



SEGES Pig Research Centre

ANNUAL REPORT 2015

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European Agricultural Fund for Rural Development:
Denmark and Europe invest in rural development

Ministry of Food, Agriculture
and Fisheries of Denmark



See European Agricultural Fund for Rural Development

introduction

THE YEAR 2015



Profits under pressure

The average Danish pig producer has only for brief periods been able to produce a profit from producing pigs. This is the harsh reality that have now persisted for some years.

The forecast bonanza in 2014 never happened because of the Russian import ban, and the situation did not improve in 2015.

We still have economic gaps to fill, and with a negative liquidity many pig producers still need to borrow money for the daily operation of their business. Hopefully, pig prices will increase in the years ahead. Within Europe pig production is currently falling and this will increase the chances of upgrading the forecasts rather than the opposite.

Competitive advantage

The pig price in Denmark averages DKK 10.80. This indicates that, in Europe, Danish pig producers are still competitive. Fortunately, the Danish pig production industry possesses a number of strengths that will help maintain pig production in the next two decades. Our slaughterhouses have also regained their competitive edge, and that is essential in keeping us ahead of our competitors. In terms of efficiency, Danish pig producers are also at the highest end, and, through our co-operative system, we are able to find solutions that will keep ahead.

The total value of efficiency improvements and the increase in slaughter weight over the last ten years amounts to DKK 128 per finished pig. An annual increase of 0.6 weaned pigs per sow/year is the most striking feature of this progress, which is reflected in a national average of 30.6 pigs per sow/year. The 25% best herds wean 33 pigs per sow/year and the most ambitious now have their eyes on a level of 40.

Better business environment on the way

We look forward to the Danish government breaking away from a political mindset that it is acceptable for the Danish business environment to be tougher than that experienced by our competitors. In particular, we are challenged by over-stringent environmental constraints which need amending. The current restrictions on fertiliser application once again led to a disastrously low protein content in the grain harvested in 2015. The 'harmony requirement' for finishing pigs should be raised from 1.4 to 1.7 livestock units per hectare, and future environmental approvals must treat facilities and land as separate entities. In the last ten years, an average production site in Denmark has improved its efficiency by increasing the production of pigs by 10% but with lower nitrogen emissions per pig place. The scheme for reporting changes is a huge step in the right direction, and, within the new rules, pig producers can increase their annual production by up to 600,000 finished pigs in existing units. Danish pig producers need to be able to build new, large, modern pig facilities. To be competitive in Denmark, pig farmers need to be able to exploit the advantages of large-scale production.

Low investments

Since 2009, less than a fifth of the finisher units necessary to maintain the current production level are new facilities, and there is no indication that this is about to change. Consequently, pig slaughterings have fallen by 3.7 million pigs in Denmark and the export of weaners has risen.

This structural development may make sense to the 'man in the street', but it represents the wrong direction for both the industry

and for the Danish economy as a whole. It increases the vulnerability of the sector. We are faced with higher risk of importing disease, and can no longer control the production chain of the pigs that are exported.

Now the basis has been established for a modernising scheme that will partly replace the current environmental support under the EU Rural Development Programme that may move things in a more positive direction.

Antibiotics and animal welfare

Despite the increase in production from 22 to 32 million weaners in the last 15 years, antibiotic use has not increased. From 2013 to 2014, antibiotic use dropped by 5.6% and records show a 9.1% drop in the first half of 2015. MRSA was found in three out of four of 4 herds in a screening programme undertaken last winter. Given this level of incidence, eradication is simply not realistic or economically viable. We need to increase our attention to matters of hygiene and biosecurity both within the farm-gate and beyond. We can demonstrate a responsible approach and undertake to meet the targets set. A report from the Knowledge Centre for Animal Welfare reveals a significant improvement in animal welfare levels in the Danish pig herds, and this is confirmed in our own DANISH audits.

DanAvl

In recent years, DanAvl has developed increased exports of breeding stock and semen, and it is our ambition to strengthen this even further. The international demand for our products says a great deal about the high quality of Danish genetics.

African Swine Fever

African Swine Fever is now an everyday occurrence among wild boars close to the Russian border, and it would take just one act of carelessness to create a catastrophe that would result from the disease entering Denmark. We all have responsibilities and must take every precaution possible. In particular, pig producers must be scrupulous regarding all biosecurity protocols including those relating to wash certificates, overseas staff on the farm and hunting trophies. It is in our common interest to protect the country from all exotic pig diseases.

Our competitive edge

We are certain that within Denmark demand for pig meat will continue to rise. However, this does not have to be supplied from pork produced in Denmark. Experience shows that, if an industry is profitable, investments will follow. Our competitive advantage can be maintained. We have every opportunity to stay at the top in terms of efficiency, and it makes good business sense to do so. The pig industry generated around DKK 30 billion in exports but a more favourable business environment is crucial for the future.

Thank you for your support

The work of SEGES Pig Research Centre is based on close co-operation between pig producers, breeders and multipliers, pig advisors, veterinarians, commercial suppliers, universities and the authorities. Together we will succeed with the task ahead in maintaining our competitive edge.

Best regards,
Erik Larsen and Claus Fertin
SEGES Pig Research Centre



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CONTENTS

	Page
Strategy, organisation and activities	4-5
STATISTICS	
Structural development	6
Modernisation of finisher units	7
Development in productivity	8
Increase in productivity	9
Production economy	10
InterPIG	11
GENETICS	
New Danavil strategy	13
Genetic progress and sales	14-15
Genetic research and development	16-19
NUTRITION	
Nutrient standards and feedstuffs table	20
Feed quality	21
Feeding of weaners and finishers	22-24
Feeding of sows	25-27
ENVIRONMENT	
Environmental regulation	28
Climate and ventilation in pig houses	29
Environmental technology	30-31
HOUSING	
Weaner and finisher facilities	33-34
Pens for insemination and gestating sows	35
Farrowing and lactation	36-37
WELFARE	
Animal welfare, action plans and audits	38
DANISH	39
Mortality and daily gain	40
HEALTH	
Serious pig diseases	41
Biosecurity and safety wash	42
Laboratory for Pig Disease	43
SPF Health Inspection, SPF Health Department and Service Check	44-45
AI semen control – 'returners' and hygiene during insemination	46
Antibiotics for treating pigs	47
Vaccination	48
MRSA	49
Chlamydia og leptospirosis	50
Gastric health	51
PRODUCTION MANAGEMENT	
Campaign: 'Pattegriseliv'	52
Project: 30 feed units less	53
'The Pig Academy'	54
INFORMATION	
Published results 2014-15	55-56
Subject index	57

STRATEGY, ORGANISATION AND ACTIVITIES

SEGES Pig Research Centre

On January 1, 2015, the Danish Pig Research Centre and the Knowledge Centre for Agriculture merged and into a new company, SEGES.

The Danish Pig Research Centre is now known as SEGES Pig Research Centre.

Within the agreement, the research priorities of SEGES Pig Research Centre will still be decided by a Sector Board, comprising twelve pig producers.

It was also agreed that any profit or deficit of SEGES Pig Research Centre will be managed through a development account that is at the disposal of the board of the Pig Research Centre. This means that the anticipated income from the increasing international sales of DanAvl breeding stock may be returned to the Danish pig producers.

Budget and economy

The primary activities in SEGES Pig Research Centre are funded by the joint payment from Danish pig producers of around DKK 130 million or DKK 4 per pig. This originates from DanAvl fees and the Pig Levy Fund.

SEGES Pig Research Centre also handles a range of commercial activities, including the

Laboratory for Pig Diseases and SPF Health Inspection.

A 2014 audit of the projects in which SEGES Pig Research Centre received financial support from the European Agricultural Fund for Rural Development and the Danish Ministry of Food, Fisheries and Agriculture revealed non-compliance with a number of formal requirements. It should be stressed that not a single example was found where funds had been used for anything other than scientific activities.

This audit was a comprehensive examination of projects dating back years, checking compliance between the following project documentation:

- Application
- Implementation
- Accounts
- Final report

If non-compliances were revealed, funds must be repaid together with a fine. Regrettably, these costs have amounted to around DKK 60 million, mainly including legal and accountancy charges, with the result that the payment of an annual bonus to Danish pig producers was not possible in 2014 and 2015 but, hopefully, this will be re-instated in 2016.

Strategy

SEGES 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

SEGES Pig Research Centre's primary activities are to create value for Danish pig producers and strengthen the Danish pig industry.

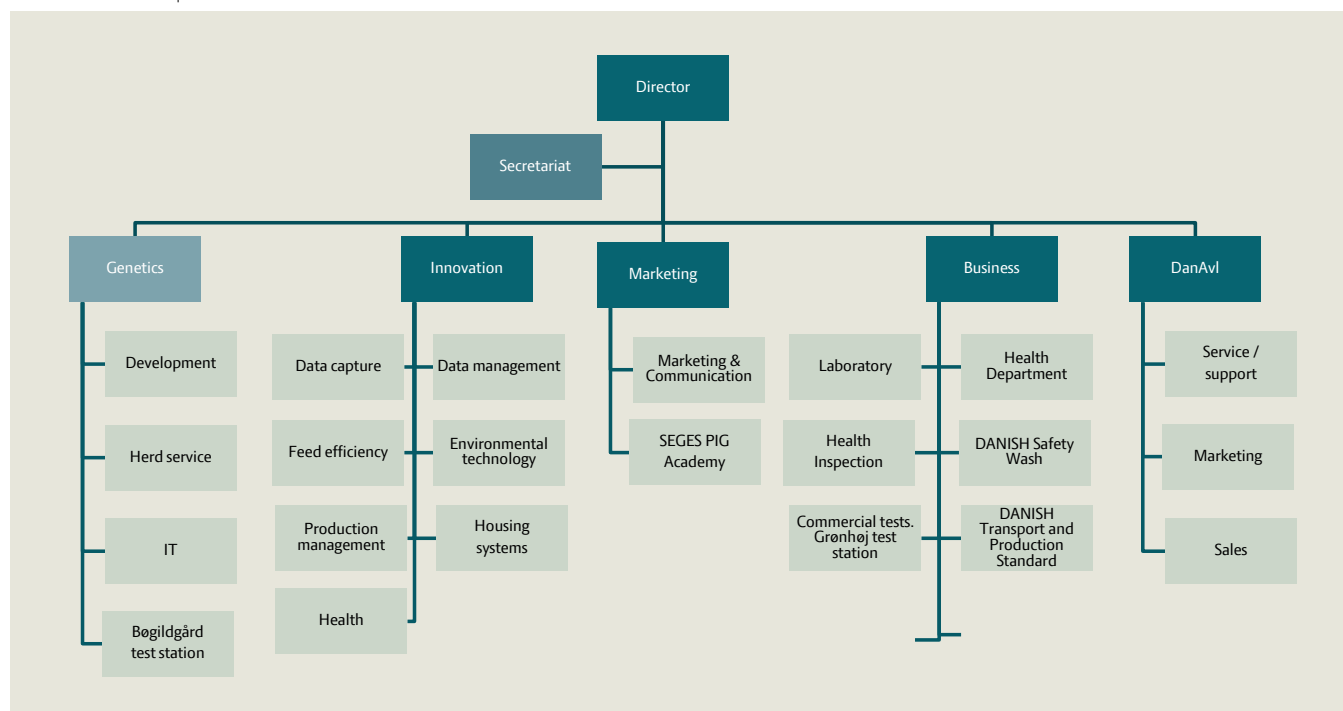
On an international basis, the structure of pig production is moving towards fewer, larger and more professional farms with the main focus on efficient production and competitiveness. Danish pig producers must be able to follow this trend and, at the same time, be able to meet market-driven and statutory demands as well as the general expectations for higher levels of animal welfare, health and food safety.

We must therefore actively support the competitiveness of Danish pig producers.

New organisation

In 2015, the organisation of SEGES Pig Research Centre is based on five departments or business areas:

FIGURE 1 Nine departments have been streamlined into five 'business areas'



- Genetics
- Innovation
- Marketing
- Business
- DanAvl

Genetics

This business area manages all basic breeding activities. The aim is to generate maximum genetic progress and to apply state of the art technologies in close cooperation with breeders and research establishments.

The pig producers on the Sector Board ultimately decide which breeding targets the industry should work towards.

The main principle of breeding is the overall economic optimisation of sow units and finisher units to make the production of a single kilo of pork as profitable as possible.

A well-functioning, solid foundation will ensure Danish pig producers the best genetics. The annual value of genetic progress corresponds to around DKK 11 per finisher produced.

Innovation

This business area was established with the aim of generating knowledge and developing tools and products for immediate implementation. The aim is to seek and generate applicable knowledge that can be implemented in practice as quickly as possible. Activities include feed efficiency, amino acid standards, Danish protein sources, milk supply in farrowing pens, organic pig production, measures to reduce tail biting, gastric ulcers and use of vaccines.

Research activities will focus on solutions to the challenges faced by Danish pig producers today and in the years ahead.

Annually, the Sector Board selects the activities for the next year from a wide range of ideas and proposals submitted.

It is the intention to engage farmers, advisors and vets to a far greater extent in order to implement new knowledge and research as quickly as possible.

New projects for 2016

- Organic pigs – reduced feed consumption
- Production in new large finisher units
- Pens for loose lactating sows
- Enrichment as a measure to prevent tail biting



Highest quality breeding stock is the result of dedicated breeding work in Denmark, and demand for Danish genetics continues to increase in many parts of the world.

- Database – calculation of national averages
- Producing entire males with absence of boar taint
- New standard values for insemination and gestation pens
- Odour and ammonia-reducing initiatives for lowering the environmental impact of sow housing
- Maximum productivity, minimal risk of diarrhoea (amino acids for weaners)
- Reduction in gastric ulcers
- Optimum use of PCV2 vaccines
- Advisory project 'SPIR'
- Tools for benchmarking, surveillance and follow-up procedures

Marketing

In close cooperation with the Innovation department, the core activity of Marketing is to drive the immediate implementation of new knowledge.

The website www.vsp.lf.dk contains a series of guidelines and knowledge in several languages. The most up to date knowledge is presented at the annual Congress for Pig Producers.

SEGES Pig Research Centre also conducts a wide range of demonstration projects and campaigns aimed at encouraging pig producers to work harder in particular areas. Current demonstration projects include '30 feed units less' and 'PattegriseLIV' (piglet life).

Business

Animal health is a core activity and activities supporting this are now carried out by our Business department. The department's role

also includes the management of the DANISH Product Standard and DANISH Transport Standard, as well as SPF Health Inspection, the Health Department and the Laboratory for Pig Diseases that all contribute to maintaining a high level of health in Danish pig herds.

More recently work has focused on improving safety wash procedures for lorries at the Danish borders and promoting biosecurity in Danish herds.

At a time when African Swine Fever has been detected close to the Russian border and PED has been found in Germany, it is crucial to have effective contingency plans in case of an outbreak of exotic animal disease.

DanAvl

One of the primary aims of DanAvl is to strengthen the competitiveness of Danish pig producers through the supply of superior genes, which will generate additional income for DanAvl.

In recent years, the export of breeding stock and semen has increased steadily. Today, DanAvl products are sold worldwide with Northern Europe as the main market. This position will be strengthened further on a commercial basis.

