recorded in 112 litters averaged 595 g in the period 7-30 kg varying from 173 g to 954 g. In the herd with the highest gain, the sows were loose-housed during lactation. In comparison, the 2013 national average of daily gain was 441 g in the period 7-30 kg.

## Development of 'weaning in the farrowing pen' (FIF)

To be able to utilise the growth potential of weaned pigs, pens and especially feeding equipment must be developed for and adjusted to accommodate both lactating sows as well as weaned pigs.

Most farmers who practice weaning in the farrowing pen today use a modified version of a traditional farrowing pen with adjustable farrowing rails. However, the aim is that by 2020 in Denmark a minimum of 10% of all lactating sows must be loose-housed. The Pig Research Centre and AcoFunki are therefore co-operating

on further developing the pen for a loose-housed lactating sow with a feeding system that, as far as possible, benefits both the sow and piglets. The aim is to have just one feeder that serves the sow as well as the weaned pigs.

The function of this pen is being evaluated in a herd where eight pens are erected in the shape of a pavilion. In four of these pens, it is possible to crate the sow around farrowing. The trial includes evaluation of pen function and feeding equipment. Results from the first batch show a good pen function and only small amounts of fouling on the solid floor by the lying area wall bordering on the slatted floor.

The feeding equipment used in this new pen is based on a modified version of AcoFunki's tube feeder with a 'pendulum'. The feeder is fitted with a dosing device enabling regulation of feed allocation during lactation. The pendulum can also be dismantled during lactation whereby feed will be released directly into the trough.

## Development of feeding equipment

Previous versions of the FIF pen contained a traditional farrowing pen, adjustable farrowing rails, one feeding system for the sow and another for the weaned pigs. Two systems mean two feeders or troughs and two pipelines for feed, which make the system very expensive. In the past, pens for loose-housed sows used to contain one feeding system for both sow and piglets.

The latter seems to be the best option, even though compromises are made, since no system fully benefits both sow and weaned piglets.

To develop and improve the feeding system, four feeder prototypes are currently being evaluated and subjected to practical testing.

These include AcoFunki's modified tube feeder and modified versions of feeders

from Domino A/S for dry feed and gruel feed, and a tube feeder developed by a pig farmer.

The pilot study and the adjustment phases are complete, and the feeders are now being evaluated in terms of feed wastage on floor, cleaning, settings and blocking.

The project received financial support from the EU and the Rural Development Programme under the Danish Ministry of Food, Agriculture and Fisheries. Journal no. 32101-U-12-00226.



FIF pen with weaned pigs. Wood flour and straw are littered in the solid floor.

## Undocked tails in Finland

Tail docking was prohibited in Finland in 2004. Annually 2.5-3 million pigs are finished in the country.

Finnish pig production is characterised by:

- High health status (no PRRS, Mycoplasma, AP2 and AP5)
- Smaller groups and lower stocking density than in Denmark (0.9 m<sup>2</sup> per finisher)
- Liquid feeding in long troughs
- No routine washing or drying
- Heat in all facilities
- Genetics: LYH or LYD
- Simple, manually operated ventilation systems

Pigs in Finland are accommodated in pens similar to Danish pens. According to Finnish pig advisors, the weaner stage is the most critical period in terms of tail



HOUSING

biting prevention during the subsequent finishing stage. It is absolutely essential, therefore, to prevent tail biting in the weaner stage.

Finnish welfare legislation requires that pigs must have permanent access to straw, chips or similar material. If this requirement cannot be met, the material must be supplied twice daily in amounts substantial enough for the pigs to make two small piles and they must also have permanent access to other materials such as chains or balls.



Typical Finnish finisher pen with liquid feeding. 2/3 drained floor and 1/3 slatted floor.

from tail biting at some point during the growth period and the average was 51%.

The project received financial support from the EU and the Rural Development Programme under the Danish Ministry of Food, Agriculture and Fisheries. Journal no. 32101-U-12-00196.



When pigs were not tail docked, the percentage of tail-bitten pigs increased; antibiotic use increased due to infection; mortality rates increased; and more incidences of tail biting were recorded at slaughter.

**Swedish-type pens**

In Sweden, pigs are not tail docked, and the prevalence of tail biting recorded at slaughter is level with that recorded at Danish slaughterhouses.

Housing of finishers in Sweden differs from that in Denmark in terms of pen design, group size and the use of enrichment materials. These two types of housing are currently being compared using Danish pigs that are not tail docked to establish whether the nature of the accommodation may explain these differences in levels of tail biting.

The project received financial support from the Green Development and Demonstration Programme. Journal no. 34009-14-0830.

**Undocked tails and no tail biting?**

In two herds with a very low prevalence of tail biting behaviour among tail-docked pigs, some groups of pigs with undocked tails were investigated. In herd 1 (single wean-to-finish), the investigation comprised 23 pens and five batches, and 45 pens and 17 batches in herd 2 which had traditional accommodation. In both herds, pigs were given straw on the floor on a daily basis as a preventive measure in the period 7-30 kg.

Herd owners supplied different types of enrichment materials to the pigs, both as a preventive measure against tail biting and when outbreaks of tail biting were observed. In both herds, the prevalence of tail biting increased in pens housing pigs with undocked tails. In herd 2, tail injuries were recorded on every pig in 11 batches. Results revealed that between 20% to 84% of the pigs in a batch had suffered

**Table 1** - Percentage pigs with tail bites per batch in two herds, 7-85 kg

	Batches	Pigs/ batch	0-30 kg		30-60 kg		60-85 kg	
			Av	Min-max	Av	Min-max	Av	Min-max
Herd 1	5	89-111	2.2	0.2 - 6.5	7.8	0-15.6	4	0-6.4
Herd 2	16	69-77	8.2	0 - 28.6	20.3	0- 59.4	7.5	1.4 -18

## DANISH Product Standard

All pig producers who deliver pigs to the co-operative slaughterhouses in Denmark, to private slaughterhouses specialising in export or to those who export weaners to Germany are included in the DANISH scheme. With a DANISH certificate, Danish pig producers are assured of access to important markets where requirements for quality, food safety and traceability are strict.

## Third-party audit

The scheme is managed by a group of representatives from all sectors of the Danish pig industry. In 2014, the contract with auditors Baltic Control was extended by three years. Baltic Control is accredited by DANAK to carry out independent audits in pig herds.

## Focus areas

Around 2,000 DANISH audits and around 1,000 audits in herds operating under a UK contract are carried out annually. All pig producers about to be audited receive an information leaflet beforehand advising them how best to prepare for the audit. In addition, the Pig Research Centre publishes advice in specialist publications when certain aspects of production are given more focus. A complete list of these is available at [www.danish.lf.dk](http://www.danish.lf.dk).

## New technical zero-tolerance

Every year, after the second quarter, results of the audits are subject to detailed quantification. As of January 1, 2014, a new technical zero tolerance was introduced, when auditors must report a pig that ought have been removed to a hospital pen or receive treatment. On all farms, there is a risk that, if a pig becomes so sick or injured that it must be euthanised, this may not be actioned until the next time a staff member enters the pig building. If, in the meantime, the farm is audited, auditors may find a pig that, in ideal circumstances, should have been

removed earlier. A nominal 'zero tolerance' was therefore introduced meaning that, on sow breeding units of up to 1,000 sows/year, the DANISH audit will allow just one sow that ought to have been euthanized earlier and two sows for units above 1,000. Under the zero tolerance regime, weaner and finisher producers are allowed one pig up to 1,000 place units, and one pig for each subsequent 2,000 place units above 1,000.