DanAvl is a 'centre of co-operation' where the interests of SEGES Pig Research Centre, breeders, multipliers, AI outlets and customers meet. The Sector Board decided to strengthen DanAvl's marketing and sales activities with a view to increasing its market share in the years ahead.

statistics

STRUCTURAL DEVELOPMENT

Number of pig farms

Records from SEGES Pig Research Centre show a total of 3,638 pig farms in 2014 in Denmark compared to 8,514 in 2004. If this trend continues, just 1,300 pig farms would remain in Denmark in 2024. This trend does, however, vary from year to year.

Herd development in Denmark

Overall, the number of farms, including pig farms, is decreasing. The speed of this decline depends on multiple factors. Following the economic crisis in 2008, the number of registered agricultural trades relative to the overall number of herds dropped from around 11% to 8.5% as shown in figure 1. The figure also shows that the sale of agricultural property is regaining momentum but the level is still roughly 16% lower than before the crisis.

In addition, figure 1 shows the percentage decline compared to the previous year. The dramatic drop in pig herds from 2007 is attributed to poor profitability in pig production. A large number of pig producers ceased producing pigs in 2008, but many continued working in the agricultural industry.

The fall in numbers of pig herds varied between 6% and 9% in 2011-2014. In the last decade, the drop has averaged 8% annually.

Specialization

Danish pig farms can be divided into three categories:

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

TABLE 1 Pig structure 2014

	Herds	Sows /herd	Pigs finished/herd	% of slaughtering in Denmark	% of sow population	% of single site farms
Sow herds	684	701	714	2.50%	46.50%	52.0%
Integrated herds	1,122	492	6,029	35.00%	53.50%	32.3%
Finisher herds	1,832	0	6,529	62.30%	0.00%	69.8%

On the basis of data from the official CHR register, SEGES Pig Research Centre analysed the degree of specialization within the three categories. The result is shown in table 1.

Trend 2013-2014

Sow herds were the only category that increased in number from 2013 to 2014, though the increase was a modest 1.8%. The number of integrated herds fell by 7.7% and the number of finisher herds dropped by 7%. Overall, the number of pig herds dropped by 5.7% from 2013-2014.

Sows per farm type

Records show that there were roughly 700 sows per sow farm and 490 sows per integrated farm in 2014. In 2003, around 31% of the total sow population was housed on specialized sow farms. By 2014, this had increased to 47%. This underlines an increasing specialization over a period of years.

Multisite

Around 50% of all sow herds produce pigs on one site. For integrated herds the number is one third, but a multi-site operation would be a sensible solution for this category as keeping

sows and finishers on the same site is not good practice. 70% of all finisher herds produce on one site. They account for 42% within this category or 26% of total slaughtering in 2014.

Pigs delivered to Danish slaughterhouses

When records from 2013 are compared with records from 2014, there is change in the share of each herd category in terms of pigs delivered for slaughter.

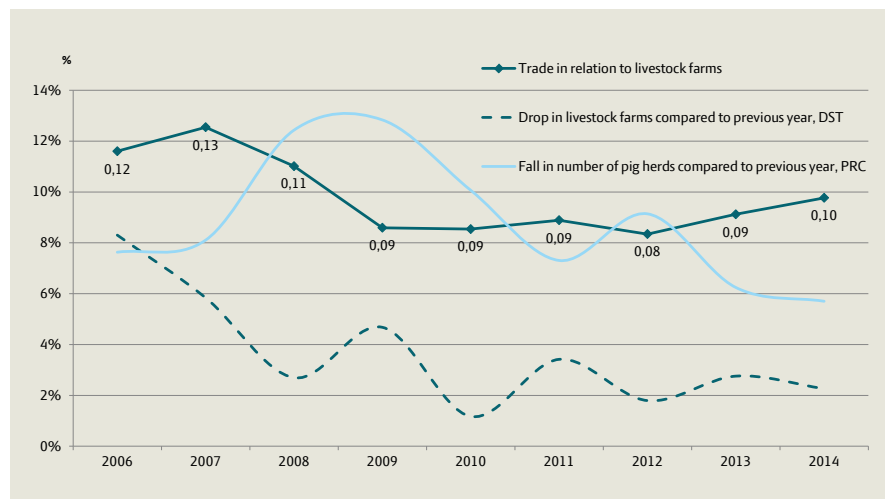
The specialized finisher farms delivered 62.3% of all pigs delivered for slaughter at Danish slaughterhouses in 2014, which is largely the same as in 2013. If considered over a period of years, the importance of integrated farms to pigs slaughtered in Denmark is decreasing. Integrated farms delivered 42.1% of all pigs slaughtered in Denmark in 2009 compared to 35.2% in 2014.

Conclusion

Generally, pig farms in Denmark have become bigger and fewer in number, but the degree of specialization remains at the 2013 level.

Per Mille Levy Fund, project no. 9739.

FIGURE 1 Registered trade in agricultural property compared with herds or drop in herds annually



FACTS

Danish pig farms have grown in size from 2013 to 2014, but are no more specialized.

The average number of pig farms in Denmark falls by 50% every seven to eight years compared to every ten years previously.

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

Sow farms had on average 700 sows in 2014, and integrated farms around 490 sows.



Small and out-dated facilities

Production of finished pigs in Denmark is in a state of crisis. This is underlined by the fact that in the period 2009-2013, investment constituted only 10-25% of what is necessary to maintain an unchanged scale of production.

This amounted to a shortfall of roughly DKK 2.4 billion and has been the primary cause of the drop in slaughterings of 2.7 million pigs in the years from 2007 to 2014.

Many Danish finisher facilities are small and fairly worn-out. The average pig facility has about 9,000 pig places and a labour input corresponding to a quarter of an employee/year. Experience shows that an industry that generates a profit will attract new investments.

Stable sow population

In the years to 2020, a stable sow population of 1 million is expected. A general progress in efficiency is forecast which will produce 34-35 million weaned pigs in 2020.

Investments ceased in 2008

In 2014, we see a shortfall of 650,000 pig places within the 5 million required to produce 20 million finishers annually, cf figure 1.

If this trend continues, forecasts predict that by 2020 only around 16.6 million finishers will be slaughtered in Denmark and weaner export will amount to 17-18 million weaners.

Can this trend be turned around

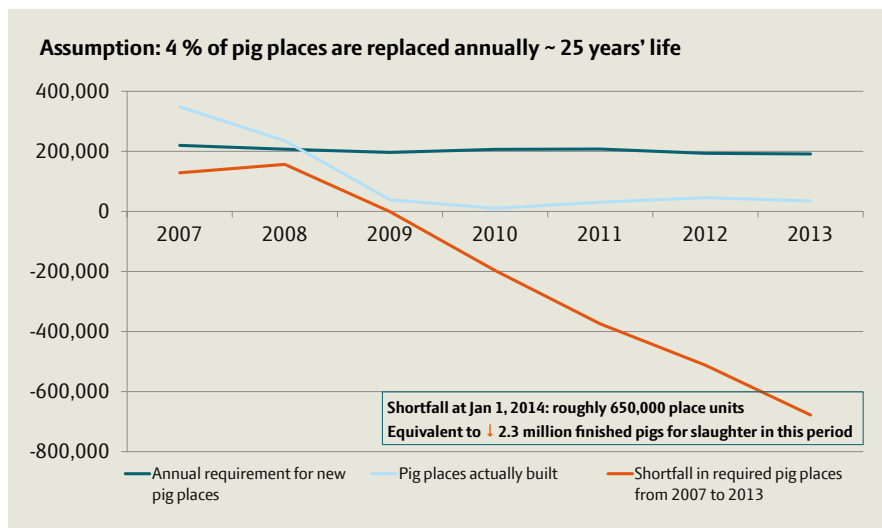
Globally, the production of pork will meet the requirements of the market. The question is whether Denmark will be able to regain our national competitiveness to put us back on the growth track and to ensure a sufficient supply of raw material to the slaughterhouses.

The agricultural industry must be given far more flexible market environment and other initiatives that support a competitive finisher production must be introduced.

Urgent priority

In the next five years, it will be necessary to establish 285,000 new pig places annually or a total of 280 pig facilities with 5,000 pig places each. 175,000 of these will replace run-down facilities and the remaining 110,000 constitute an annual net increase in production capacity. Investments on this scale can be expected to lead to 3.0 million extra pigs finished by 2020, corresponding to a total annual throughput of roughly 21.5 million pigs slaughtered. In addition, forecasts suggest a

FIGURE 1 Construction of new finisher facilities in proportion to numbers needed



continuing export of 14 to 15 million weaners. The knock-on effect of this investment will be 4,200 new jobs and an increase in export value of DKK 4.5 billion a year.

Rural Development Programme

The setup of a modernisation scheme is part of the Rural Development Programme 2014-2020. The purpose is to fund investments in farm modernisation.

Funding is expected to amount to 20% of a pre-defined standard cost, as shown in table 1.

To be eligible for funding, the applicant must be in possession of an approved financing plan when initial application is made. In 2016, DKK 126 million has already been set aside for modernisation of finisher facilities.

With funding up to DKK 740 per pig place, this amount will cover construction of roughly 170,000 new pig places.

Creation of a more flexible market environment

A draft of new regulation indicates less rigid and more flexible conditions which will not

have an adverse environmental impact without adversely affecting the environment (for detailed information, see p 28).

In addition, pig farmers of the future must be able to run a pig production facility which is comparable to the 33% most efficient production sites today. This is an essential component of the business plan, which aims to ensure long-term and profitable production.

EXPECTED ADJUSTMENTS IN GENERAL FRAMEWORK CONDITIONS

- New, less stringent rules for fertiliser application
- Spreading of 170 kg N/ha from pig manure
- Flexible regulation of livestock farms
- Relaxing the links between livestock numbers and land required for spreading of slurry
- Discontinuation of the PSO levy. In 2015 this constitutes DKK 16.60 per pig. In the period 2011-2015, the PSO levy was increased by DKK 10.80 per pig.

TABLE 1 Expected standard costings for modernisation of finisher facilities in 2016¹

Project	Standard cost	Grant → up to ²
Building on bare land (new construction)	DKK 4,300/place unit	20 % = DKK 860
Addition to existing finisher unit	DKK 3,700/place unit	20 % = DKK 740
Renovation of existing floor/pens	DKK 1,600/ place unit	20 % = DKK 320

¹ Basis for application: place units = m² net pen area/(0.65 m² x 1.05). (1.05 = increased number of pig places available as hospital pens)

² The anticipated funding required per place corresponds to DKK 15-17 per pig over 25 years at 6 % interest rate.

DEVELOPMENT IN PRODUCTIVITY

Changes in productivity

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

Development on sow breeding farms

The improvement in productivity on the best 25% farms follows the average for all farms. The best 25% sow breeding units wean approximately 2.4 pigs more per sow/year than the average of all farms. Piglet mortality dropped to an all-time low in 2014 at 21.9%, which is attributed to an increase in the total number of piglets born and a fall in mortality in the farrowing unit.

Development on weaner farms

Productivity on weaner farms is unchanged compared with the previous year. Records show a daily gain of 441 g and a feed conversion ratio of 1.93 feed units per kg gain.

Development on finisher farms

Daily gain has increased by 15 g from 2013 to 2014. The best 25% farms achieved a daily gain that is approximately 50 g higher than the average for all farms, which is lower than last year. Put differently, the gap between the 25% best farms and the average farms has narrowed. The feed conversion ratio (FCR) remains largely constant, though, if correction is made for increased slaughter weight, we do see a slight improvement in FCR. This leads to an increase in production value of DKK 25 per pig place.

PROGRESS FROM 2013 TO 2014

- Sows weaned on average 0.6 more pigs per sow per year
- Total piglet mortality dropped by 0.4 percentage points
- Finisher FCR improved by 0.01 feed unit per kg gain
- Finisher daily gain improved by 15 g per day
- Weaner productivity remains unchanged

FIGURE 1 Sows, weaned pigs per sow per year

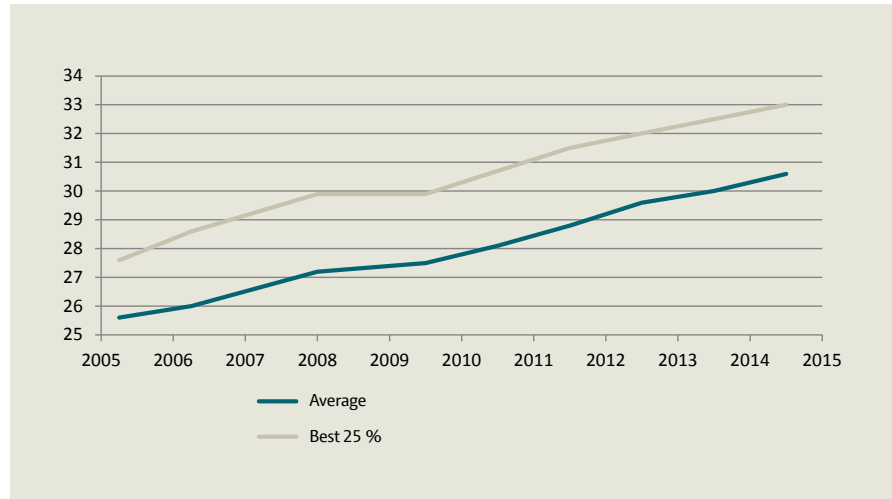


FIGURE 2 Weaners, production value per pig place per year

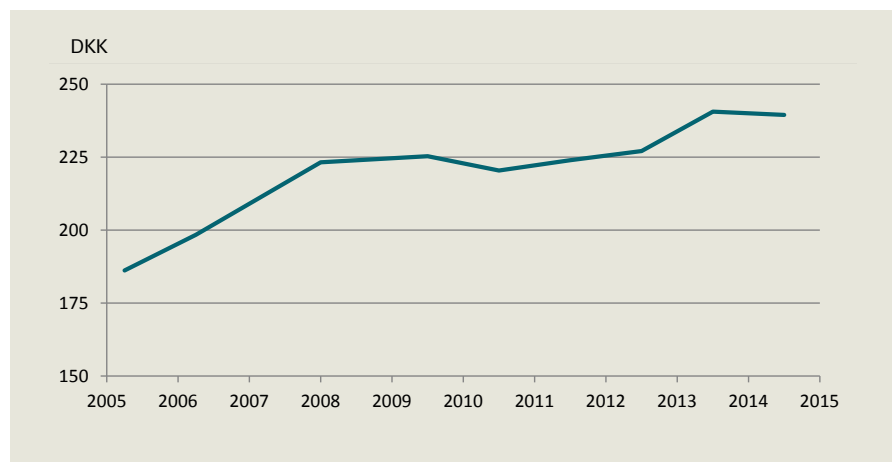
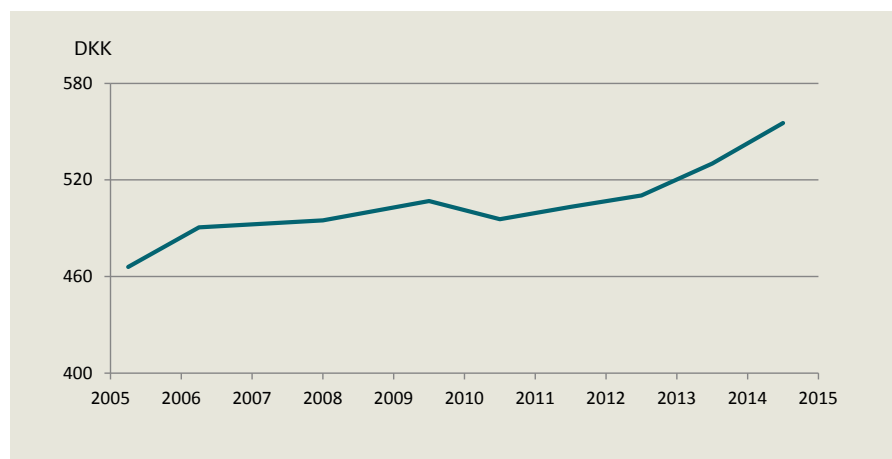


FIGURE 3 Finishers, production value per pig place per year





10-year increase in productivity

The Danish pig industry has consistently improved productivity: the number of weaned pigs per sow/year keeps increasing, daily gain is increasing and FCR among both weaners and finishers is improving. These are the reasons why the cost of producing a kg carcass weight remains largely stable at current prices. They are also a factor explaining why settlement prices do not automatically rise with inflation and the cost of food becomes relatively cheaper. There are numerous ways of calculating the value of productivity improvements. One approach is to use the Theoretical Weaner Prices for 2015 in combination with the productivity levels in 2004 and 2014 to calculate a production price. Productivity must not be impacted by the increase in slaughter weight and adjusted values (100 kg live weight) are therefore applied in these calculations. The result is a comparison of a herd with 2004 productivity values with a similar herd, with 2014 productivity values applied. The changes in productivity are shown in table 1.

The increase in productivity is an expression of genetic progress combined with improved nutrition, climate and management. It is the result of all research and development activities of the Danish pig industry combined.

In the period until weaning, productivity has improved by six pigs per sow/year and feed consumption has dropped by 9.4 feed units per weaned pig. In this period, daily gain among weaners increased by 22 g, feed conversion improved by 0.14 feed units and mortality dropped by 1.9 percentage points.

A corresponding trend is seen for finishers: daily gain has increased by 95 g; feed conversion has improved by 0.1 feed units; mortality has dropped by 0.5 percentage points; and lean meat percentage has increased by 0.7 percentage points. This is a significant increase in productivity that measured with current 2015 prices has a significant economic impact on the production costs.

The price of producing a kg carcass weight in 2015 would have been considerably higher without this increase in productivity. At a slaughter weight of 77 kg, the production price of a kg carcass weight is DKK 1.32 lower under the current level of productivity compared with 2004. This corresponds to a saving of DKK 102 per pig. At a slaughter weight of 85 kg, the price is DKK 1.51 lower under the current level of productivity, which corresponds to a reduction in production costs of



The increase in productivity is an expression of genetic progress combined with improved nutrition, climate and management.

DKK 128 per pig. The 8 kg increase in slaughter weight lowered the cost price by DKK 0.30 net per kg, once correction is made for an increased feed consumption, a lower lean meat percentage and more carcass weight to share fixed costs. The value of the overall increase in productivity per pig is roughly DKK 54 until weaning; DKK 17 for weaners 7-30 kg; and DKK 31 for finishers 30-100 kg at a slaughter weight of 85 kg. A continued increase in slaughter weight is important partly to lower the costs per kg carcass weight and partly

to raise the value of a finisher in proportion to a weaned pig. The latter is important to strengthen the competitiveness of Danish finisher producers in relation to countries such as Germany and Poland that import around 11 million Danish weaners. However, a higher slaughter weight must not jeopardise the marketability of the resulting pig meat.

The profitability in pig production is determined by costs combined with earning per kg carcass weight.

TABLE 1 Increase in productivity, 2004-2014

	Difference 2004-2014
Weaned pigs/sow/year	+6
Sow feed per weaned pig	-9.4
Feed units, 7-30 kg	-0.14
Daily gain 7-30 kg	+22
Mortality 7-30 kg	-1.9
Feed units 30-100 kg	-0.10
Daily gain 30-100 kg	+95
Mortality 30-100 kg	-0.5
Lean meat %	+0.7
Production price per kg carcass at a slaughter weight of 77 kg, DKK	-1.32
Value per pig, DKK	-102
Slaughter weight	+8
Production price per kg carcass at a slaughter weight of 85 kg, DKK	-1.51
Total value of increase in productivity since 2004, DKK – at a slaughter weight of 88 kg per pig	128

statistics

PRODUCTION ECONOMY

Gross margin

Analyses from the DB Tjek ('gross margin check') software programme reveal a large potential for improved performance in pig production, when the correct strategic choices are made in terms of production systems. Factors such as on-farm mixing of feed, larger unit size, SPF health status, own breeding stock and liquid feed all help increase gross margins. In weaner production, larger herds, herds carrying out on-farm mixing of feed and herds with a high health status all have a significantly better gross margin per sow/year than other weaner herds. A high health status and large batches raise the sales price of weaners. The improved gross margin is directly reflected in the financial result. The increased gross margin obtained with on-farm mixing must pay for mixing equipment and for labour taken up mixing the feed. This gross margin of DKK 498 corresponds to a DKK 0.18 drop in feed price per kg. If costs for handling feed mixed on-farm amount to DKK 0.10 per kg, half of the

TABLE 1 Gross margin per sow/year

Gross margin per sow/year DKK	2006-2014
Feed mixed on-farm, minerals	498
500-1,000 sows/year	461
More than 1,000 sows/year	667
Myc	418
SPF	664

DKK 498 is still a worthwhile result overall. Productivity levels are slightly higher in herds with a high health status. This in particular affects weaner productivity where mortality drops and FCR improves. Medicine costs are slightly lower in herds with a high health status.

TABLE 2 Statistics, sow units

Comparison with conventional	Sow units 30 kg	
	MS	SPF
Weaned pigs per sow/year	0.41	0.69
Farrowing rate	NS	0.91
Medication, incl. vaccinations, DKK per sow/year	-65	-107
Mortality post weaning	-0.40	-0.55
FCR per kg gain, feed units	-0.03	-0.05

In finisher production, feed consumption and feed price are essential to the financial result. Figures 1 and 2 illustrate the effect of FCR and feed price on feed costs per kg gain.

FIGURE 1 Impact of FCR on feed costs

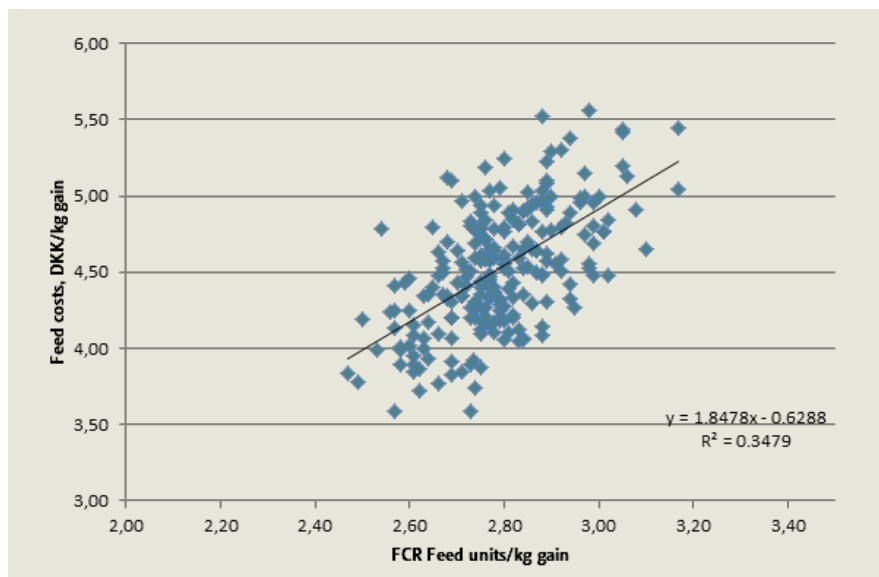
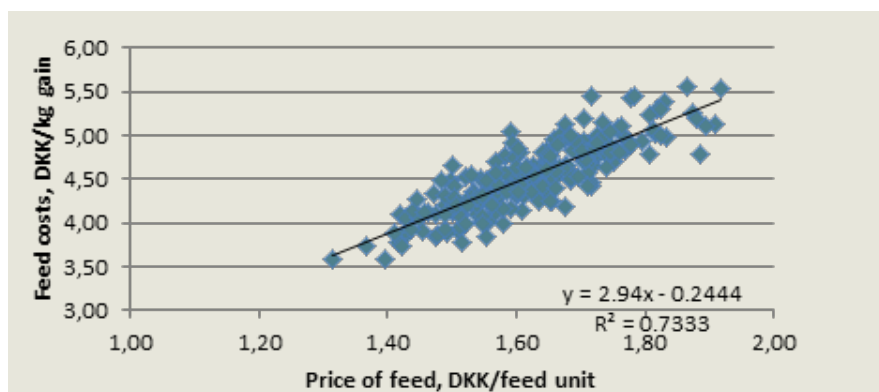


FIGURE 2 Impact of feed prices on feed costs



Analyses demonstrate that the effect of the feed price on the feed costs is twice as significant as on FCR. FCR is also important to the feed costs, and pig producers should therefore focus on improving the feed conversion ratio. Home-mixing finisher producers have a significantly better gross margin per finished pig than pig producers who buy ready-mixed compound feed. The use of supplementary feed lowers costs by DKK 24, which corresponds to a feed price that is DKK 0.11 cheaper per kg than purchased feed. Assuming costs for handling feed mixed on-farm amount to DKK 0.05 per kg, profit will increase by DKK 13. The use of liquid feed for finishers increases gross margin by DKK 15 per pig. The additional costs of using liquid feeding amount to DKK 8 per pig. Pigs fed liquid feed are typically fed according to a feed curve, and this often results in a slightly lower daily gain than ad-lib dry feeding. However, lean meat percentage

is slightly higher for pigs fed liquid feed and there are several possibilities for using alternative ingredients that may lower the feed price. This is one reason why liquid feeding is an attractive option.

TABLE 3 Gross margin, finishers

Gross margin per finisher, DKK	2004-2014
Ready mixed feed	
Feed mixed on-farm, supplementary feed	24
Feed mixed on-farm, minerals	38
5,000-8,000 finishers	11
More than 8,000 finishers	19
Dry feed	
Liquid feed	15



What is InterPIG

InterPig is a global network of expert pig production economists that annually collects pig production costs and prices in each member country. InterPig enables SEGES Pig Research Centre to stay up to date with production costs in Europe and globally. The average profitability in each country is a guide to pig production expectations for the future.

Figure 2 illustrates the importance of keeping up to date with trends as nothing remains static in a highly dynamic pig industry.

Competitiveness

Danish pig producers remain 'world champions' in efficiency. The Netherlands are our closest competitor in sow production, but fell further behind in the latest year. In the Netherlands, pig producers weaned 1.28 pigs fewer per sow/year than Danish pig producers in 2014. Finisher productivity is also good in Denmark, but the overall advantage is smaller.

Competitiveness is not simply being able to produce pork cheaply. In the UK, production costs in 2014 averaged DKK 12.72/kg pork versus DKK 11.27/kg pork in Denmark, but the pig price was DKK 2.80 higher and British pig production is currently expanding.

Profitability in 2014

Profitability in 2014 was negative for the average Danish pig producer, as was the case for most European pig producers.

The UK and Spain reported a decent profit in 2014. French and Danish pig producers ranked in the upper third with a small profit. Austria also reported a small profit, but only as long as calculations included an investment grant of 15% for construction of new pig housing. The average French and Danish pig producer had a deficit of DKK 0.38 and DKK 0.22 per kg, respectively.

As illustrated in figure 1, Brazil, Canada and the US all showed profits. High pig prices in the US and Canada were primarily caused by outbreak of PEDv. In 2014, US pig production dropped by 1.4% compared with 2013 and pork prices rose sharply as a result. Brazil was not hit by PEDv and production is increasing and is primarily sold on the domestic market at good prices.

Weaner competitiveness

Figure 2 shows the marginal production cost for a 30 kg pig in Denmark compared with other countries over time.

It is clear that Germany is catching up with Denmark: years ago the cost of producing a single weaner in Denmark was DKK 140 lower than in Germany – today the difference is only around DKK 60 per weaner. In that same period, Spain has overtaken Denmark, whereas the Netherlands are falling behind.

Development in pig numbers

The InterPig network was established in 2002, and since then the sow population in EU-15 has dropped by a sixth.

The smallest drop in the sow population is seen in the Netherlands and Denmark, where every 13th sow has disappeared, while in that same period the population in Germany has dropped by one fifth.

In EU-15 the number of pigs slaughtered increased by 5% in that same period as sow productivity has increased. However, in most countries the number of pigs slaughtered has dropped.

Only Spain, Belgium and Germany have seen a rise in the number of pigs slaughtered. In Germany, the number increased by 33% in the period 2002-2014 as the import of weaners from Denmark and the Netherlands increased. However, since 2011, the number of slaughtering in Germany has remained stable.

FACTS

- Denmark 'world champions' in efficiency, but not in profitability per kg pork produced.
- Denmark 'world champions' in pigs weaned per sow per year.
- Spain 'European champions' in production cost per kg pork produced
- Profitability varies greatly over time.