## Expected drop in non-compliances

In the fourth quarter of the 2013 DANISH audit, 13.1% of the auditors reported pigs that should have been removed to a hospital pen or be treated prior to the audit. After the introduction of the 'zero tolerance' in January 2014, this dropped to 7.8% in the audits in the second quarter of 2014.

This shows that in most cases auditors find just one or very few pigs that ought to have been removed.

In actual numbers, 7.8% corresponds to 127 pigs that should have been removed or treated prior to the audit. Records show that 1,484,450 pigs were audited in the second quarter of 2014, corresponding to 8 in 100,000 pigs that ought to have been moved to a hospital pen or received treatment.

## Improved routines for euthanising pigs

In 4.0% of the DANISH audits undertaken during the second quarter of 2014, auditors reported the numbers of pigs that ought to have been destroyed earlier. In 2013, this figure was 6.0%. Quantifications show that 1,484,450 pigs were audited in the second quarter of 2014; of these, auditors reported 46 pigs that ought to have been destroyed, corresponding to 3 in 100,000 pigs.

## Top 5 non-compliances

The non-compliance that was most frequently reported during the second quarter of 2014 was the use unapproved spray colour, which is a new check point in the standard. This was followed by inaccurate documentation in the treatment log, CHR registrations and tail lengths. These are all areas that can easily be improved without any major additional cost.

1. Spray colour not FDA approved (21.2%)
2. Inaccurate documentation of drug use in treatment log (20.5%)
3. Failure to record all delivery declarations in CHR register (13.4%)
4. Failure to routinely record purchase/sale of weaners in CHR register (12.7%)
5. More than 50% of the pig's tail is docked (10.6%)

Percentage audits where non-compliances were reported in the second quarter of 2014.



The standard is available for download at [www.danish.lf.dk](http://www.danish.lf.dk).

## New Act

A new law requiring loose-housing in the service area came into force on January 1, 2015, for new pig facilities and must be implemented on all facilities by January 1, 2035.

The Act states that

- Sows in the period from weaning until four weeks after insemination, and
- Gilts from transfer to the insemination unit until four weeks after insemination must be housed in large or small groups.

'Empty' sows may be confined for up to three days during oestrus as these sows are particularly vulnerable in the period from weaning to insemination, when they are often mounted and injured by other sows.

Current legislation for group-housed gestating sows will also apply to loose-housing in the service area including space allowances, pen dimensions and flooring.

The Act covers the transition scheme for new facilities built on the basis of either an environmental approval obtained prior to the commencement of the Act or an environmental approval granted after January 1, 2015, following an application submitted to the local authorities before January 1, 2015.

## Campaign

In 2014, the Veterinary Task Force of the Danish Veterinary and Food Administration launched a campaign on provision of rooting and enrichment materials for pigs.

The second stage of the campaign, which took place in September and October 2014, included 100 audits, and all non-compliances found were subjected to sanctions according to the normal procedures.

Audits focused on the amount of material supplied to the pigs, the materials used, such as and the maintenance and suitability of the materials used, bearing in mind that pigs tend to reject dirty materials.

There are many good reasons for pig producers to check that they comply with the regulations on rooting and enrichment materials. Pig producers are advised to pick solid and durable solutions such as "wood in a holding device" or "straw racks". Information on the detailed regulations and possible solutions is available at [www.vsp.lf.dk](http://www.vsp.lf.dk).

## Correct storage of dead pigs

The Danish Veterinary and Food Administration conducted a campaign in September-November 2014 to ensure that pig producers comply with the legislation on storage and disposal of dead pigs.

Auditors checked that:

- Dead pigs were being stored in an appropriate manner. Auditors distinguish between the storage site, collection point, cooling well and freezer.
- The storage facility and its contents were adequately protected from scavengers, using, for example, a lid or a cover.

- The storage site did not pose a risk of transmitting viruses. The collection point was located sufficiently far from the production site and public roads.
- Transport and moving of dead pigs took place in a manner that minimises the risk of transmission of viruses.
- Deadlines for registration of different types of storage facilities were being met.

The campaign was conducted in herds with a minimum of 200 sows and gilts or 1,000 finishers with storage facilities, collection points or cooling wells.

## Sow mortality

Daka's records of sow mortality show that in 2013 the company collected 131,000 dead sows, which was 1,000 fewer than in 2012. This is a small drop in annual sow mortality from 12.8% to 12.7%, which was reflected nationally. The aim was for sow mortality to drop to 11.5%, and a continuing focus on mortality rates is therefore essential.



*In the campaign "Correct storage of dead pigs" auditors' checks include that pig carcasses are secured from scavengers, for example by using a cover shown in this photo.*

The statutory Health Inspection operates with a limit value of 16% mortality rate of sows per year on a rolling average over a 12-month period.

The website [www.soliv.dk](http://www.soliv.dk) offers more advice on how to reduce sow mortality.

### Welfare summit

In March 2014, the Minister for Food, Agriculture and Fisheries of Denmark, Dan Jørgensen, hosted a summit on welfare in the Danish pig industry, at which representatives from Danish agriculture, slaughterhouses, animal welfare organisations, veterinarians and retail participated. The objective of the summit was to discuss “sustainable farming where economy and animal welfare go hand in hand”.

The summit produced a joint declaration of intent. All parties agreed to work towards a significant improvement in animal welfare that benefits both the reputation and growth opportunities of both Danish farming and the food industry. The declaration included the following points:

- **Improved piglet survival.** The industry will work towards an increase in piglet survival of 1 piglet per litter by 2020.
- **Loose-housing of all sows.** The aim is for minimum 10% of all lactating sows to be housed loose in the farrowing unit by 2020.
- **No castration of piglets.** The aim is to cease castration of piglets without anaesthesia by 2018.
- **Reduction in tail docking of piglets.** The percentage of tail docked piglets must decrease significantly.
- **Increased effort to prevent gastric ulcers in sows and finishers.** The prevalence of gastric ulcers must be reduced through, improved health inspection and other measures
- **Animal welfare as an integral part of the project “Månegrís”.** Focus on housing design that benefits animal welfare.

• **Better consumer choice in terms of animal welfare.** Slaughterhouses and retail commit to working towards providing more information and creating more choice for consumers to purchase products from higher welfare production systems.

These are all aims that the Pig Research Centre and the industry have been working on and been aware of for some years. The organisation is also aware that there are no easy and quick solutions to all these challenges. However, the Pig Research Centre supports the declaration and looks forward to its future work on improving the welfare of Danish pigs.



*Summit on animal welfare: The representatives following the signing of the declaration.*



*Straw in a rack is a simple method for supplying rooting and enrichment material to finishers and other categories of pigs.*

### Laboratory for Pig Disease

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

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

SPF Health Inspection mainly submits blood samples each month, for analysis of pleuropneumonia, pneumonia, PRRS and Salmonella. The Laboratory also handles examinations for rhinitis and pig dysentery.

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

Estimated number of examinations carried out in 2014:

- Serological examinations SPF: 270,000
- Salmonella meat juice: 250,000
- Post-mortem examinations: 4,000
- Gastric analyses: 12,500
- Nose swabs: 4,000
- Bacteriological samples: 8,500

The Laboratory participates in numerous research activities in areas such as gastric ulcers, piglet diarrhoea and development of new diagnostic methods, including PCR, for detecting the most common pig diseases.

It is also involved in providing support to practising veterinarians, who contact the Laboratory in connection with matters such as sampling of materials and queries related to laboratory results.

The Laboratory handles routine microbiological analysis of commercial semen from Danish boar stations, in cooperation with Hatting KS and Mors Boar Station. In the



*Veterinarian Svend Haugegaard examines pig lungs.*

past two years, analysis of semen and of sows with return problems has become a significant activity.