FIGURE 1 Production price and profitability in 2014 per kg carcase weight

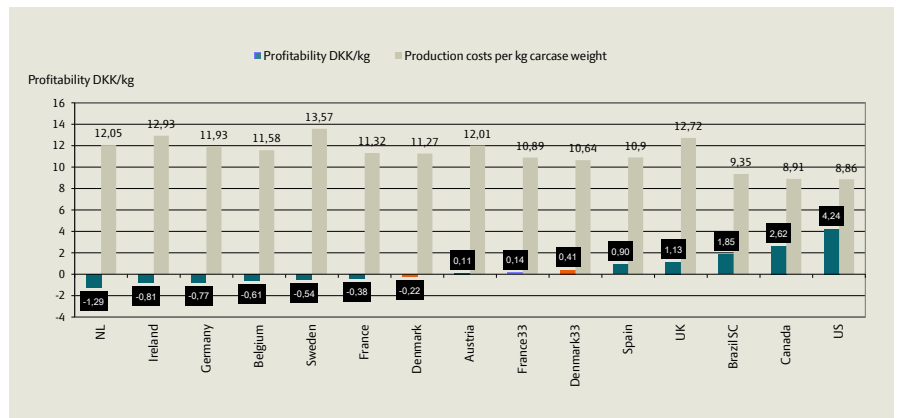
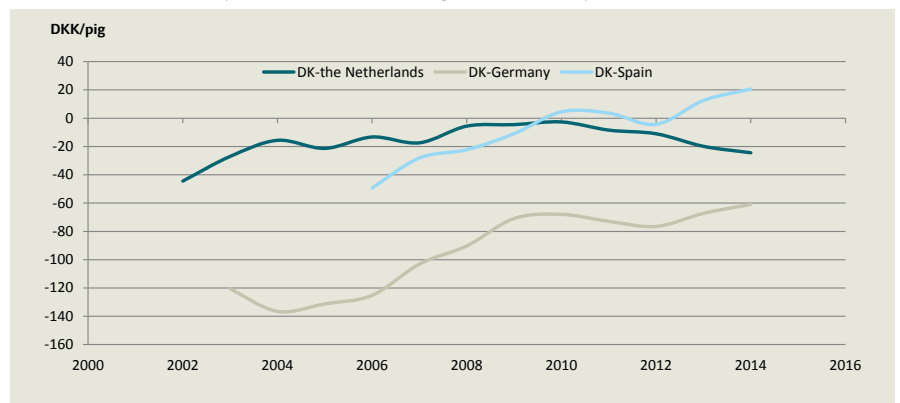
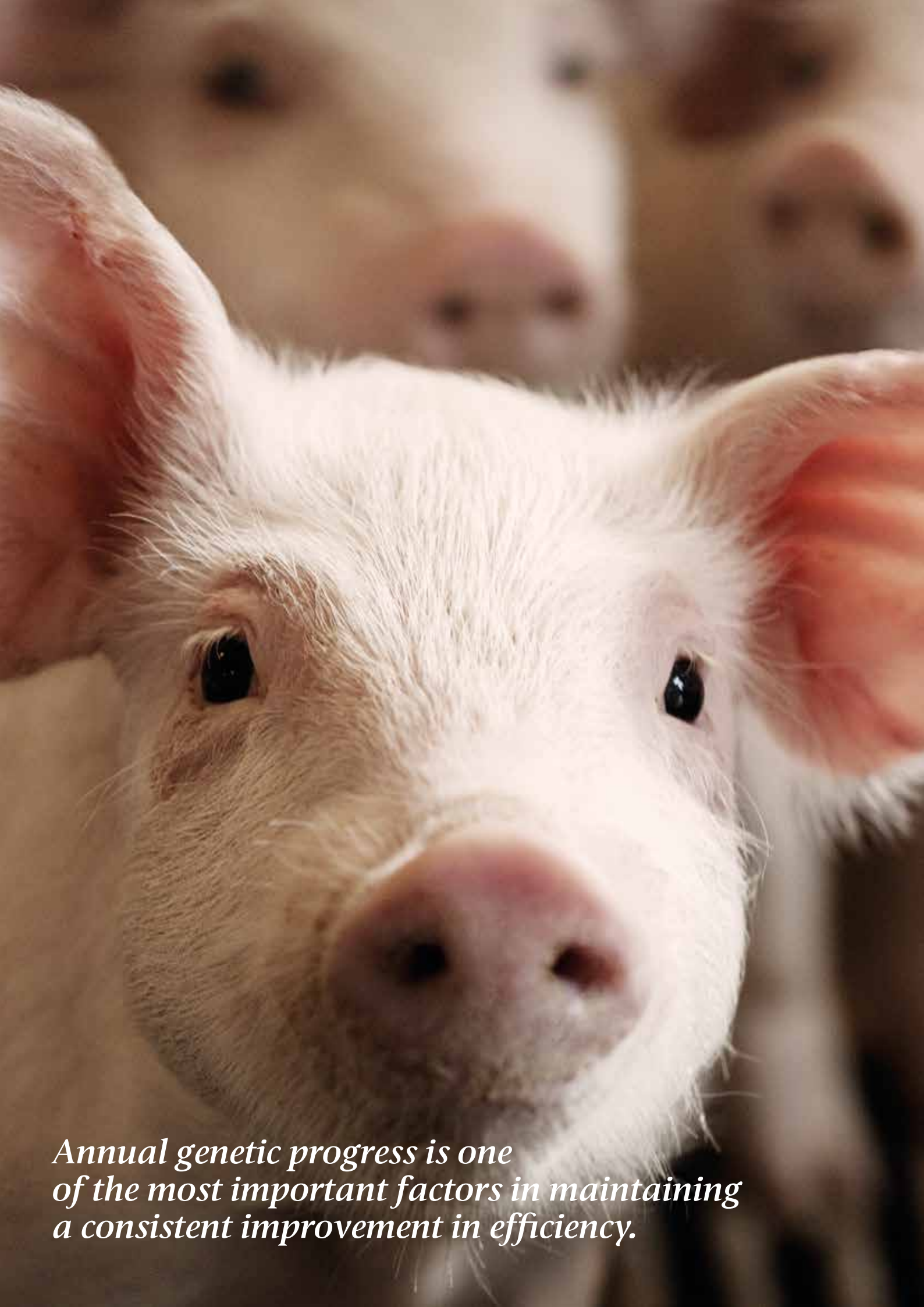


FIGURE 2 Difference in production costs at 30 kg, Denmark compared with other countries





Annual genetic progress is one of the most important factors in maintaining a consistent improvement in efficiency.

genetics

NEW DANAVL STRATEGY



Increased productivity and efficiency

The need for improved productivity and efficiency in pig production globally further highlights the advantages of DanAvl. There is a ready market for DanAvl products with their unique genetics and a strong focus on production advice, health parameters and meat quality issues.

Customers

DanAvl's customers are pig producers who face a highly volatile and competitive market environment internationally. European pig production is static while production in South America and Asia is increasing.

In order to maintain or improve competitiveness, the pig industry must continue to improve its efficiency, producing more volume with less input. Annual genetic progress is one of the most important factors in maintaining a consistent improvement in efficiency.

DanAvl's breeding objectives remain to promote efficiency and productivity of their pig producing customers. This was and will always be the foundation of the DanAvl business.

Maintaining competitiveness

Since 2008, DanAvl has shown continuous expansion and is today a strong international brand. DanAvl has a significant market share in Europe, but there is still a further potential here as well as in fast-growing markets such as South America. DanAvl is still a leading player in the German market, but sales in Southern Europe have also gained momentum in recent years, and there has been an annual increase in sales in both Spain and France.

Future DanAvl strategy

In order to realise its full potential, DanAvl is currently preparing a new strategy to consolidate its position as one of the top three breeding programmes in the world.

The prime objective of DanAvl is to promote the competitiveness of the Danish pig industry. Nothing in our future work will compromise this aspiration (see figure 1).

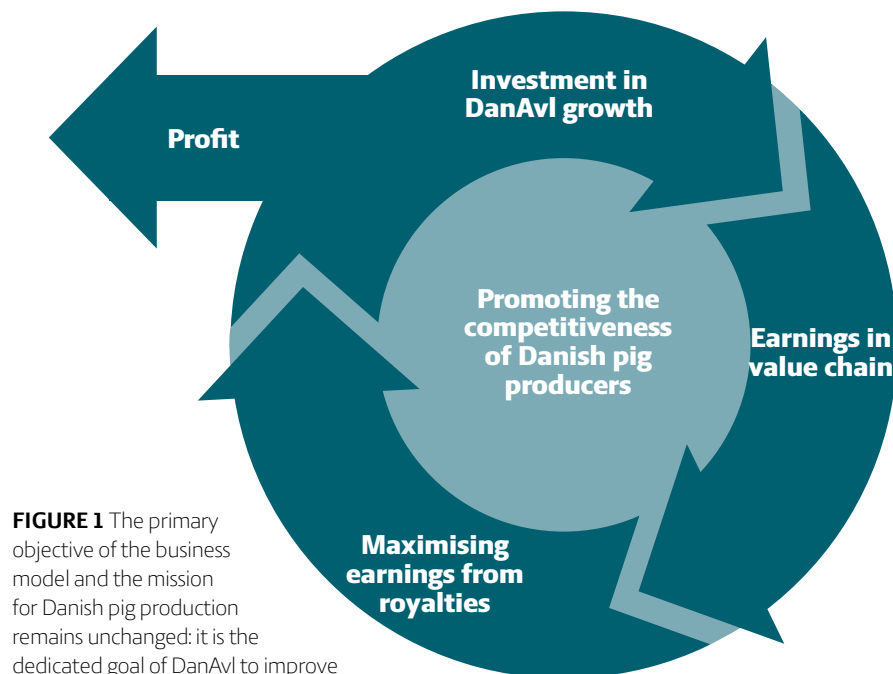


FIGURE 1 The primary objective of the business model and the mission for Danish pig production remains unchanged: it is the dedicated goal of DanAvl to improve efficiency and productivity of each individual pig producer. This was always and will always be at the core of DanAvl's activities.

To utilise the potential of Danish pig genetics, DanAvl's value offer will be sharpened, namely the benefits for our customers in choosing DanAvl solutions to improve the productivity and efficiency of their pig production.

DanAvl will focus even more on the needs of individual customers as well as markets, through increased market dialogue, insight and knowledge of what the producers of tomorrow will need.

DanAvl's value offers will continue to be based on Danish genetics – multiple tests have repeatedly confirmed that Danish genetics are the most efficient genetics when measured on economic KPIs. We will also focus on health, meat quality, conformation and service and advice before, during and after sale of our

products. This work cannot be performed without making structural and organisational changes. A further consolidated value chain will form the core of the company to make DanAvl an even stronger breeding programme and brand with customer focus offering unique solutions.

GENETIC PROGRESS AND SALES

Genetic progress

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

Daily gain, in the period 0-30 kg as well as 30-100 kg, has improved since last year's annual report, which is attributed to progress in both the Landrace and Yorkshire strains. Feed conversion has also improved, which is attributed to progress in Duroc lines in particular.

Progress in 'Live Pigs per Litter at 5 Days' (LP5) and longevity for the sow breeds has also improved: LP5 is now 0.24 vs 0.19 last year, and longevity is now 0.0017% vs 0.0006% last year.

Table 2 shows the economic importance of genetic progress. The table as well as the calculations are updated according to the new economic weightings, described in the Genetic Development section. The calculations are based on the economic values used in the index calculations and on the dissemination of the traits in the production chain. Genetic progress and improvement in gross margin in production are assigned a higher value, which is attributed to the implementation of genomic selection in 2010-2011.

Herd structure

Currently, 26 nucleus breeders have a contract with SEGES Pig Research Centre, and in total they represent 38 herds with purebred animals: 12 Duroc, 13 Landrace and 13 Yorkshire. As of August 2015, 134 Danish multiplication herds were approved and of these 28 had some affiliation to a nucleus breeding herd.

In table 3, the number of purebred litters and hybrid litters produced in the past year is shown, and in table 4 the number of sows currently on contract with SEGES Pig Research Centre (as at August 2015) is shown.

SEGES Pig Research Centre also has contracts with 88 international multiplication herds.

Production

In the past year, 2,558 boars were performance tested at Bøgildgård Boar Testing Station of which 450 were Landrace Duroc boars and 443 Yorkshire boars as Bøgildgård Boar testing Station was used for testing D(YL) hybrids this past year (for more information, see Genetic Development). The results of the performance tests are shown in table 5.

TABLE 1 Genetic progress over 3 years for each trait and breed and average of a D(LY) finisher.

Breed	Year	Daily gain (30-100 kg), g/day	FCR, FUp/kg gain	Lean meat, %	LP5, no.	Conformation, points	Daily gain (0-30 kg), g/day	Killing out, kg	Longevity, %
Duroc ave.	3 yrs	20.0	-0.039	0.17	-	0.02	4.0	-0.04	-
Landrace ave.	3 yrs	13.3	-0.029	0.08	0.22	0.06	2.0	-0.05	-0.03
Yorkshire ave.	3 yrs	16.7	-0.029	0.04	0.27	0.05	2.7	0.00	0.00
Ave. 3 breeds	3 yrs	17.5	-0.034	0.12	0.24	0.04	3.2	-0.03	0.017

TABLE 2 Importance of genetic progress for gross margin, average of 3 years

	Genetic progress	Economic weighting, DKK	Value of genetic progress, DKK (assum. 100 % dissemination)	Dissemination in production	% GM improvement in production, DKK/finisher
Gain (30-100 kg)	17.5	0.13	2.28	80%	1.82
FCR	-0.034	-147	4.95	80%	3.96
Lean meat %	0.12	9.7	1.14	150%	1.71
LG5**	0.24	9.8	2.37	85%	2.01
Conformation	0.04	12.5	0.49	100%	0.49
Gain (0-30 kg)	3.17	0.11	0.35	100%	0.35
Killing out	-0.03	-5.1	0.17	100%	0.17
Longevity**	0.017	42.5	0.71	100%	0.71
Average of 3 years and all breeds			12.45		11.22

** Yorkshire and Landrace 50 % contribution each.

TABLE 3 Number of purebred and hybrid litters in the past year

	Purebred litters		Hybrid litters	
	Code 100*	Code 200**	Code 100*	Code 200**
Duroc	3,918	1,672	63	1,042
Landrace	5,150	10,868	5,748	81,453
Yorkshire	4,999	15,865	10,156	81,453

* 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 herd, August 2015

	Purebred females		
	Nucleus herds*	Multiplication herds, DK	Multiplication herds, int'l
Duroc	1,786	-	-
Landrace	2,206	31,966	13,296
Yorkshire	2,367	28,752	19,565
Total	6,359	60,718	32,861

* Sows on contract.

TABLE 5 Ave. prod. results from performance-testing at Børgildgård Boar Testing Station the past year

Breed	Number	Daily gain (30-100 kg), g/day	FCR, FUb/kg gain	Lean meat %	Killing out %	Scanning objective, mm
Duroc	2,558	1,122	2.3	62	25.4	7.3
Landrace	450	1,017	2.4	60.8	25.9	7.7
Yorkshire	443	918	2.48	60.5	25.6	8
Total	3,451					

TABLE 6 Nucleus breeding herds – average production results for boars the past year

Breed	Number	Daily gain, g/day		Lean meat %	Conformation, points	Scanning obj, mm	Scanning weight, kg
		0-30 kg	30-100 kg				
Duroc	7,948	400	1,172	61.3	2.93	7.3	95.7
Landrace	16,064	372	1,045	62.6	2.99	8	94.6
Yorkshire	16,203	359	1,010	61.7	3.13	8.5	94.2
Total	40,215						

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	Scan. weight, kg
		0-30 kg	30-100 kg				
Duroc	10,185	403	1,107	61.5	3.01	7	95.2
Landrace	21,389	377	975	63	3.09	7.5	94
Yorkshire	19,867	362	962	61.5	3.19	8.9	94.1
Total	51,441						

TABLE 8 Nucleus breeding herds – litter size of purebred litters the past year

Breed	Litter size	LP5	Per cent litters from first parity sows
Duroc	9.5	-	73.3
Landrace	15.6	12.3	67.3
Yorkshire	16.7	14.2	63.8

TABLE 9 Index and time in production of AI boars

Breed	Boars entered the past year	Months in service of boars departed in the past year	Active boars, August 2014	Index for active boars, August 2014
Duroc	2,840	12.5	3,115	118
Landrace	715	5.9	425	128
Yorkshire	837	6.0	457	129

TABLE 10 DanAvl AI boars sold in Denmark and internationally, August 2015

	Internationally		Denmark	
	Number	Index	Number	Index
Duroc	2,250	101	3,115	118
Landrace	457	111	425	128
Yorkshire	440	114	457	129
Total	3,147		3,997	

TABLE 11 Sale of genetic breeding stock from DanAvl in 2014 in Denmark and internationally

	2013		2014	
	Denmark	Int'l	Denmark	Int'l
Purebred females	5,132	28,693	4,695	22,000
Hybrids	249,895	421,347	257,853	440,247
DD and XX boars	543	2,277	432	2,071
LL and YY boars	16	1,562	17	1,287
DD and XX semen, doses	4,864,952	1,116,687	5,127,527	1,771,001
LL and YY semen, doses	232,488	-	218,005	-
On-farm replacement production sows internationally*	-	424,519	-	581,399

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



In nucleus breeding herds, 40,215 males and 51,441 females were performance tested. Tables 6 and 7 show the average production level of the past year for males and females, respectively, in nucleus breeding herds.

Litter size and live piglets at 5 days

Table 8 shows the litter size of purebred nucleus litters in the past year: the LP5 average 14.2 for Yorkshire (vs 13.8 last year), and 12.3 for Landrace (vs 12.4 last year).

AI boars

Table 9 shows the current (August 2015) index for all three breeds and the number of active boars at Danish AI centres. The average index level for active Duroc boars has increased from 113.4 to 117.5, and index levels for Landrace and Yorkshire boars have decreased slightly. In addition, table 9 also shows the number of boars registered at Danish AI centres and their average working age.

In total, 12 distributors (August 2015) have 3,147 boars in 70 AI centres internationally. Table 10 shows the distribution of breed and index for AI boars both in Denmark as well as internationally. The index levels for Landrace and Yorkshire boars internationally have increased by 2.9 and 2 index points, respectively.

Sale of semen and breeding stock

Sale of Duroc semen nationally as well as internationally continues to increase: global sales have increased by 58.6% compared to last year.

The numbers of on-farm replacement sows also continue to increase globally: records show an average of 581,399 on-farm replacement production sows compared to 424,519 the previous year. Sale of genetic breeding stock is shown in table 11.

The sale of purebred females in Denmark as well as the export of purebred females decreased from 2013 to 2014. The sale of hybrid females continues to increase domestically as well as internationally. The decline in the sale of purebred females is attributed to the Russian import ban.

Fees on genetic material

The income from fees on sales of genetic material totalled DKK 115.9 million in 2014. In 2014, approximately 59% of the fees originated from international sale of genetic products.

Breeding objectives

The breeding objectives for Duroc, Landrace and Yorkshire and economic weights were revised in June 2015. They need to be regularly revised to take account of genetic progress, changes in costs and pig prices and the development of new traits in the breeding objectives.

The latest revision of the breeding objectives for Duroc, Landrace and Yorkshire was carried out in March 2011. Since then, prices of energy and pig feed have soared, the number of live born piglets per litter has increased as has the number of piglets reared by sows, weaner gain has dropped and finisher gain has increased, and payment for lean meat percentage at slaughter has been revised.

Based on these significant changes, a new set of economic weights was calculated for the traits included in the breeding objective. Table 12 presents the figures for 2011 and 2015. With the exception of the economic weight for longevity and conformation, all economic weights were revised.

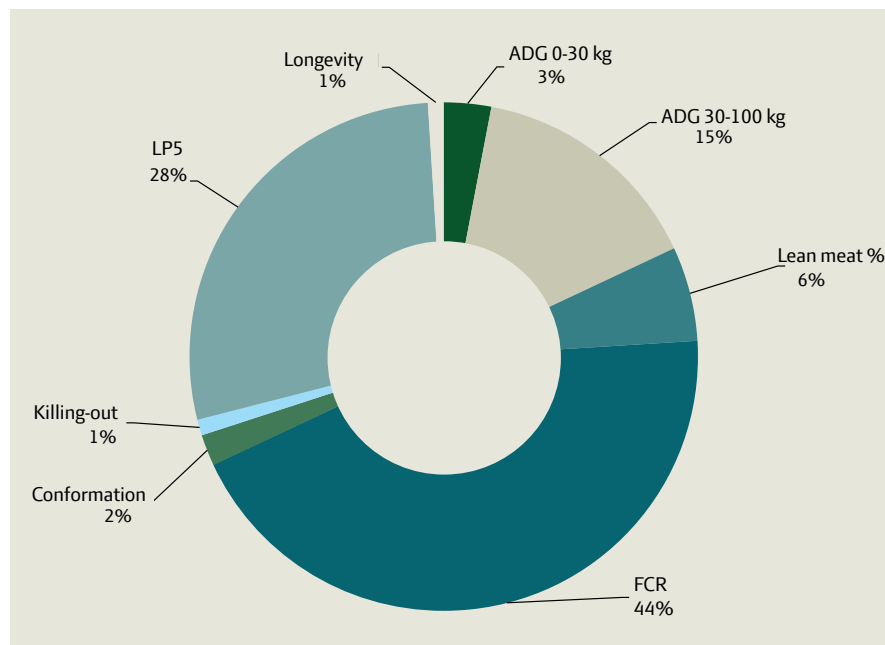
The economic contribution for the traits in the breeding objective was also revised and is shown in figures 1 and 2. These figures cannot be compared directly with the corresponding figures in last year's report as the genetic parameters were updated.

Analytical methods in DanAvl's existing bio-economic simulation model (BESI) were also reviewed. It was decided not to add new traits to the breeding objectives. Boar taint was considered, but will not be added at the moment, due to uncertainties relating to trait definition and insufficient knowledge of the economic value of boar taint.

Social interactions

The project "Selection based on interactions between pigs" found a socio-genetic effect on daily gain in Duroc and Yorkshire, which is

FIGURE 1 Relative economic of contribution traits in the breeding objective for DanAvl Landrace and DanAvl Yorkshire.



expected to improve genetic progress in the future. However, before it can be implemented in the breeding programme, the socio-genetic model needs to be further developed, a more consistent and improved prediction ability is required and validation of the effect on behaviour is necessary. This will be further investigated in the new project "Breeding for feed efficiency and behaviour among pigs in groups" which is financially supported by the Green Development and Demonstration Programme.

The structure and documentation of on-farm testing were revised as of January 1, 2014 because the data available regarding social interactions when the project was initiated were no longer applicable. Only data from Bøgildgård test station or data collected after the structural changes were implemented can be used for this purpose.

It is essential that pigs that are removed

from pens during the trial be included in the socio-genetic analyses. Not only on account of unstable estimates when the data basis changes, but simply because this information is likely to be very relevant in terms of socio-genetic effects. Using data from Bøgildgård, estimates for the direct and the socio-genetic effect in Duroc were compared depending on whether a) all pigs were included, b) culled or dead pigs were excluded, or c) groups with culled or dead pigs were excluded. In terms of daily gain, exclusion of culled pigs (b) led to a reduction in the socio-genetic effect of around 29% compared with all pigs (a), whereas exclusion of the whole group (c) led to a reduction of "only" 18%. In terms of feed intake, exclusion of the culled pigs (b) resulted in a reduction of 29%, while exclusion of whole groups (c) reduced the socio-genetic effect by roughly 86% - in other words, the socio-genetic effect was lost. Based on these results, data where not all pigs in the pens are known cannot be used for estimating socio-genetic effects.

A preliminary model for estimation of socio-genetic effects was developed on the basis of the data collected after the structural changes were implemented. The model uses daily gain as the point of departure, and results reveal a significant socio-genetic variation for gain in Duroc and Yorkshire, but not Landrace. This socio-genetic variation contributes to an increased total heritability. The preliminary estimates for heritability and descriptive data collection are shown in table 13.

TABLE 12 Economic weights in the breeding objectives in 2011 and 2015

Trait	2011	2015	Unit	Breed
Longevity	85	85	DKK/%	LL, YY
LP5	22	19.6	DKK/pig	LL, YY
Conformation	12.5	12.5	DKK/points	LL, YY, DD
FCR	-133	-147	DKK/FU/kg	LL, YY, DD
Lean meat %	8.6	9.7	DKK/%	LL, YY, DD
Daily gain (0-30 kg)	0.09	0.11	DKK/g/day	LL, YY, DD
Daily gain (30-100 kg)	0.14	0.13	DKK/g/day	LL, YY, DD
Killing-out %	-4,9	-5,1	DKK/kg	LL, YY, DD



TABLE 13 Data collection and preliminary estimates for the project “Selection based on interactions between pigs”

	Duroc	Landrace	Yorkshire
Number of pigs	28,600	55,200	57,500
Number of pens*	2,400	5,000	4,800
Av. parentage**	0.11	0.19	0.17
Direct heritability	0.11	0.20	0.25
Total heritability	0.38	-	0.35

* Averagely 12 pigs/pen (8-15 pigs)

** Based on six generations

The model is highly sensitive to (absent) systematic effects that may contain variance between groups, and a conservative approach was therefore selected where adjustments are made for sections. Analyses revealed no significant social environmental effects or effect of group size on the extent of the socio-genetic variance. The prediction ability of the socio-genetic model was in some cases, but not consistently, better than the conventional genetic model.

Stochastic simulations were made with assumed genetic parameters that corresponded to the estimated (DD) parameters to assess the potential genetic progress of selection for direct and socio-genetic effects, compared with selection based on the direct genetic effect alone. These simulations demonstrate that, if the estimated parameters prove to be true, a 13% increase in genetic progress may be possible in the future with the socio-genetic model compared with the conventional model.

Overall, this indicates that there are socio-genetic effects in Duroc and Yorkshire that may in future contribute to an improved genetic progress. However, as mentioned, implementation of the socio-genetic model in the breeding programme requires further development of the model to ensure more consistent prediction ability and validity.

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

Breeding for feed efficiency and behaviour within pigs in groups

This is a comprehensive project that runs from July 2015 to June 2019. The project receives financial support from the Green Development and Demonstration Programme and aims at improving genetic progress for feed efficiency and improving social behaviour in the Danish pig

breeding programme, including reducing tail biting and aggressive behaviour. This will be done by combining group information, support traits, advanced statistical models and genomic information. However, feed efficiency and behaviour are extremely complex traits to breed for as they are extremely difficult to record.

The development of new methods for analysing group information and genomic knowledge generated in recent years made this project possible. By combining the new methods, we expect to be able to use their combined potential to increase genetic progress for these difficult traits. Combining these methods was made possible through our collaboration with the Centre for Quantitative Genetics and Genomics at Aarhus University that is a leader in quantitative genetic and genomic research.

In this project, group information will be utilised in two ways that also complement each

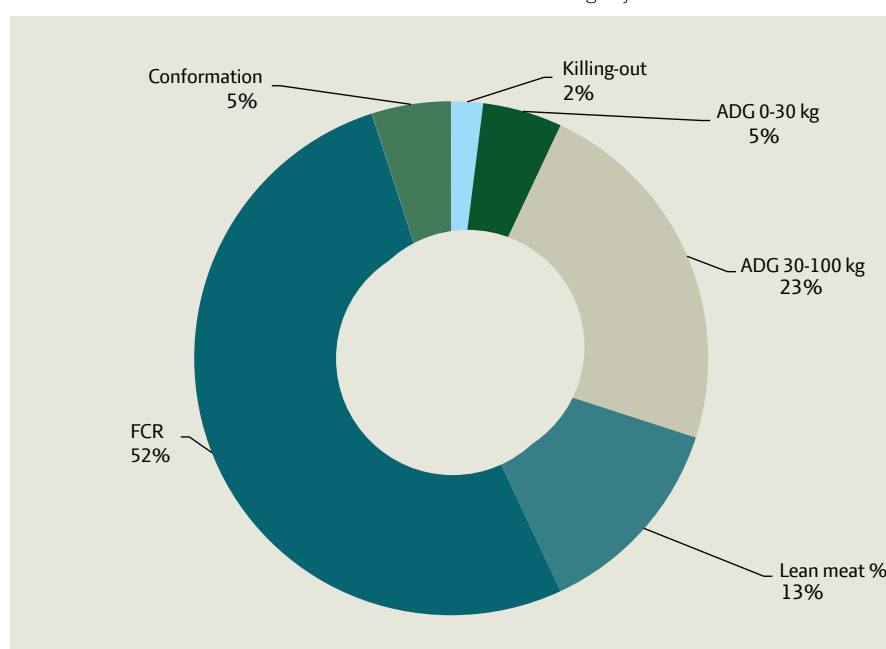
other. We will use observations of feed conversion at group level which, in a cost-effective manner, will improve the accuracy of the assessment of the pigs' breeding values. We will also use observations on pen mates to assess the pigs' social breeding values. Pigs' social breeding values are expected to reflect variations in the pigs' social behaviour in groups, but are in fact based on traditional traits such as daily gain and feed conversion. We will also make direct recordings of traits related to behaviour and welfare to be able to assess the effect of selection for social breeding value. This will make improved genetic progress for feed efficiency possible while we will, at the same time, be able to include behaviour in the Danish pig breeding programme.

The project received financial support from the Green Development and Demonstration Programme. Journal no. 34009-14-0849.

LP5 also improves rearing ability

Litter size has increased significantly among Danish sows in the last decades: before 1992, when breeding for litter size was introduced, litter size averaged 10 and 9.5 for first parity Landrace and Yorkshire sows, respectively. After 2004, when 'Live Pigs per Litter at 5 Days' (LP5) was implemented, litter size has increased further. The most recent records from herds in the breeding system show a total of 12.7 live pigs five days after farrowing among first parity Landrace and Yorkshire sows. With

FIGURE 2 Relative economic contribution of traits in the breeding objective for DanAvl Landrace Duroc





this increase in litter size sows must be capable of rearing more piglets.

During the development of LP5 fifteen years ago, sows' rearing ability was a focus point. Litter weight and litter size of the piglets suckled by the sow for three weeks post-farrowing were included in the consideration of improved breeding objectives for fertility. The intention was to use litter weight three weeks after farrowing as an objective for the sow' rearing ability. Litter weight and litter size were therefore recorded in 7,126 Landrace litters and 5,147 Yorkshire litters.

Results show heritability of litter weight as well as the number of pigs still being reared by the sow three weeks after farrowing. Heritability is highest for litter weight at around 0.09, and only around half of this for the number of pigs. However, results do show a clear favourable genetic correlation between the number of pigs and the litter weight. High litter weight is mainly seen in families with large litters. There was no correlation between total piglets born and litter weight: thus, high litter weight was observed in sows that delivered many piglets as well as in those that delivered few piglets.

Results also revealed a clear favourable correlation between LP5 and litter weight: in litters where LP5 numbers are high, litter weight is also high up to three weeks post-farrowing. This indicates that when we breed for LP5 we also improve the sows' rearing ability. These results confirm that breeding for LP5 not only helped increase the number of live pigs. It also helped improve sows' rearing ability through an increase in the weight of the litter up to three weeks post-farrowing. As litter weight is heritable, it will be possible to increase the sows' rearing ability slightly if litter weight is included in the breeding objective. The close genetic correlation between litter weight and LP5 seems to recommend reconsideration of LP5 as part of the breeding objective, as the breeding objective would then include two, very closely related traits.

Genomic selection with three-way hybrids

For the last two years, we have worked on developing models for genomic selection using data from three-way hybrids. Roughly 3,000 pigs were produced and data are now ready for testing in the new statistical and genetic tools developed by the Project Group. Analysis of data is a challenge as three-way hybrids are further away from the pure bred nucleus, herd. Hence new models and new ideas are required to determine how we can use this

in the breeding assessment with genomic selection in the future. The models should also be capable of handling heterosis (dominance). With data from three-way hybrids, it is possible to include more traits, such as pH at slaughter, that cannot be recorded in the purebred nucleus.

At Bøgildgård test station, phenotypic data were collected in conjunction with recordings of growing pigs and individual recordings were made of feed conversion. Data are collected for daily gain, feed efficiency, fat thickness, mortality, slaughter quality measured as lean meat percentage, pH and boar taint. Hair samples are collected from all parents and all three-way hybrids will be subject to DNA analysis. Genomic data will be generated routinely on all pigs and their parents. Data will now be analysed and used partly to validate the new models and partly to assess if and how best to practically apply data from three-way hybrids in genomic selection.

Model calculations proved that it is possible to obtain more heterosis in hybrids by using DNA information. Calculations show that for the breeds that are similar to each other at DNA level we can use the heterosis that exists between breeds only by combining DNA information with trial recordings of purebred animals. In such cases, DNA information and recordings from hybrids are less important. When, on the other hand, purebred animals differ at DNA level we get a better utilisation of heterosis by gathering DNA information and trial recordings of hybrids. The project ends in 2016.

The project is undertaken in cooperation with Aarhus University and received financial support from the Green Development and Demonstration Programme. Journal no. 34009-12-0540.