The Laboratory routinely collects samples of relevant material for monitoring Classical Swine Fever and African Swine Fever. These samples are analysed at the National Veterinary Institute, when authorised by the Danish Veterinary and Food Administration.

In recent years, the overall activities of the Laboratory have increased by 10% annually.

### SPF Health Inspection

SPF Health Inspection is performed in all breeding and multiplication herds with SPF health status. This involves monthly inspections of the animals in the herd and the collection of blood samples. The blood samples are analysed for presence of antibodies against SPF diseases.

Nationally, around 260 herds are classified as Red SPF Herds. On these farms, inspection also includes appraisal of animal welfare parameters such as shoulder ulcers, tail biting, stocking density and condition of hospital pens.

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

2014 saw an increased threat from new pig diseases spreading closer to Danish

borders. In response, SPF Health Inspection launched a nation-wide biosecurity campaign. The campaign followed the rapid development of African Swine Fever (ASF) in Russia and subsequent spread to the Baltics and Eastern Poland.

Another disease posing a risk to Danish pig producers is Porcine Epidemic Diarrhoea (PED). The disease developed in England in 1970s from where it spread to mainland Europe, with the exception of Scandinavia. In 2010, new, aggressive variants of PED emerged in Asia showing mortality rates of 70-100%, and in 2013 several of these variants were seen in North America. Subsequently, PED variants genetically almost identical to those seen in North America were detected in Germany and Italy.

This need for a biosecurity campaign followed SPF Health Inspection reports indicating that too many Danish pig producers had relaxed their routine procedures in the entry area to the site and on other biosecurity protocols.

A wide range of advisory materials concerning biosecurity routines were produced and published in specialist pig journals and websites, and a series of seminars on biosecurity for Danish pig producers was held in spring 2014.



*Biosecurity seminar.*

### DANISH Safety Wash

In 2013, the Pig Research Centre invested in a wash site for livestock transport vehicles in Padborg near the Danish-German

border. The site is called 'DANISH Safety Wash' and around 20,000 vehicles, used for export of livestock, are washed and disinfected to prevent the introduction of exotic diseases into Denmark. SPF Health Inspection regularly inspects the wash site and carries out microbiological analyses to ensure that vehicles are thoroughly disinfected before leaving the site.



District veterinarian Peter A. Nielsen collects microbiological samples during inspection of washing and disinfection facilities.

In 2014, SPF Health Inspection investigated routines to optimise wash and disinfection procedures to reduce the risk of introducing disease through transport vehicles still further and, at the same time, shorten the current 48-hour quarantine that applies to direct export from a herd. SPF Health Inspection estimates that this is possible, providing a so-called safety wash is carried out. During a safety wash, staff wash vehicles extremely thoroughly in soap and water in a closed garage and subsequently thoroughly disinfect all surfaces. This process takes 2.5-3 hours and must be performed in a closed area to ensure optimum effect of the disinfectant, which is particularly important in winter time. A new safety wash in Padborg is currently being planned.

### Caesarean in SPF pigs

SPF Health Inspection's facilities in Vejen include an operating theatre for perform-

ing C-sections. C-sections are performed on genetically high-value sows from herds infected with an SPF disease. The herd may, in such cases, choose C-section on the best sows to produce SPF-certified pigs.



C-section of a sow for production of primary SPF pigs – performed by veterinarians Vagn Nielsen and Tine Skovby Christensen, the SPF Health Department.

### The SPF Health Department

The SPF Health Department manages the SPF database as well as all declarations and changes of health status. The following diseases are declared by the SPF Health Department:

- Pleuropneumonia (APP)
- Enzootic pneumonia (Myc)
- Swine dysentery
- Rhinitis
- PRRS
- Lice
- Mange

In 2014, records of herds in the SPF system showed

- 260 Red
- 2,830 Blue

The distribution of SPF diseases in mid-2014 is shown in table 1.

**Table 1** - Herds declared negative of the SPF disease, %

Disease	Blue	Red
Lice	100	100
Mange	100	100
Swine dysentery	99.8	100
Rhinitis	98.2	100
APP	83	94
PRRS	63	90
Myc	30	67

In 2014, the SPF Health Department launched a new website compatible with computers, tablets and mobile phones with different operating systems. This provides a high level of functionality for users of the site.

**PED**

Porcine Epidemic Diarrhoea (PED) is caused by a virus. The disease was first seen in England in 1970s and spread from there across most of Europe, but did not arrive in Denmark. In its original form, PED causes mortalities up to 10-20% among piglets. In the last decade, this variant has been seen sporadically in Spain and Italy. Aggressive variants of PED emerged in Asia in 1990s, where close to 100% of all piglets aged 1-10 days die within the first two weeks after the virus is introduced in the sow herd, corresponding to around 1 pig/sow/year.

PED is widespread in the Asian pig industry. The disease is controlled through faecal immunisation of all gilts and sows, and yet it is one of the most significant production diseases in Asia.

In spring 2013, the aggressive Asian variant of PED emerged in the US. The source of the infection remains unknown, but is believed to be feed imported from Asia contaminated with PED or through contact with persons.

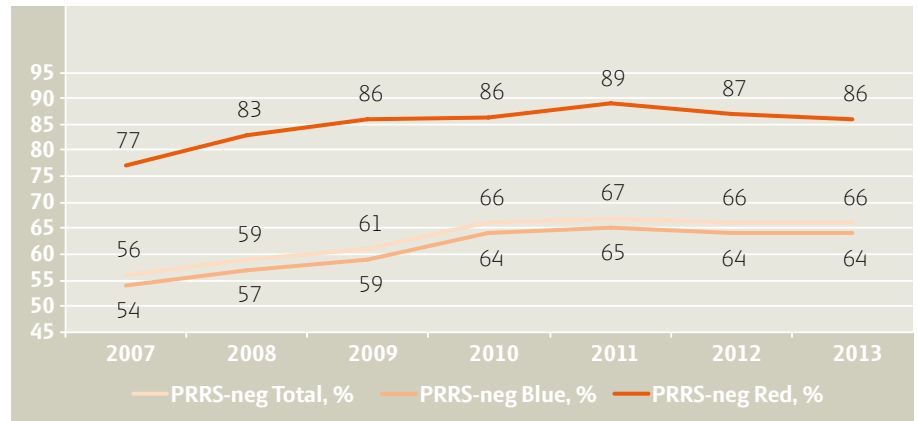
As yet there is no effective vaccine against PED, which, as is the case with all viruses, cannot be treated with antibiotics. The disease is also highly infectious and is therefore virtually impossible to eradicate. It is our joint responsibility to ensure that PED is not introduced to Denmark, and the best way to do this is to ensure compliance with the biosecurity guidelines published at [www.vsp.lf.dk](http://www.vsp.lf.dk).

**PRRS**

Porcine Reproductive and Respiratory Disease (PRRS) is caused by a virus and is one of many challenges faced by Danish pig producers. However, PRRS is being used increasingly as a trade obstacle to the export of pork, and the industry and the Danish authorities have therefore increased the efforts in the fight against the disease.

Records show an increase in the percentage of PRRS-negative herds in Denmark,

**Figure 1** - Development in PRRS-negative SPF herds, %, shown according to Red and Blue herds, and the total number of SPF herds.



Nearly 70% of all sow herds and 64% of all finisher herds are registered in SPF-SuS: of these, around 66% are PRRS negative. Among the Red SPF herds, primarily in breeding and multiplication herds, almost all pigs are PRRS negative. Among the Blue SPF herds (primarily commercial herds), slightly fewer are PRRS negative. Consequently, it is estimated that the overall percentage of PRRS-negative herds is slightly lower than the percentage of herds declared PRRS-negative in the SPF-SuS system. About 65% of all sow herds and 60% of all finisher herds are therefore estimated to be PRRS negative.