GenSAP

SEGES Pig Research Centre is one of the participants in an international consortium called GenSAP (Centre for Genomic Selection in Animal and Plants) that consists of 15 international partners and is led by Aarhus University. The consortium develops new theories within genomic selection. The partners in the consortium are representatives from the animal and plant industries in Denmark and from international genetic institutes. We are the only pig breeding company in the consortium. As some of the best scientists in livestock breeding and genetics participate in the consortium, we have a unique opportunity

for jointly generating new knowledge in this area. We participate in the aspects concerning breeding and selection theories. Knowledge generated in this area will give us a head start in genomic research that we can use in DanAvl. Model calculations made in this consortium demonstrated that our current breeding tool, EVA, may restrict in-breeding further by using its DNA information. By using a combination of EVA and genomic information, it is possible to reduce parentage effects between parents and reduce in-breeding without jeopardising genetic progress. This is an important outcome for us as less in-breeding will eventually increase genetic progress. The project ends in 2017.

EVA in the white breeds

EVA is nearly ready for implementation in the white breeds. Implementation will follow the same procedure as for Duroc, and EVA will be used on boars in quarantine and at AI stations for selection of boars for breeding and for assigning nucleus litters to these boars. All breeders will have access to all boars in relation to their proportionate litter quota. However, the white breeds differ from Duroc in a few areas. For instance, there are fewer white boars for AI than Duroc as they are only needed for breeding and multiplication. The percentage of boars selected for quarantine and AI is therefore lower than for Duroc and EVA must therefore be capable of optimising genetic progress and the speed of in-breeding. Furthermore, their breeding objectives also include maternal traits, where genetic progress depends on family information and where information is available at a late point in the boars' lives. They may vary more in index and for a longer time than Duroc. It is essential that breeders are assured of access to semen from EVA boars to a greater extent today than previously, as the implementation of EVA will restrict the access to semen as the number of boars selected by EVA for breeding will be lower than today. It is therefore proposed that EVA also replaces the current family-related restrictions on access to the quarantine and takes over pre-selection of boars for quarantine. A new simulation study indicates that this may result in long-term genetic progress and a decline in in-breeding. It is also proposed that EVA breeding boars be reserved for breeders so that they can only be used for purebreds as long as there is a demand for this. This should solve the challenges with access to semen. Finally, it should also be possible to assign litter to boars for a longer time than with Durocs to take account of possible increases in index due to LP5.

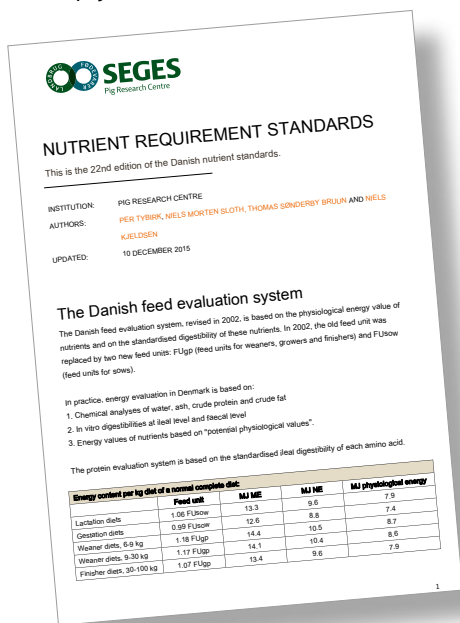


Litter size has increased significantly among Danish sows in recent decades.

NUTRIENT STANDARDS AND FEEDSTUFFS TABLE

Revision of standards April 2015

The standard amino acid profile for weaner and finisher feed was revised in 2015: it is now possible to lower the protein content, which will lead to a lower feed price. The standard for protein and amino acids was raised by 4% in feed for special pigs, such as the Contract for UK Production, where the bonus is proportionate with lean meat percentage. For more information, see brief no. 1513 at www.vsp.lf.dk.



SEGES Pig Research Centre's nutrient standards are available in Danish and English at www.vsp.lf.dk.

Weaners

The revision is based on evidence from new Danish and international studies that it may be possible to lower some of the standards for secondary amino acids in per cent of lysine. This will make it possible to lower the protein content and thereby decrease the risk of diarrhoea outbreaks at a given lysine level.

Finishers

The amino acid profile for finisher feed was revised as a result of a recent trial. A standard was introduced of 8 g standardised digestible lysine and 125 g standardised digestible protein per feed unit for pigs produced, for example, for the Contract for UK Production or the Antonius scheme, where a high lean meat percentage has additional value. This standard will benefit producers of pigs with lower lean meat percentage. Pigs produced to the 'UK standard' will experience the following: an increase in feed



Pig producers are advised to increase the protein and amino acid concentration in feed for pigs produced under the Contract for UK Production, especially if the lean meat content is below 60%.

price, a small increase in lean meat percentage, slightly better feed efficiency and either a small increase in average slaughter weight or an increase the number of finished pigs. For producers of 'standard' pigs, the economics of this strategy is largely neutral, while producers of pigs, where a high lean meat percentage is beneficial, will earn around DKK 1 per pig or DKK 3-6 per pig place per year, when the lean meat percentage level coincides with the national average. An increase in protein content will increase ammonia emissions, and producers are therefore advised to use the regular standards for 'standard' pigs.

New trial activities:

Phosphorus for weaners

SEGES Pig Research Centre is currently investigating the need for phosphorus in weaner feed containing 300% of the standard inclusion of phytase. The aim is to determine the lowest phosphorus level possible in weaner feed with 300% inclusion of phytase without jeopardising productivity and welfare.

Amino acids for finishers

SEGES Pig Research Centre is also investigating whether a higher amino acid concentration is required in feed for pigs with an FCR better than 2.6 feed units per kg gain. At the organisation's experimental station, low-protein diets are being compared with high-protein diets in a dose-response trial. The

aim is to investigate if it is possible to achieve the same lean meat percentage, feed conversion and daily gain with low-protein feed, compared to formulations with a normal or high-protein content, brought about by increasing the concentration of the cheapest amino acids (lysine, methionine and threonine).

Feedstuffs table

SEGES Pig Research Centre feedstuffs table provides a basis for analysis of grain and other feed ingredients, and it is routinely updated in co-operation with the feedstuff industry.

THE FEEDSTUFFS TABLE INCLUDES:

- Table values for nutrient content of a wide range of ingredients (including the latest analysis values of the current year's harvest)
- A calculation module that is used for analysing the nutrient content of a diet on the basis of the ingredient composition of "open diets" compared with the standards. This calculation also provides the expected 'I-factor' that is used for verification of energy content.
- Information on errors, which may be made by, eg, producers who analyse their own grain or purchased feed.

The feedstuffs table is available for download (spread sheet) at www.vsp.fl.dk.



Analysis of purchased feed

SEGES Pig Research Centre regularly analyses samples of commercial pig diets to verify the content listed on the label in terms of both nutrient and ingredient content.

In 2015, the analyses included diets from the following compound feed producers:

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

ATR Landhandel declined to participate in the analysis.

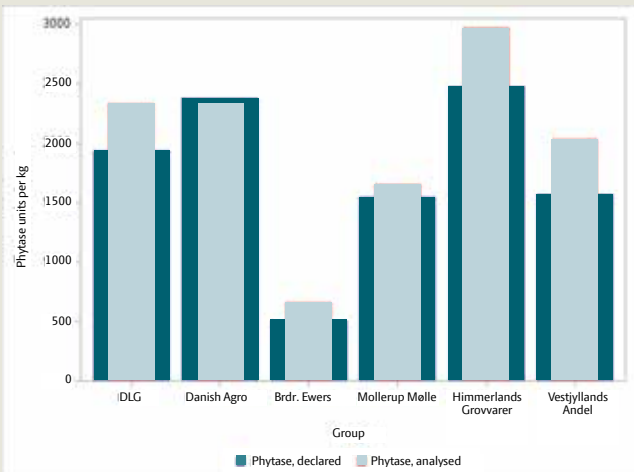
The analysis included 90 diets of which ten from each company were forwarded to the Danish Veterinary and Food Administration for microscopic-botanical analysis to determine the content of individual ingredients.

Analysis results – nutrients

In figure 1, the analysed content of feed units is compared with the declared content of feed units for each feedstuff producer. Values below zero indicate that the analysis verified fewer feed units than declared.

As shown in figure 1, most diets were close to zero with the exception of feed from Himmerlands Grovvarer where the declared

FIGURE 2 Declared and analysed content of phytase



content was higher than what was revealed in the analysis.

The declared content of calcium and phosphorus was largely verified in the analysis. In most samples, the analysed content of phytase was higher than declared on the label. However, it should be noted that feed from Danish Agro did not include a safety margin for phytase content (figure 2).

Analysis results – ingredients

Analyses of the samples from Brdr. Ewers and Vestjyllands Andel showed 100% correspond-

ence between information printed on the labels and the analysis results. The largest deviations were found in samples from Himmerlands Grovvarer where analyses revealed deviations in 4 out of 10 samples.

Analysis of commercial pig diets

SEGES Pig Research Centre analysed piglet diets from five different producers and compared them with a control diet formulated by SEGES Pig Research Centre.

The differences in production value between the diets were higher than reported in previous analyses. Analysis of feed from DLG showed a significantly lower production value than the other five diets.

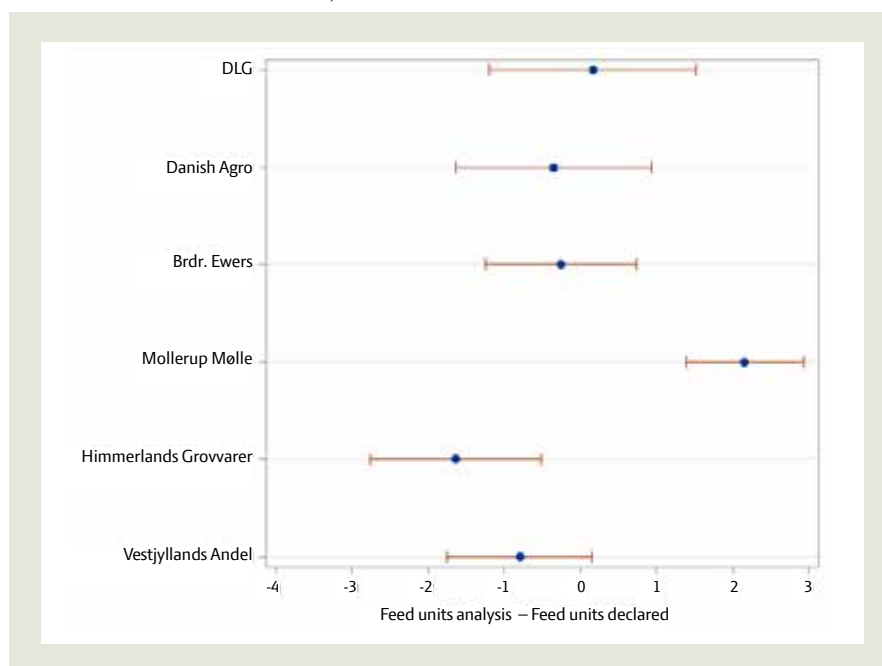
The highest production value was obtained with feed from Hedegård Agro and the control diet, which was significantly higher than what was achieved with the other diets.

The correspondence between declared and analysed content of feed units was lower than that obtained in all previous analyses of commercial diets.

Furthermore, results demonstrated a poorer match in terms of amino acid content than that found in previous analyses, as all diets were generally deficient in synthetic amino acids.

The projects 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.

FIGURE 1 Difference between analysed and declared content of feed units



FEEDING OF WEANERS AND FINISHERS

Energy in weaner feed

SEGES Pig Research Centre compared varying levels of energy in feed for weaners weighing between 9-30 kg. The energy content, expressed as feed units (FUgp), varied from 1.00 to 1.20 per kg feed. The energy content was varied by increasing the content of wheat and fat and by reducing the inclusion of barley, wheat bran and oats.

When the content of feed units per kg was increased:

- Feed intake increased up to 1.17 FUgp per kg (feed intake dropped at 1.20 FUgp per kg, probably due to poor taste and/or more dust in the pellets as fat content was increased)
- Daily gain increased up to 1.12 FUgp per kg
- FCR was reduced by 0.006 FUgp/kg gain as energy content increased by 0.1 FUgp/kg feed.

The best production value was achieved at 1.08 FUgp/kg feed. At the current feed prices, the economic optimum shifts to 1.11 FUgp per kg feed as the price per feed unit drops, the higher the energy content.

When identical prices per feed unit and current feed prices are used for the calculations, results reveal only very small financial differences with the energy content typically seen in weaner feed. Between 1.06-1.17 FUgp per kg, gross margin drops by no more than 1%, which shows that the price per feed unit is far more important economically than the content of feed units per kg feed. Investigation of the gastric effects in the two

groups fed the highest and lowest energy content revealed fewer gastric ulcers or scars in the pigs fed the low-energy feed, probably due to the high content of barley. For more information, see trial report no. 1034 at www.vsp.lf.dk.

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.

Reduced copper in weaner feed

SEGES Pig Research Centre investigated the effect of lowering the content of copper in weaner feed from the permitted maximum of 150 ppm down to 20 ppm. Results revealed a significant drop in productivity and production value, and more pigs were treated for diarrhoea and treatment periods were longer.

Tests were also carried out to establish whether the addition of 1% benzoic to the feed might replace the copper that was subtracted. Weaners fed this diet had a production value equal to that of the control group given 150 ppm copper, and treatment frequencies were also identical.

The trial comprised four groups and the production values for each are shown in figure 1.

Blood plasma for weaners

SEGES Pig Research Centre wishes to minimise the risk of introducing exotic diseases such as PED and swine fever into Danish pig herds, and therefore recommends that the use of blood plasma in weaner feed, should be

stopped, unless documentation confirms that the plasma product was:

- Subject to sufficient heat-treatment during spray drying
- Stored for minimum six weeks with a maximum 8% water content.

Appropriate documentation must be provided during DANISH audits and this will now be a requirement in the DANISH scheme. Pig producers who buy feed or blood plasma from producers or suppliers included on the "positive list" fulfil this requirement for documentation. The list is available on the SEGES Pig Research Centre website.

Liquid feeding – feed given towards the end of the growing period

Some pig producers may succeed in improving the production value per pig place per year by increasing the feed given, but this must not adversely affect FCR. This was the conclusion of a trial with finishers (female pigs and castrates) where a high feed amount (3.1 FUgp a day) was compared with a low feed amount (2.8 FUgp a day) towards the end of the growing period.

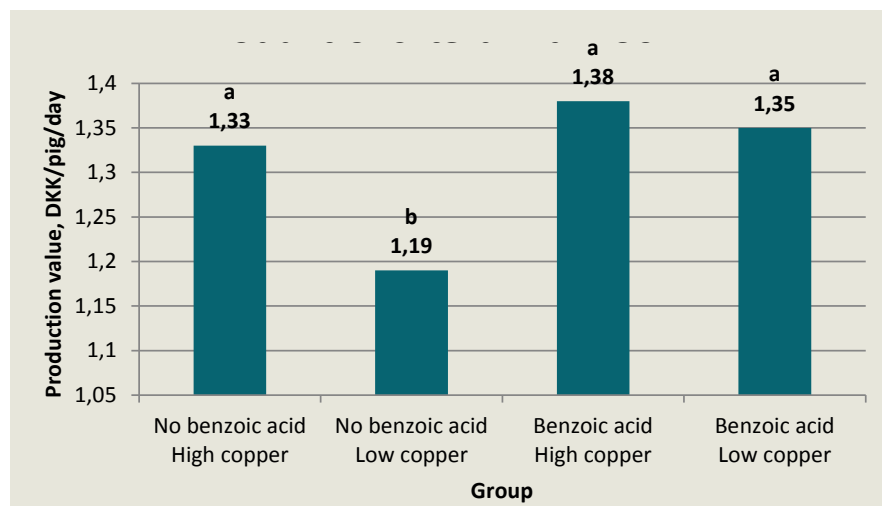
The feed given towards the end of the growing period should be only as high as necessary to reach optimum slaughter weight within the production period available for each batch. If the feed given is too high, an economic loss will incur due to a lower lean meat percentage and some herds will also have a poorer feed conversion.

Even though castrates perform worse than female pigs, both should be given the same feed towards the end of the growing period, as differences in feed conversion and lean meat percentage between high and low feed amounts are almost identical for both genders.

Pig producers experiencing problems with poor feed conversion or low lean meat percentage are not advised to lower the feed given to castrates only, as the effect expected for female pigs is just as great as that of lowering the feed given towards the end of the growing period. Castrates given less feed than female pigs in this period will also have a lower slaughter weight due to a poorer feed conversion. For more information, see trial report no. 1027 at www.vsp.lf.dk.

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-07-00234 and 3663-D-09-00354.

FIGURE 1 Effect on production value (7-30 kg) of feed with combinations of high/low content of copper with or without benzoic acid





Restricted liquid feeding with feed mixed on-farm yielded better production results than ad lib dry feeding with pelleted feed.

Liquid feed or dry feed

In a concept trial with finishers, SEGES Pig Research Centre compared restricted feeding of liquid feed mixed on-farm with ad lib pelleted feed available from tube feeders.

Results revealed overall better production results with liquid feed mixed on-farm than with pelleted dry feed. The production value obtained with liquid feeding was on average DKK 14.2 higher per pig for a production site with both castrates and female pigs, when calculations were made with the same feed price for liquid feed mixed on-farm and pelleted dry feed.

The results also showed that this additional income per pig was not sufficient to offset the increased costs of liquid feeding, such as more costly housing and feeding systems. Liquid feed mixed on-farm must therefore be DKK 0.027 cheaper per feed unit than pelleted feed to reach identical financial results on a site with castrates and female pigs. The price of liquid feed mixed on-farm includes costs of the equipment for on-farm mixing.

Previous analyses demonstrated that feed mixed on-farm is typically DKK 0.05 cheaper per feed unit than pelleted feed. On this basis, earnings would increase by around DKK 4.6 per pig with restricted liquid feed mixed on-farm compared with ad lib pelleted dry feed on a site with both castrates and female pigs.

On a site with both female pigs and male pigs, earnings would be largely identical with both

these concepts, assuming that a high feed curve is applied with liquid feeding. For more information, see trial report no. 1023 at www.vsp.lf.dk.

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-09-00354 and 32101-U-12-00195.

Dutch vs Danish feed

SEGES Pig Research Centre compared a typical Danish feeding concept, the 'unity mix, with a typical Dutch concept, two-phase feeding.

Feed for the trial was purchased from a commercial feed compounder in the Netherlands who was unaware that the feed would be used in a trial.

Throughout the entire finishing period, the production value was significantly higher for the pigs fed the Dutch feed. The overall effect can be attributed to a dramatic increase in productivity in the grower period, especially due to the higher copper content allowed in Dutch feed. When calculations took into account the actual purchase price of the feed, profits dropped when the Dutch feed was used. For more information, see trial report no. 1024 at www.vsp.lf.dk.

Meal vs pellets – particle size

The effect of meal feed vs pelleted feed for finishers was studied in a herd with 'state of

the art' tube feeders with an integrated water supply. The pelleted feed and the meal feed were finely ground with around 80% of the particles below 1 mm. Feeder settings were routinely adjusted to minimise feed wastage.

As seen in previous studies, this trial demonstrated significantly better productivity with pelleted feed than meal feed. Production value per pig place was 10 points lower for pigs fed meal feed, when pelleted feed was set to index 100. Meal feed must therefore be DKK 0.08 cheaper per FUGp than pelleted feed to achieve the same gross margin.

These differences in production value were attributed to the fact that pelleted feed yielded a better production value of 3.7% and lean meat percentage was 0.5 percentage points higher. In addition, daily gain was 1.3% lower for pigs fed pelleted feed. 'State of the art' feeding equipment, correct feeder settings and fine particle size were not sufficient to reduce the difference between the two types of feed and this was also the case in previous trials.

Pelleted feed increased the frequency of gastric ulcers, as also observed in previous studies. The risk of having a gastric score of more than 7 was 3.5 times higher for pigs fed pelleted feed compared with meal feed. Mortality and treatment frequency did not differ between the groups.

Broad beans

Analyses of four batches of broad beans of the Fuego variety revealed large variations. Energy content varied from 73 to 95 FUGp per 100 kg, and crude protein content varied from 22.4% to 25.2%. This shows that broad beans should always be analysed before inclusion in feed formulation.

In some cases, it may require technical adjustments of both transport and feeding systems to allow cost-effective use of broad beans. This is currently being investigated in a trial with finishers.

SEGES Pig Research Centre is currently investigating the effect of including 22% broad beans in finisher feed.

Feeding of entire males

Research showed that entire males given feed with a higher content of energy and protein/ amino acids had an increased daily gain, with production value increased by 10%. Entire males fed with the trial diet were 4-5 days



>

younger at slaughter than the control group, and had a lower taint score during a Human Nose analysis.

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.

Entire males fed fibre and pure grain for a few days before slaughter had significantly lower skatole levels compared with the control group: 15% chicory fed to entire males for four days before slaughter reduced skatole by 58%. Feeding grain for three days reduced skatole by 29%. The inclusion of Jerusalem artichoke for four days, beet pellets and palm cakes for 14 days reduced boar taint by 30-50%.

Androstenone levels in fat did not differ, but a smaller percentage of entire males scored 2 (=boar taint) in the Human Nose analysis of pigs in the groups fed chicory and artichoke. Feeding pigs chicory and grain for a brief period is an economically realistic method to lower rejection rates, particularly if it is only fed to pigs ready for slaughter. Jerusalem artichoke is not available for sale.

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

nutrition

FEEDING OF SOWS



Protein standard for lactating sows

A high level of milk production is a vital factor in increasing piglet survival rates and improving daily litter gain. Trials have consistently confirmed that the sow's milk availability is limiting to piglet growth after the first week of lactation. It is therefore essential that the sow's nutrient requirement is fulfilled through its diet to the greatest extent possible, as the sow will otherwise need to mobilise body reserves to obtain nutrients.

SEGES Pig Research Centre investigated whether the current standards for amino acids and protein lactation feed support maximum growth, without a negative impact on the mobilisation of body reserves.

This was investigated in a herd where sows in six groups were fed increasing protein concentrations. The amino acid profile of the protein used complied with the current Danish standards for lactating sows.

Litters were cross-fostered to 14 piglets and sow weight changes and litter weight gain were recorded during the lactation period. Sows' daily feed intake was also recorded and used to calculate litter gain, feed conversion and mobilisation of the sows' body reserves.

The preliminary results in table 1 indicate that an increase in crude protein content increases average daily litter gain and reduces the sows' mobilisation of body reserves.

Reproduction results were also recorded to ensure that performance and economy are taken into account with the new protein standard for lactating sows. Preliminary results indicate that feed conversion may improve when protein concentrations increase, but it is too early

to revise the standards. Future trials will clarify whether the amino acid profile of the protein needs to be revised.

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.

New vitamin D product for sows

Vitamin D3 is important to sows' intake and utilisation of calcium and phosphorus. It is also one of the factors that regulate deposition and excretion of calcium and phosphorus in bones and excretion of calcium and phosphorus from kidneys.

The minimum standard inclusion rate for vitamin D3 in sow feed is 800 i.u. per feed unit (FU_{sow}), though in practice around 1,400 i.u. per feed unit are used. According to Danish legislation, vitamin D3 content must not exceed 2,000 i.u. per kg pig feed. Synthetic vitamin D is transformed in the liver to make it absorbable to the pig. The first metabolite is 25-hydroxy vitamin D3 (Hy-D). Today it is possible to add Hy-D directly to pig feed which should increase the biological value to pigs. 1 micro gram Hy-D corresponds to 40 i.e. vitamin D3.

SEGES Pig Research Centre carried out analyses to establish whether inclusion of 50 µg Hy-D per feed unit (corresponding to 2,000 i.u. = maximum inclusion allowed) in sow feed throughout the entire reproductive cycle increases litter weaning weight and improves immunity among weaners (recorded by gain and mortality rate until 30 kg) compared with the normal vitamin D3 inclusion.



Lactating sow.

Results revealed an actual Hy-D content in the feed of 44 µg, corresponding to 1,940 i.u. vitamin D3 per feed unit.

The investigation only included litters cross-fostered to 14 piglets per litter. Piglets were weighed at birth and at weaning, and mortality was recorded. The weaners were monitored post-weaning where daily gain and mortality were recorded. All weaners were given the same treatment, and therefore any effect of Hy-D was attributed to the level supplied in the lactation period. Sows were blood sampled at farrowing, after the first week of lactation and at weaning. The content of 25-hydroxy vitamin D3 in the blood samples throughout lactation averaged:

Group	Control	Hy-D
Sows	36	36
Vitamin D3, µg/mL	23.6	52.7

TABLE 1 Effect of increased concentration of lysine and other amino acids (protein) for lactating sows (preliminary results)

	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
St.dig. lysine per feed unit, g	5.5	6.1	6.6	7.1	7.8	8.5
St.dig. CP per feed unit, g	92	101	108	116	126	136
Av. feed intake, kg/day	6.26	6.29	6.23	6.31	6.37	6.22
Av. litter gain, kg/day	2.65	2.80	2.86	2.92	3.00	3.02
Av. weight loss, kg/day	-0.84	-0.75	-0.80	-0.68	-0.57	-0.57

HY-D

The use of Hy-D increases the vitamin D3 level in blood. Preliminary results indicate that Hy-D improves weaning weight and lowers piglet mortality.



Floor feeding of sows.



Energy density of gestation feed

Group-housing of sows from weaning was made a statutory requirement as of January 1, 2015. In group-housing environments, sows compete for feed, and it is often difficult to ensure that all gilts and sows eat a sufficient amount of feed to ensure that reproduction is not adversely affected.

Analyses of different feed amounts given and diets in the implantation period made at the Faculty of Agricultural Sciences, Aarhus University, in 2006 revealed that response in terms of reproductive efficiency differed between gilts and sows.

Foetal loss was higher in gilts fed 3.6 feed units per day compared with 1.8 feed units per day, whereas this was not the case for sows. This investigation also included two different diets that contained 0.9 and 1.13 feed units, respec-

tively, per kg feed. Results showed no effect of diet on foetal loss among gilts, while foetal loss was lower in sows fed the low-energy diet.

SEGES Pig Research Centre investigated whether sow performance within a pen group – measured as average number of total born piglets born per litter and average farrowing rate - is affected, when gilts and sows follow identical feeding regimes with two different diets (0.9 or 1.05 feed units/kg) during gestation. The nutrient content of the diets was identical per feed unit and the only difference was that the sows had to eat 17% more of the diet containing 0.9 feed units per kg than the other.

The content of feed units per kg was reduced by substituting wheat with oats in the diets. The sows were weighed and back fat recorded at transfer to the gestation unit immediately

after insemination and at transfer to the farrowing unit. Weight and back fat were used to pen variation at transfer. It was expected that sows' gain and back fat would be identical in the two groups, as they followed the same feeding regime, but results showed that the highest gain in terms of weight as well as back fat was achieved in the group fed 0.9 feed units per kg. This indicates that the Danish feed evaluation system may underestimate energy content in high-fibre diets for gestating sows.

Farrowing rate in this investigation was defined as the percentage of sows that make it from transfer to the gestation pen just after insemination to transfer to the farrowing pen.

IMPROVEMENTS THROUGH FEED

Preliminary results indicate that litter size and farrowing rates improve when using feed containing 0.9 feed units per 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-12-00197.

Feed supplement in late gestation

Several international studies have suggested that an increase in fibre content of feed in the final weeks of the gestation period may positively affect farrowing performance and that it may lower the number of stillborn and increase the fat content of the sows' colostrum. As litter size keeps increasing, it is also possible that an increased protein content in the feed in late gestation may have a positive impact on foetal gain. On the basis of preliminary studies with different sources of fat and fibre, and different protein levels and feed amounts given in late gestation made at Aarhus University, SEGES Pig Research Centre carried out studies to determine whether a daily allocation of a low-fat feed supplement containing fibre and protein during the last two weeks before farrowing may lower both piglet mortality during lactation as well as the number of stillborn piglets per litter. The feed supplement was developed by SEGES Pig Research Centre in cooperation with DLG and Aarhus University, and produced by DLG. Results show an increase in the daily fibre and protein supply and a slight increase in the daily amount of fat. The feed supplement replaced 350 g of the regular sow feed during days 102-108 in gestation and 700 g a day from day 109 until farrowing.

TABLE 2 Effect of feed supplement in the final weeks of gestation

Group	Control	Feed supplement
Number of batches	32	32
Number of sows	298	322
Total born piglets/litter	18.4	18.1
Stillborn of total born, %	8.7 ^a	6.6 ^b
Piglet mortality during lactation, %	14.6	13.7
Total piglet mortality, %	22.3 ^a	19.9 ^b
% sows treated for MMA	6.4	5.3

^{a,b} Different superscripts indicate significant differences ($P < 0.01$).



Results demonstrated a significant reduction in the percentage of stillbirths in the trial herd, when sows were fed the supplement during the last two weeks before farrowing. However, piglet mortality during lactation was not affected nor was the percentage of sows treated for MMA. Total piglet mortality was lower among the sows given the feed supplement, primarily because these sows delivered fewer stillborn piglets (table 2).

The results revealed the potential for improving the feed used in the transition period from gestation to farrowing, but it is unclear whether the effect is caused by fibre, protein and fat combined or just one of these ingredients. However, based on these results and other trials, pig producers are advised to add moderate amounts of high-fibre ingredients (such as dried sugar beet pulp) to feed for gestating sows (at 4-8%) and for lactating sows (at 2-5%).

The project received financial support from the Green Development and Demonstration Programme. Journal no. 3405-11-0342.



International research results show that sows fed roughage exhibit less 'sham chewing'.

Roughage for gestating sows

In two herds, gestating sows were fed 2 and 3 kg of corn silage, respectively, as a supplement to the liquid feed used. In a third herd where electronic sow feeding was practised, sows had ad-lib access to sugar beet pellets in feeders.

It is expected that sows fed roughage (corn silage or sugar beet pellets) will experience a greater feeling of satiety and exhibit calmer behaviour. In this trial, 'sham chewing' was the parameter used to assess whether the feed had a positive effect on sows' motivation to eat.

Use of corn silage presents a challenge as it is difficult to determine a correct estimate of the content of feed units per kg. Standard values from SEGES Kvæg (cattle division) are available, but must be supplemented with back fat measurement and subsequent adjustment of feed curves.

The outcome of the trial revealed a back fat thickness higher than expected when sows were fed corn silage. It was calculated that sows needed to eat 3.5 kg corn silage to register intake of one feed unit per day, but in reality sows only had to eat 2.8 kg. This is attributed to the fact that corn silage from 2014 had a high content of corn cobs and thereby contained more energy than that stated in the tables.



Systems for allocating straw may also be used for distributing roughage such as corn silage.