Some PRRS-negative herds may be at risk of becoming re-infected with PRRS. Pig producers may therefore wish to have a controlled PRRS infection in the sow unit, enabling all sows to carry antibodies against PRRS, but without the virus invading the herd. It is thereby possible to wean pigs that are free of PRRS virus. These pigs will be exported at a higher price.

Three pig producers each succeeded in producing ten PRRS-free weaner batches, despite the fact that the sow herd was infected with PRRS. All three production units differed in production system, quarantine protocols and PRRS vaccination strategies. This suggests that it should be possible for most pig producers to handle

PRRS in a way that ensures PRRS-free pigs at weaning.

It is a far greater challenge to turn a PRRS-positive finisher herd to a PRRS-negative status. Even if the pig producer purchases PRRS-free pigs, PRRS will circulate between pens and sections, with the result that all pigs will catch the virus at some point. In a trial it was attempted – unsuccessfully – to eradicate PRRS in a finisher herd with the use of a PRRS vaccine. Consequently, the only option remains complete eradication.

**PRRS losses**

New infection with PRRS of a PRRS-negative herd costs DKK 200-500 per sow/year. In PRRS-positive herds, PRRS costs DKK 0-177 per sow/year. Pig producers should prepare a strategy for handling PRRS to minimise losses.

### Post-weaning diarrhoea

Diarrhoea outbreaks among weaners in the third to eighth week post-weaning, a disease previously known as Lawsonia diarrhoea, are one of the main causes of treatment with antibiotics in Danish pig production.

The Pig Research Centre therefore investigated causes, diagnostics, antibiotic treatment and preventive measures for post-weaning diarrhoea in herds with more than 1,000 place units for weaners (Report no. 1406). Results showed that, in 91% of the herds, antibiotics were used for treatment of intestinal disorders and in 86% of these antibiotics were administered in feed or water.

Herd veterinarians in the study generally considered diarrhoea problems as infectious. Lawsonia was the main source of infection, but, in 53% of the herds, results showed that diarrhoea was triggered by a combination of infections. Furthermore, veterinarians believed conditions related to feeding and composition of the feed to

be the primary cause of diarrhoea. In 89% of the herds, a range of preventive measures had been tried including vaccination against Lawsonia, and changes in feed composition and feeding strategy.

The veterinarians' opinion on the factors which triggered the outbreak in each herd was based on clinical signs, post-mortem examinations and laboratory analyses of organs, blood samples and faecal samples. In 51% of the herds, materials were submitted for laboratory analysis.

### Sock swabs

The applicability of using sock swabs for diagnostics was investigated in cooperation with 28 practising veterinarians, University of Copenhagen and the Technical University of Denmark (Report no. 1406).

In this investigation, 103 diarrhoea outbreaks in 43 herds with weaners were analysed using sock swabs, including repeated sock swabs from 2-3 consecutive visits in each herd. The sock swabs were analysed for Lawsonia, E.Coli F4 and

F18 and Brachyspira pilosicoli. Lawsonia was found in 50%, E.coli in 90% and B. pilosicoli in 26% of the infectious diarrhoea outbreaks.

Three repeated sock swabs in the same herd produced the same result in approximately one third of the herds. In addition, in some herds, all three sock swabs revealed that diarrhoea was unlikely to be infectious; in such cases, it is fair to assume that this type of diarrhoea does not require antibiotic treatment. However, the possibility of not initiating antibiotic treatment must be considered carefully in each individual herd. Alternatively more laboratory analyses can be ordered for intestinal infections not included in the sock swab. It is also essential to know that diarrhoea outbreaks arising during the weaner stage may in fact be triggered by infectious agents. Negative sock swabs do not rule out the use of antibiotic for treatment of all types of diarrhoea in a herd.

The investigation confirmed that it may be difficult to decide on the right time to initiate treatment for enteritis based on diarrhoea prevalence. In some herds, some types of diarrhoea that are treated are probably non-infectious, whereas in other herds pigs are under-treated as enteritis does not trigger obvious diarrhoea and may thereby be overlooked. Sock swabs may contribute to help a decision on the optimum time for treating a group of pigs for enteritis and may also be used in connection with the diagnostics required by law when applying group-treatment for enteritis.



*Sock swabs proved efficient in practice, and the use of sock swabs led to changes in treatment strategies and preventive measures in 38% of the herds in this investigation.*

The project received financial support from the Innovation Act and University of Copenhagen and the Technical University of Denmark. Journal no. 3412-08-02226.



## International conference

In 2014, the Pig Research Centre hosted an international conference on gastric health in pigs.



30 participants attended the conference.

The thirty participants included scientists from Norway, Belgium, the Netherlands, Germany and Scotland alongside scientists from University of Copenhagen, Aarhus University and the Technical University of Denmark and representatives from the Danish Veterinary and Food Administration. In the course of two workshops, the participants ranked research efforts within the following areas

- Prevention
- Diagnosis
- Causes and welfare

Key areas included

- Feeding strategies
- Behaviour during feeding
- Common European system for evaluation of gastric index
- Development of diagnostics on the live pig
- A robust pig model for gastric ulcers
- Importance of infections
- Effect on pig welfare, and
- Factors triggering gastric ulcers

The above areas are in line with the discussions which have taken place between the Pig Research Centre, Aarhus University and other organisations. The conference produced an agreement on co-operation with Scottish scientists on behaviour of pigs suffering from gastric ulcers.

## Gastric health at summit

Improvement of gastric health was also on the agenda at the Welfare Summit held in



Rack with 'wrapped hay' for finishers.

March 2014 in Copenhagen. The Danish Minister for Food, Agriculture and Fisheries subsequently presented an action plan for improved pig welfare, which included gastric health as one of the seven target areas.

## Screening of all sow herds

All sow herds with a Health Advisory Agreement will be included in a screening that will cover 90% of all sows in Denmark. It is planned to analyse stomachs from 20-30 sows from each herd. In herds with severe cases of gastric ulcers, an action will be prepared as part of the Health Advisory Agreement; the screening will run from 2014 to 2018.

## Wrapped hay for finishers

The Pig Research Centre are currently analysing data from a study of 'wrapped hay' used as rooting material in finisher pens. Practical experiences with 'wrapped hay' supplied ad lib to sows are positive, and it was therefore decided to investigate the effect on finishers. Results were expected by the end of 2014.

The project received financial support from the EU and the Rural Development Programme under the Danish Ministry of Food, Agriculture and Fisheries. Journal no. 32101-U-13-00237.

## Specialist diets

Many feedstuff producers advertise diets particularly suitable for herds with gastric ulcers. The Pig Research Centre is currently testing the effect on gastric health and productivity of diets from:

- Vestjyllands Andel
- Danish Agro
- DLG
- ATR Landhandel

Results are expected in 2015.

## Feed conversion and gastric health

To improve understanding of the occurrence of gastric ulcers, the Pig Research Centre is currently analysing individual feed conversion of finishers in relation to gastric health. Results are expected in 2015.

The study required new feeding stations and electronic identification of the pigs. Finishers are fed ad lib in these feeding stations, and feed intake and weight are recorded every time a pig visits a station. Thus, it is possible to record the day-by-day development in individual gain and feed conversion.



Open feeding stations for finishers.

## Behaviour and gastric health

In co-operation with scientists from Scotland Rural College and the University of Copenhagen, behavioural studies are being made of pigs when they visit the individual feeding stations. These video recordings will be analysed and compared with gastric examinations at the slaughterhouse.

The project received financial support from the EU and the Rural Development Programme under the Danish Ministry of Food, Agriculture and Fisheries. Journal no. 32101-U-13-00237.

### Reduction in mortality

Significant amounts of knowledge have been generated through a wide range of Danish pig industry research to help reduce mortality rates from the whole period from the pigs' birth to slaughter.

### Risk factors for stillborn piglets

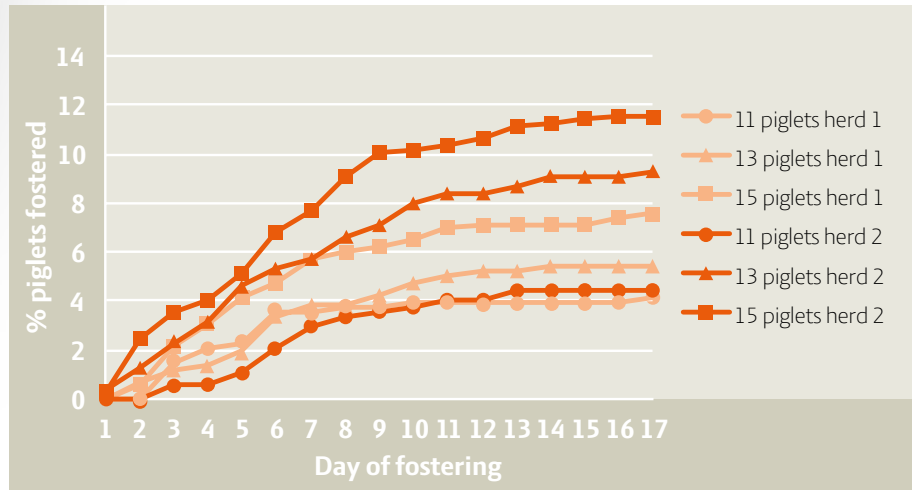
Post-mortem examinations were made on 953 stillborn piglets from nine herds with more than 1.8 stillborn piglets per litter. The examinations demonstrated that, if a sow had previously delivered stillborn piglets in a litter, the risk of it doing so in a subsequent litter increased. It may therefore pay off to keep a closer check on these sows when they farrow. Results also showed that sows with complications during farrowing delivered twice as many stillborn piglets as sows with no complications during farrowing. In addition, piglets that weigh less than 1 kg at birth have a 3-4 times greater risk of being stillborn than piglets that weigh 1-1.5 kg at birth. The percentage of stillborn among piglets that weighed 1-1.5 kg at birth may be up to 40% higher among male piglets than female piglets. The reason for this is unknown.

### Risk factors for piglet mortality

In nine herds, a total of 9,100 liveborn pigs were monitored from their birth to transfer to the finisher unit. The herds in this study had mortality rates above 3% in either the weaner period or the finisher period. All pigs that died were submitted to the Laboratory for Pig Disease in Kjellerup for post-mortem examination where results revealed large variations in the causes of death in the farrowing unit. Reduction in mortality requires identification of the factors causing death in each individual herd, which is obtained by submitting a large number of piglets to the Laboratory for Pig Diseases for post-mortem examination.

In the farrowing unit, 47% of the piglets that weighed below 1 kg died. In comparison, mortality averaged 13% among the piglets that weighed 1-1.5 kg and 7% among the piglets that weighed more

**Figure 1** - Age of runts at fostering (in a trial with 11, 13 or 15 piglets/litter in two herds)



than 1.5 kg. There is a large potential in rescuing piglets that weigh less than 1 kg, but pig producers should concentrate their efforts on the piglets that weigh more than 750 g as piglets smaller than this are unlikely to survive.

Mortality in litters of sows with a complicated farrowing averaged 20% vs 16% in litters where the sow had no complications.

Mortality was 2 percentage points higher among male piglets than female piglets, which is attributed to infections related to castration procedures.

Mortality among piglets born of sows older than third parity was 5 percentage points higher than among piglets born of first parity sows.

Results revealed no influence on piglet mortality of:

- Days in the farrowing pen before farrowing
- Farrowing during weekends
- Administration of oxytocin
- Length of gestation
- Body condition of the sow

In the weaner unit, mortality among pigs with a weaning weight below 5.6 kg was 3

percentage points higher compared with pigs that weighed more than 7.5 kg at weaning. Mortality among pigs that were 60-80 days old at transfer to the finisher unit was 1 percentage point higher in the finisher period compared with pigs that were 90 days old at transfer.

### Runts

Runts or weaker pigs are normally the result of competition for sow milk, but it is unclear why a piglet becomes a runt. Previous research showed that the more piglets that suckle the sow, the higher the percentage of piglets that are subsequently moved. Figure 1 indicates that herd variations in runts per litter are significantly larger than effect of litter size. Most runts are fostered within the first seven days of their lives.

In one trial, runts were identified, ear-tagged, weighed and assessed. A piglet was characterised as a runt either because it was thin or because it failed to approach the udder at milk letdown. The coat may be normal, spiky or greasy. These piglets were monitored until weaning. The smaller the piglet, the greater the risk of the piglet dying after it was moved. The visual assessment provided no indication of the piglet's chance of survival after being moved. However, runts did tend to

have a poorer chance of survival as they did not manage to get to the udder at all. Most sows delivered only one or two runts, which indicates that the problem is mainly attributed to hierarchy fights and not sickness in the sow. The percentage of runts depends on herd and litter size, but generally averages 4-8% per litter. The smaller the piglet, the more attention it needs after being moved. This also applies to piglets that did not try to get to the udder before they were moved.

**Additional milk in the farrowing pen**

Increasing litter size and varying weaning weight make it relevant to investigate whether provision of additional milk may improve survival and litter weight at weaning. Two pilot studies investigated the effect of supplying additional milk in a milk cup placed in the farrowing pen:

- 14 piglets/litter +/- additional milk (Report no. 1408)
- 18 piglets/litter + additional milk, no control group (Report no. 1409)

Systems and dried milk were purchased from 3S.

In the first pilot study, mortality was lower and fewer piglets were moved during the suckling period in the group given additional milk. From the point of cross-fostering mortality averaged 10% in the control group and 5% in the trial group given additional milk. Correspondingly, fewer piglets were moved from the trial group: 13 pigs were weaned per litter in the trial group vs 12 in the group that was offered no additional milk. The trial did not include piglets that weighed less than 800 g.

Data was not sufficient for statistical analysis. The outcome must therefore only be considered as a promising pilot study, and further trial activities have been initiated.

An economic model calculation showed that to obtain the same production economy with additional milk supply piglet mortality must be lowered by approxi-

mately 3 percentage points or utilisation of housing capacity must be improved significantly (Brief no. 1426). If additional milk is supplied systematically, automatic supply is recommended to ensure that the milk is fresh and hygiene is kept at a high level.

Forty litters were included in the second pilot study with 18 piglets/litter and additional milk. From the point of cross-fostering mortality averaged 11%. Piglets weighing less than 800 g were not included in the pilot study. Data was not significant for further analysis, but the result was promising in terms of sows rearing more of their own piglets (Report no. 1409).

The project received financial support from the EU and the Rural Development Programme under the Danish Ministry of Food, Agriculture and Fisheries. Journal no. 32101-U-12-00229.



*Runts need extra attention*



*The level of hygiene was generally high in milk cups supplied with additional milk (3S).*

## Umbilical hernia

Results from a survey completed by 92 pig producers did not indicate any correlation between the prevalence of umbilical hernia and the type of feed used during the pigs' growth period. Home-mixed meal or pelleted feed and liquid feed or dry feed were tested. In addition, there was no indication that straw affects the prevalence of umbilical hernia.

Another investigation demonstrated that ultrasound scanning of pigs weighing 7 kg can be used to map the anatomical and physical conditions in pigs that trigger umbilical hernia at a later point in their life.

A total of 496 female pigs were monitored in this investigation, of which 14 developed umbilical hernia. At weaning, 11 of these were estimated to be at risk of developing umbilical hernia. Three pigs that were not estimated to be at risk of developing umbilical hernia subsequently did develop umbilical hernia. Another 51 pigs were deemed to be at risk of developing umbilical hernia, but did not. In this trial, the prevalence of umbilical hernia averaged 2.8%.

The examination method showed a sensitivity of 0.8 regarding the ability to detect the correct positives of the pigs that did develop umbilical hernia; there

was a specificity of 0.9 regarding the ability to detect the correct negatives of the pigs that did not develop umbilical hernia. These figures demonstrate that the method can be used in practice although it might benefit from further development.

Of the 11 pigs that did develop umbilical hernia, 9 had visible and significant defects around the navel area at weaning. This indicates that in herds with a high prevalence of umbilical hernia, examination of the navel area at weaning may detect the pigs that may at a later point develop umbilical hernia.

Post-mortem examinations of 14 pigs with umbilical hernia revealed intestines in the hernial sac in 8 of these pigs, while encystments of varying sizes were found in the remaining six. These findings indicate that umbilical hernia may be a multifactorial disease.

## Prolific sows

Piglets of sick sows are at increased risk of becoming sick or dying. It is therefore important that sick sows are treated to safeguard their wellbeing as well as that of their piglets.

However, some sows may fail to show symptoms of disease at farrowing, and are

therefore overlooked during the inspection rounds. As a consequence, piglets with these sows may not get the amount of colostrum they need.

Furthermore, many aspects of disease in farrowing sows are still unknown to us, which makes it difficult for farmers and veterinarians to make a diagnosis of sick pigs. In order to be able to lower piglet mortality and antibiotic use in the farrowing unit, more research is therefore needed. It is essential to continue improving diagnosing of sick, farrowing sows.

Early detection of disease will not only improve a pig's chances of survival, but will also shorten prolonged disease outbreaks in many sows and stabilise the milk producing capacity of these sows.

The project focuses on

- Diseases that result in milk deficiency in farrowing sows
- Early symptoms of disease during farrowing and thereby of reduced milk producing capacity

The aim is to develop a practical tool for early diagnosing of diseases that may reduce the milk producing capacity.



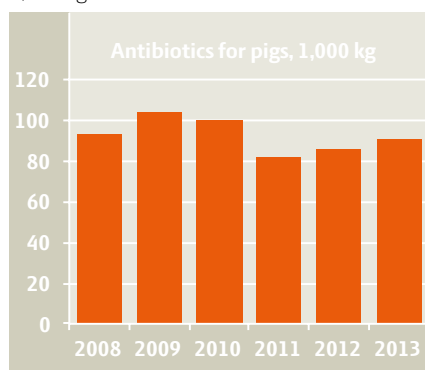
The project has two distinct phases. In the first phase, a small number of sows will be monitored intensively from two days before farrowing to two days post-farrowing. Results from blood samples, milk samples, video recording of sow behaviour will be analysed and a detailed clinical investigation will be made. The study will be conducted in one herd, and the most promising analyses will subsequently be analysed in detail on a large number of pigs in the follow-up work. The project will take place in co-operation with Swedish University of Agricultural Sciences and the University of Copenhagen.

*Ultrasound of the navel area of a 7 kg female piglet.*

**Yellow Card**

In the period 2009-2013, Danish pig producers and veterinarians managed to reduce antibiotic use by 13%. By 2013, antibiotic use had dropped to a level lower than that of 2008.

**Figure 1** - Antibiotic use in pig production, 1,000 kg



In 2014, the Yellow Card Scheme was tightened, and the calculation of animal daily dose (ADD) was adjusted and new regulations on diagnostics applying to group-treatment against intestinal disorders and respiratory disorders were introduced.

**Table 1** - Limit values

Yellow Card, ADD per 100 pigs/day	Sows	Finish-ers	Wean-ers
01.12.10	5.2	8.0	28.0
01.06.13	5.0	7.0	25.0
01.12.14	4.3	5.9	22.9

**Diagnostics before group-treatment**

Samples must be submitted for microbiological cultivation or PCR testing (polymerase chain reaction). The Laboratory for Pig Disease is accredited to perform microbiological cultivations. In this respect, the sock sampling method presents a new possibility for analysis of faecal samples using a PCR test. This includes testing for Lawsonia, B. pilosicoli, and E. coli F4 and F18 that are all known to trigger intestinal

disease. The method was developed and tested by the University of Copenhagen, The Danish Technical University and the Pig Research Centre.

**Renewed focus on E.coli resistance**

Analyses of bacteria resistance patterns are essential to be able to administer the most efficient antibiotic treatment of a given disease in a herd. For E.coli, such analyses were typically made by cultivating faecal samples or intestinal samples from one or more piglets. The Pig Research Centre is currently investigating if sock samples can be used for resistance analysis in relation to group-treatment.



*Faecal samples are collected with a cover-boot.*

**Pig weights**

To administer the correct dose of antibiotic, it is necessary to know how much the pig weighs. Brief no. 1341 from the Pig Research Centre demonstrates a range of typical growth patterns for weaners. The best method is to weigh the pigs in two pens representative of that stage of production and thus determine the weight of the pigs in the section where group-treatment is required.

**What does a difference of 2 kg mean?**

Example: The pigs are estimated to weigh 15 kg, but they do in fact weigh 13 kg. The result is a faulty estimate of 600 kg in a section with 300 pigs. The result is 15% overdosing.

**Group-treatment through water**

Several research projects undertaken by the Pig Research Centre have focused on

efficient group-treatment. In order to summarise the conclusions of these projects, a list was made of different water-piping installations and the various pros and cons of these. The overall challenge lies in ensuring a high level of flexibility when using one or more types of antibiotic in any specific production stage. Another challenge is to ensure that no medicine solution is left in the pipelines when there is no water flow. In addition, the list includes requirements for high-quality drinking water and for how to prevent reflux from the premises. It is important that all pig producers familiarise themselves with these key issues.

**Treatment of weaners through water**

The outcome of a study made by the Pig Research Centre demonstrated that it is possible to treat a group of weaners through the drinking water if they are fed dry feed. However, if liquid feed is being used, weaners drink too little for treatment via water to be efficient.

**Liquid feed**

The Pig Research Centre investigated the efficiency of the medicator Medliq® for dosing of medication in liquid feed via the downpipes in sections with double pens (Report no. 1405). The dosing accuracy of the medicator was good, but filling and cleaning the containers was very time-consuming. The system also required a degree of maintenance to maintain sufficient accuracy.

The project received financial support from the EU and the Rural Development Programme under the Danish Ministry of Food, Agriculture and Fisheries. Journal no. 3663-D-10-00459.

**New stock solution every day**

In co-operation with the University of Copenhagen, the Pig Research Centre investigated the solubility and stability of different antibiotics during periods of standing. Solubility was good in both cold tap water and tepid water. A few types of antibiotics lost some of their effect after standing for



A new stock solution must be made on a daily basis if antibiotics are administered through a medicator.

four days. Consequently, it is recommended that a new stock solution should be freshly mixed for the medicator on a daily basis. This also ensures the early detection of any inaccurate settings of the medicator.

The project received financial support from the EU and the Rural Development Programme under the Danish Ministry of Food, Agriculture and Fisheries. Journal no. 3663-D-10-00459.

### Questionnaire on antibiotic use

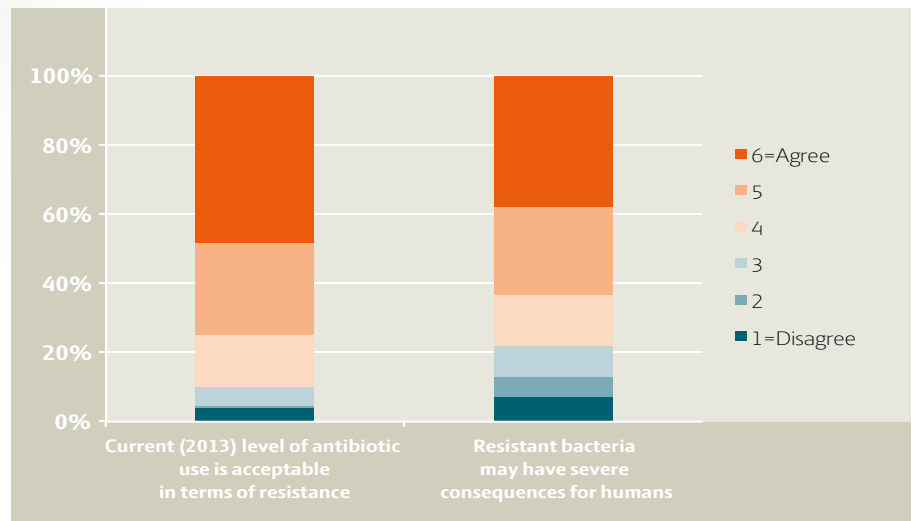
In December 2013, a comprehensive questionnaire was sent to 600 pig producers asking them for their opinion, knowledge and routine details related to antibiotic use. 263 pig producers responded (44%); the typical respondent was male (97%), 48 years old who had worked with pigs for 27 years. Three of four responded that the current level of antibiotic use was sensible in terms of any risk of resistance (see figure 2). The questionnaire forms part of the international project MINApig.

The majority (63%) almost or fully agreed that the development resistant bacteria has severe consequences for humans.

The respondents showed extensive knowledge on topics that are part of the curriculum at the agricultural schools. On average 77% of respondents provided

ing high levels of hygiene when leaving pig farms, in order to limit the transmission of MRSA to the surrounding environment. The project is led by Statens Serum Insti-

**Figure 2** - Percentage distribution of replies to two questions.



correct answers to 18 statements about antibiotics.

The project received financial support from ERA-NET and Green Development and Demonstration Programme. Journal no. 3405-11-0435.

### MRSA

MRSA is the name of a series of staphylococcus bacteria that are resistant to some, but not all, types of antibiotics. A special, animal-related, type of MRSA called CC398 was estimated by experts in autumn 2014 to be present in 30-50% of all Danish pig herds. In other countries this type is also found in horses, calves and dogs. Advisory literature was therefore prepared for all who regularly come into contact with live pigs. This material is available for the National MRSA Advisory Service, recently established under Statens Serum Institut. In addition, the Pig Research Centre participates in a comprehensive research project aimed at underlining the importance of maintain-

tut and also includes representatives from the University of Copenhagen and the National Research Centre for the Working Environment. The project is financed by the Danish Veterinary and Food Administration and the Pig Research Centre.

A survey made in 2013 among more than 250 pig producers showed that Danish pig producers are generally well-informed on MRSA:

- 64% know that MRSA bacteria transmit from pigs to humans
- 70% know that MRSA bacteria are resistant to a wide range of antibiotics
- 81% know that humans or pigs that carry MRSA bacteria are not necessarily sick.

The project received financial support from the EU and the Rural Development Programme under the Danish Ministry of Food, Agriculture and Fisheries. Journal no. 3663-D-10-00459.

### A widespread infection

Pleuropneumonia is a disease that causes significant losses, particularly among finishers. In 2014, the Pig Research Centre conducted several investigations to increase knowledge of how to prevent and detect the disease.

Pleuropneumonia:

- Impairs growth and feed conversion efficiency
- May cause disease and death among the pigs
- Is caused by a bacterium (*A. pleuropneumoniae*)
- There are several types of the bacterium (serotypes)

### Eradication

In 9 chronically infected sow herds, attempts were made to eradicate the infection through short-term, heavy medication with a fluroquinolone antibiotic. Eradication with fluroquinolones is not generally permitted in Denmark, but permission was granted specifically for this trial by the Danish Health and Medicines Authority.

The herds were subsequently monitored for a year to establish whether eradication had been successful and to investigate the effect of the treatment on the presence of resistant bacteria on the farms. In addition, mortality and drug use patterns were studied.

At the time of reporting, the one-year follow-up period had not been completed in all 9 herds. However, preliminary results indicated that eradication was successful in 6 of the 9 herds. Results concerning antibiotic resistance are not yet available. Once available, the results will be incorporated in the authorities' assessment of whether to allow the use of fluroquinolones for eradication purposes.

The project received financial support from the EU and the Rural Development Programme under the Danish Ministry of Food, Agriculture and Fisheries. Journal no. 3663-D-10-00459.



*In 9 sow herds, attempts to eradicate pleuropneumonia through short-term medication took place in combination with vaccination and temporary cessation of farrowing over a four-week-period.*

### Vaccination trials

Two of the vaccines available in Denmark for prevention of pleuropneumonia are currently being tested in a finisher herd where vaccinated pigs are compared with non-vaccinated control pigs. By analysing the effect of the vaccines on FCE and daily gain, it will be possible to evaluate the economic benefit of vaccinating pigs. An investigation of this kind has not been previously undertaken in Denmark. Results are expected in 2015.

### Vaccine development

The vaccines used against pleuropneumonia in pigs today are administered through intramuscular injection. It is assumed that the efficiency of the vaccines may be enhanced if they were administered as spray in the pigs' nose and the pigs would inhale it. This would establish a local immunity in the lungs. Scientists at University of

Copenhagen are currently working on the development of this type of vaccine. The Pig Research Centre participated in the preliminary discussions, and, provided that the project is a success will test the vaccine in a commercial herd.

### Ultra-sound scanning of lungs

A project investigated whether ultra-sound scanning of lungs may be used for estimating the extent of pneumonia in pigs. Normally, the extent of pneumonia is evaluated by examination of the lungs from euthanised or slaughtered pigs, and a reliable method for use on live pigs would therefore be a great advantage.

However, a test scanning made in one herd revealed that scanning of the whole lung is not possible as the front part is hidden behind the scapula. The rear part of the lung was scanned without problems, and the method is therefore applicable only for detecting pleuropneumonia, which is typically found in the rear part of the lungs. Consequently, other types of pneumonia that are primarily found in the front part of the lung will not be detected during a scanning. For this method to be used in practice, further analyses of the accuracy are required. This study was a part of a master's project at the University of Copenhagen.

Improving the efficiency of growing pigs is an area of continuous focus for pig producers and advisors. The Pig Research Centre routinely investigates tools for helping producers and advisors exploit the potential of their pigs.

### Weighing of pigs

Many pig producers routinely weigh the finishers in their herd. The Pig Research Centre has developed a spreadsheet in which the pig producer can enter data on daily gain and feed conversion efficiency and convert these data to tables or graphs. However, in many herds, the manual task of weighing pigs presents a practical challenge that could be eased if automatic weighing were a possibility.

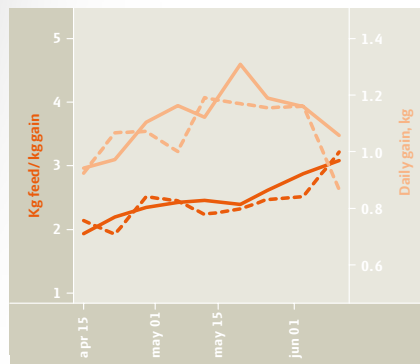
The Pig Research Centre tested an automatic weigher (Pigscale) manufactured by Schippers for weighing finishing pigs. Results showed satisfactory accuracy, but also some technical challenges. One of these challenges was the price. The device retailed at DKK 30,000 which for a weigher for just a single pen is a somewhat expensive solution compared to using a weigh bridge that weighs several pens. Whilst daily gain is important, it is feed conversion that really generates profitability. In herds with liquid feeding, the amount fed can be read directly on the computer, but this is not possible in herds using dry feed. The Pig Research Centre therefore investigated a hopper scale from the manufacturer "Tørfoder-specialisten". The hopper scale cost DKK 9,000 and provided a fairly easy method for recording the current feed conversion of a pen. The Pig Research Centre closely follows the technical developments in this area, including the possibility for using cameras for estimating the weight of pigs.

### New software

Agrosoft and the Pig Research Centre are in the process of developing new software for online surveillance of production efficiency.

This software gathers information from feed scales, water meters, weights and

**Figure 1** - Daily gain and feed consumption in two batches of pigs.



thermometers to monitor the development of feed consumption for a batch of pigs and other factors. The Pig Research Centre will now investigate the best way to make use of these recordings for troubleshooting and optimising the production system.

However, such a system also presents a series of challenges, particularly relating to the accuracy of recording.

### PIGIT

In the PIGIT project, the Pig Research Centre, Aarhus University and the University of Copenhagen are investigating the possibility for using new technologies to monitor pig growth and behaviour. This includes using cameras for estimating the weight of pigs and predicting impending outbreaks of tail biting through changes in drinking patterns.

### Surveillance and recording

Individual identification of pigs is primarily relevant in sow units. The Pig Research Centre has tested technologies for electronic ID in outdoor production units with a positive outcome. Individual identification is expected to become a commonly used technology in the near future.

Individual ID of growing pigs is currently being used in trials at the Pig Research Centre's experimental station Grønhøj, where feed consumption is now being recorded for each individual pig. Preliminary results show that there is still much scope for exploiting the full potential of growing pigs.



Equipment for recording of feed consumption of a single pig.



### Feeding of piglets

A study undertaken in an organic herd concluded that weaning weight of organic weaners increased by up to 1 kg per pig when they were fed from dry feeders from two weeks of age until weaning.

In this study, dry feeders that were placed on a pallet in a farrowing paddock with one feeder for each 4 farrowing paddocks were compared with feeding in farrowing huts positioned along the tracks.



Feeding principle tested for feeding of organic piglets.

The increase in weaning weight is likely attributed to the fact that the feeders were placed at central points in the farrowing paddocks and that the pigs – due to curiosity and social behaviour – were attracted to the feeders when other pigs eat, which is not the case when pigs are fed in farrowing huts.

The study revealed that:

- The feeders must be waterproof to prevent blocking
- The feeders must be located in the pigs' activity areas, preferably close to the sow's feed and close to a water source
- The feeding area must be covered so that the pigs can seek shelter from the rain while they eat, as this may increase feed intake.

The theory, that larger and stronger pigs at weaning have improved health and a higher weight gain post-weaning, is currently being further investigated.

### Guidelines for farrowing paddocks

In cooperation with the Knowledge Centre for Agriculture and the organisation "Udviklingscenter for Husdyr på Friland", the Pig Research Centre developed a set of guidelines for use in the farrowing paddock.

The aim was for the guidelines to serve as a management tool that would significantly help decrease piglet mortality in outdoor pig production and thus increase the number of weaned pigs.

The guidelines include recommendations for management in the period from when the farrowing paddock is first established and until pigs are weaned.

The guidelines are available for downloading from the website at [www.vsp.lf.dk](http://www.vsp.lf.dk) and the authors.



The guidelines include fact sheets on, among other things, tasks at hand.

### Electronic ear tags

In outdoor pig production, the distance between the person reading and the pig itself and also the incidence of soiled ear tags often results in inaccurate reading of sow ID and thus errors in the production reports. In addition, it is a time-consuming task for the staff. The Pig Research Centre

has therefore tested different types of ear tags and automated readers of ear tags to find an electronic solution to these challenges.

The optimum solution was found to be the kind of ear tag that is today used in indoor gestation pens with electronic sow feeding. Sow ID is read either with portable PDA running Pocketpigs or with a stick reader that may provide accurate readings over long distances in the farrowing paddock

The conclusion regarding the suitability of electronic identification was clear-cut: Reading is much faster and accurate and the percentage of inaccurate readings drops drastically.

The study was made in two large sow herds, and after the study finished both pig producers chose to continue using electronic identification of sows.



A stick reader is used for reading sow ID.

The project received financial support from the Green Development and Demonstration Programme. Journal no. 34009-12-0446.

## Reports

- No.1318: Only small variations in nutrient content of wheat and rye produced on-farm
- No.1319: Corn silage in dry feed
- No.1320: Neo-natal diarrhoea in Denmark 2013
- No.1321: Frequent emptying of slurry on finisher farms – effect on odour emission
- No.1322: Accurate analyses of iodine value
- No.1323: Farrowing fields – management routines
- No.1324: Heat in slatted floor during farrowing reduces piglet mortality in traditional farrowing pens
- No.1401: New pen elements for traditional pens
- No.1402: Antibiotic supplied in dry and liquid feed
- No.1403: Test of straw racks for finishers
- No.1404: 3 PPRS-stable sow batches each delivered 10 batches of PPRS-free weaners
- No.1405: Satisfactory dosing accuracy with Medliq®
- No.1406: Sock swabs provide useful information on diarrhoea in weaners
- No.1407: Product test of Pig Scale for weighing of finishers
- No.1408: Additional milk in farrowing pens with 14 piglets/litter
- No.1409: Additional milk in farrowing pens with 18 piglets/litter

## Trial reports

- No.982: Importance of PRRS for antibiotic use and health
- No.983: Effect of straw on pen mate-directed behaviour among finishers
- No.984: Economy of producing entire males – two farms
- No.985: Estimated costs related to PRRS in Denmark
- No.986: Correlation between gastric changes and respiratory disorders in finishers
- No.987: Gastric analysis of culled sows reflects gastric health of the entire herd
- No.988: Split suckling of newborn piglets
- No.989: Grain for 4 days before slaughter lowers skatole in entire males
- No.990: New Mycoplasma hyosynoviae vaccine fails to prevent lameness
- No.991: Test of 3 backfat meters for sows
- No.992: Gastric ulcers may develop and heal within a few weeks
- No.993: Digestibility of soy and rapeseed products in weaners
- No.994: Correlation between mounting activity and development of leg problems in insemination units with group-housing
- No.995: Enzymes do not impact the negative effect of rye on gain in finishers
- No.996: Screening of entire males
- No.997: Free valine and tryptophan in mineral supplements
- No.998: 10% point extraction through suction point below the lying area in finisher unit with drained floor in the lying area
- No.999: 10% point extraction through suction point below every other pen partition in finisher unit with drained floor in the lying area
- No.1000: 10% point extraction through suction point below the lying area in finisher unit with solid floor in the lying area
- No.1001: Gestating gilts and sows must be fed according to body condition the first 4 weeks after insemination
- No.1002: Horse beans for weaners improve productivity
- No.1003: Commercial diets for weaners – Jutland 2013/14
- No.1004: Variations in accuracy between 3 different brands of liquid feeding systems
- No.1005: New neo-natal diarrhoea – pathology and microbiology in 4 herds
- No.1006: Effect of chemical air cleaner from Munters A/S in a finisher unit with full air cleaning
- No.1007: New neo-natal diarrhoea – what does it look like and how does it affect the pigs?
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