EXPERIENCE WITH CORN SILAGE AND BEET PELLETS

- Difficult to manage body condition when sows are fed roughage
- All sows must have easy access to roughage
- Routine inspection of dosing accuracy of roughage
- Manure composition changes when sows are fed roughage, requiring a winch system to be installed
- Roughage must be stored in a rodent-proof warehouse (mice, rats)
- Corn silage must be used within two days from collection from silo/plastic.

Preliminary results demonstrate that corn silage supplied in the amounts studied in this trial does not affect reproduction results in sows.

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-13-00234.

ENVIRONMENTAL REGULATION

More pigs may be kept in older units

The new basis for reporting alterations in pig producing businesses enables producers to house more pigs in their existing facilities, recognising that these days pigs reach slaughter weight sooner and excrete less nutrients.

Producers operating with old permits may increase the number of pigs in their units, without being adjudged to have such an adverse impact on the local environment, as was estimated on the date when the environmental approval was originally granted. However, livestock farms located in catchment areas with increasing livestock density cannot make use of this simplified scheme and must still apply for the formal environmental approval if changes are made.

Approvals granted pre-2007

More than 80% of all Danish finishers are housed in small and medium-sized pig houses built before 2007.

With the recalculated basis for a single livestock unit (LU), these farms may increase the number of pigs by 8-20% depending on whether they have previously applied for the "full house" scheme.

N.B. This scheme is scheduled to end on May 29, 2017.

Approvals granted post-2007

Fewer than 20% of all Danish pigs are housed in facilities approved by the Danish Livestock Act that came into force on January 1, 2007. With the new rules, producers with an approval granted in the period 2007-2011 may expand production up to 17%, provided they comply with phosphorus regulations.

N.B. This scheme is scheduled to end on January 1, 2018.

Rules that must be met

To use the scheme for reporting changes, the following rules must be met:

- General nuisance limits for odour
- Established distance requirements from certain types of sensitive natural environments
- A series of phosphorus requirements in local areas.

More finishers

The new rules make it possible for Danish pig producers to increase their production by 500,000-600,000 finished pigs per year in existing units.

In addition, finished pig production can be increased by further 300,000-400,000 head in existing units, provided there is compliance with the new rules relating to livestock numbers and land area.

New environmental regulation

The Danish approach to environmental legislation has led to an overly complex set of rules and regulations. The possibility of bringing these rules into closer alignment with EU Directives is under consideration.

The draft of new environmental regulation is expected to be based on a simpler and more flexible approach, without compromising the level of environmental impact.

Pig units and land as separate entities

Approvals based on treating pig production facilities and the surrounding land as separate entities will lead to greater flexibility. Pig units should have approval based on the actual amount of odour released and the true level of ammonia emissions. So approval should be linked to the overall size of the production facility rather than the number of animals kept.

When the new regulations are implemented, all current area requirements for each individual environmental approval will be cancelled, and the environmental impact of animal slurry will be calculated by new, general fertiliser regulations applying to the local agricultural area.

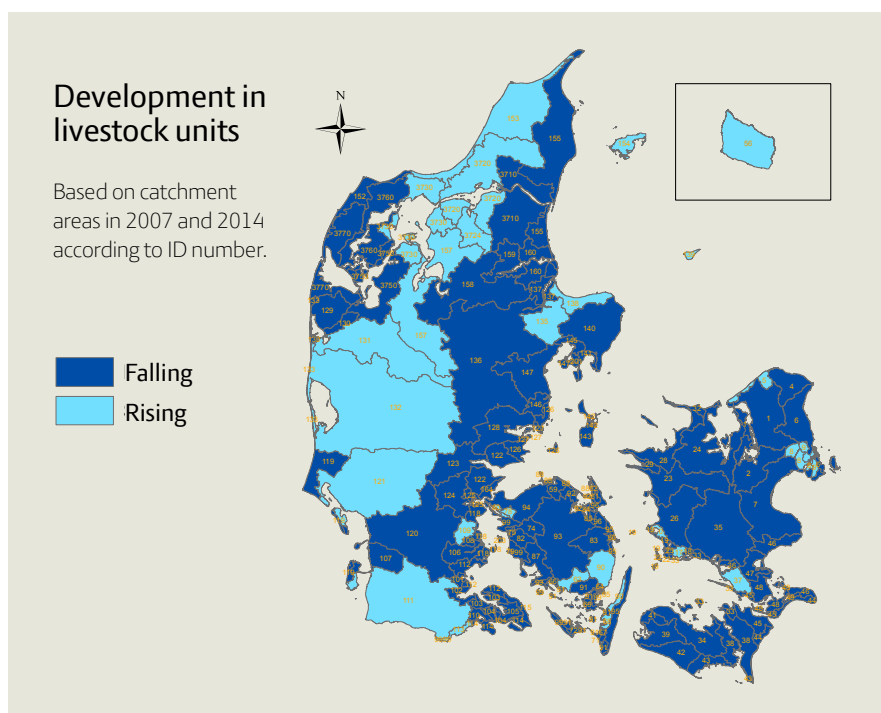
The new fertiliser regulations will cover all agricultural areas and include those not yet approved under the 2007 Livestock Act. Some producers will then experience less strict terms and others will have to conform with more stringent area requirements.

Cancellation of the special 'Area Approval' will make it easier to move slurry to new areas. The burden imposed by the rule relating to increasing livestock density will be shared over all areas where slurry is spread. Most pig producers will experience only a marginal adjustment of manure standards.

Use of the theoretical "livestock unit" is expected to be phased out and pig producers will then be allowed to spread slurry up to a level of 170 kg nitrogen per hectare. A new phosphorus regulation of agricultural areas is currently being discussed, with the possibility that a 'phosphorus account' may be incorporated within the manure account at some point in the future.

So it may be that a new phosphorus standard may restrict the actual amount of livestock manure that can be spread on agricultural areas.

FIGURE 1 Catchment areas with increasing livestock density



CLIMATE AND VENTILATION IN PIG HOUSES



Ventilation principles

SEGES Pig Research Centre conducts trial activities aimed at optimising and improving the climate within the social environment of the pig pen. Work is also undertaken to help develop the principles of ventilation and energy-saving measures.

Point extraction

The idea behind point ventilation is that, with 'point extraction', the first 10% of the maximum ventilation capacity is directed through extraction points located in the slurry pit below the lying area and through an air cleaner. The remainder of the foul air leaving the building passes unfiltered through ceiling outlets. 'Point extraction' is highlighted on the Technology List of the Danish Environmental Protection Agency for use in finisher units with 1/3 drained floor or 25-49% solid floor in the lying area. The effect of 10% 'point extraction' in a finisher unit with 2/3 solid floor was also investigated.

Results show that, as a result of applying point extraction 34% of the total ammonia emissions and 27% of the odour emissions were directed through the 'point extraction' system for subsequent cleaning. The effect of 'point extraction' in pens with a 2/3 solid floor was lower than in pens where a smaller proportion of the floor was solid. This was expected as the slurry pits, relatively speaking, contribute less to the overall emissions from the unit, the higher the proportion of solid floor. It is also to be expected that the efficiency of the 'point extraction' system is affected by the location of the extraction points further away from the lying areas and by the degree of fouling of the solid floor.

Additional air intake

A variety of additional air intake in a farrowing unit was investigated to evaluate possibilities for optimising the sows' immediate environment during the summer.

The investigation considered four different factors:

- Control (no additional air intake)
- Trough valve
- A single ceiling inlet per sow
- Transverse ceiling inlets in the section

The additional air intake was controlled in relation to outdoor temperatures. Results demonstrated that the optimum environment for the sows was obtained with one ceiling inlet per sow, if assessed according to temperature and carbon dioxide concentra-



Trough valve: the air is directed towards the head of the sow.

tions recorded down in the pen. However, the environment generally tended to be better in pens with additional air intake compared with control pens.

Data showed no differences in sows' lying behaviour or in the occurrence of piglet fouling on the solid floor in the farrowing pens.

AgriFarm Concept unit

AgriFram has developed and built the first finisher unit with hybrid ventilation and air cleaning. With this ventilation principle, the majority of the air exchange in the pig house

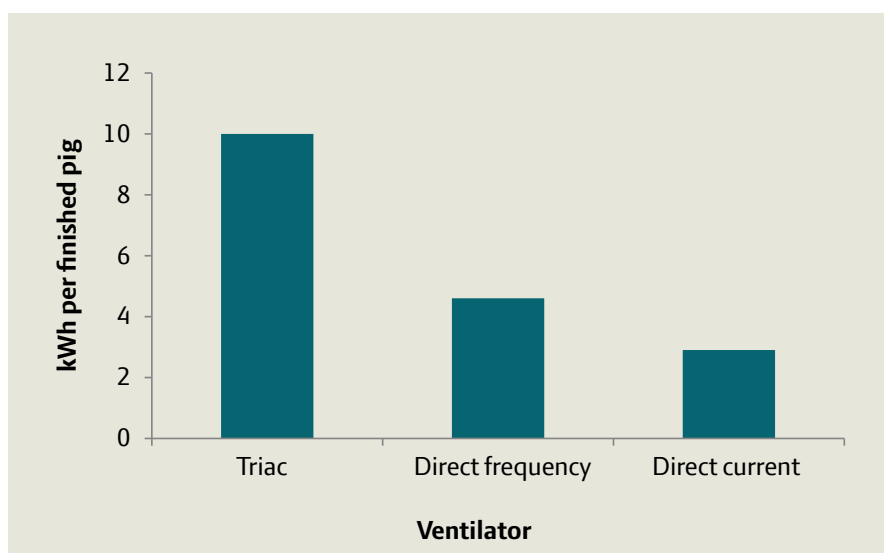
takes place via natural ventilation, and a small part is directed through 'point extraction' and passes through an air cleaner, the Agri AirClean system. SEGES Pig Research Centre is currently testing this concept to document the effect on pig welfare, the environmental impact of the pig house and air cleaner and the energy required to operate the system.

Energy-efficient ventilation

Ventilation accounts for up to 50% of the energy consumption per finished pig, and it is possible to save a considerable amount of energy by using a 'direct current fan'. Products from SKOV A/S and Munters A/S are currently being tested, and preliminary results indicate a reduction of up to 30-40% of the energy spent per finished pig compared with frequency controlled fans. Triac controlled fans are typically used in older pig houses, and, if these are replaced by direct frequency controlled fans, it may be possible to reduce energy consumption per finished pig by up to 70%. In addition, 'direct current fans' benefit the working environment as they make less noise.

In new pig buildings, 'direct current fans' will often be a straightforward solution, but for existing pig houses the owner should consider whether a reasonable pay-back period is possible before replacing otherwise well-running fans. Most ventilation companies market direct current fans, but before making an investment, buyers should obtain documentation regarding the expected savings in energy, and it may also be necessary to replace controls and cables.

FIGURE 1 Electricity consumption of different types of fans



SEGES Pig Research Centre participates in development and improvement of environmental technologies for reduction of ammonia and odour emissions from pig housing. This work involves both joint ventures with companies manufacturing these technologies and research establishments and research projects initiated by SEGES Pig Research Centre. New environmental technologies are also tested with the aim of documenting their effectiveness to enable acceptance of these technologies on the List of Environmental Technology from the Danish EPA.

THE LIST OF ENVIRONMENTAL TECHNOLOGY OF THE DANISH ENVIRONMENTAL PROTECTION AGENCY

Is a reference source of well-documented and efficient environmental technologies. It is used as a reference by pig producers, advisors and local authority caseworkers, when preparing and reviewing applications for environmental approvals. The List of Environmental Technology is routinely updated. In 2015, frequent removal of slurry was accepted on the list, as was the air cleaner Farm AirClean BIO Flex from SKOV A/S in both two- and three-step versions.

Frequent removal of slurry

Frequent or weekly removal of slurry from finisher units was accepted on the Technology List as delivering a 20% reduction in odour emissions. The technology has no effect on ammonia emissions and is only approved for finisher units with drained flooring in the lying areas.

SmellFighter

The SmellFighter system is a solution marketed by Infarm A/S for reduction of odour emissions in combination with acidification of slurry. This is done by mechanical separation of slurry during the daily acidification process. Research activities at SEGES Pig Research Centre's experimental station, Grønhøj, previously demonstrated that the SmellFighter reduces odour emissions by 43% compared to pig housing where slurry treatment was not applied.

The SmellFighter is currently being tested in a finisher unit with approximately 7,000 pig places. Results are expected in 2016.

In January 2015, Infarm A/S was acquired by Jørgen Hylgaard Staldservice A/S.

Cooling of slurry

Cooling of slurry has been provisionally accepted on the List of Environmental Technology. The concept is currently being tested in several herds to document its effect on ammonia emissions with the aim of securing

permanent approval on the list.

At Grønhøj Experimental Station, results reveal a 35% decrease in ammonia emissions from units where slurry was cooled with 55 W/m², compared with units where no slurry cooling took place. Large-scale testing of the effect of slurry cooling on odour emissions is now underway.

Munters MAC 2.0

In 2014, the chemical air cleaner MAC 1.0 from Munters A/S was accepted on the List of Environmental Technology as delivering 89% ammonia reduction.

Munters A/S subsequently launched a version 2.0 of the MAC where the air cleaner is placed horizontally instead of vertically, which makes cleaning and maintenance easier. Operational efficiency and operating costs have been monitored for a year now, with the aim of having the air cleaner accepted on the List of Environmental Technology.

Acceptance on the List of Environmental Technology is anticipated in 2015.

The project received financial support from the Green Development and Demonstration Programme. Journal no. 34009-12-0533.

Cleaning of point extraction air

In order to obtain the environmental benefit of 10% 'point extraction', the air directed through the point extraction system must be mechanically cleaned. Ammonia and odour concentrations are generally higher when air is passed through 'point extraction', compared with air directed through ceiling outlets. Air cleaners are dimensioned to 10% of the maximum ventilation capacity of the pig house and will therefore operate at full capacity all year round.

SEGES Pig Research Centre is currently investigating the ability of air cleaners to reduce ammonia and odour concentrations in air passing through 'point extraction'. The research includes investigation of the effect of both alkaline and acid in a chemical air cleaner from Munters A/S on ammonia and odour emissions from a finisher unit with 'point extraction'.

TABLE 1 Environmental technologies for pig housing accepted on the List of Environmental Technology at August 2015

Technology	Product	Ammonia reduction, %	Odour reduction, %	Note
Cooling of slurry		< 30	-	
Acidification of slurry	JH Forsuring NH4+	64	-	
Frequent removal of slurry		-	20	Weekly removal of slurry in finisher units with drained floor in lying area
Partly solid floor		17-34	33	For finishers, compared with drained floor
Point extraction		= (0.7 × E) - 12	= (0.39 × E) + 9	For finishers, <49% solid floor. Depends on effect of air cleaner(s), "E"
Chemical air cleaning	Munters A/S, MAC 1.0 (TLV-A)	89	-	At max capacity of 25,000 m ³ /hour
Biological air cleaning	Skov A/S, Farm AirClean BIO Flex 2-stage	88	74	At max impact of 2,100m ³ /hour/m ² front surface
	Skov A/S, Farm AirClean BIO Flex 3-stage	87	81	At max impact of 3,600m ³ /hour/m ² front surface



The SmellFighter is a slurry treatment facility from Infarm A/S.

SEGES Pig Research Centre is represented in the 'BioPunkt' project together with Aarhus University, the Danish technological Institute and SKOV A/S, with the aim of improving and further developing treatment of extraction air using a biological air cleaner from SKOV A/S.

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

Simple separation

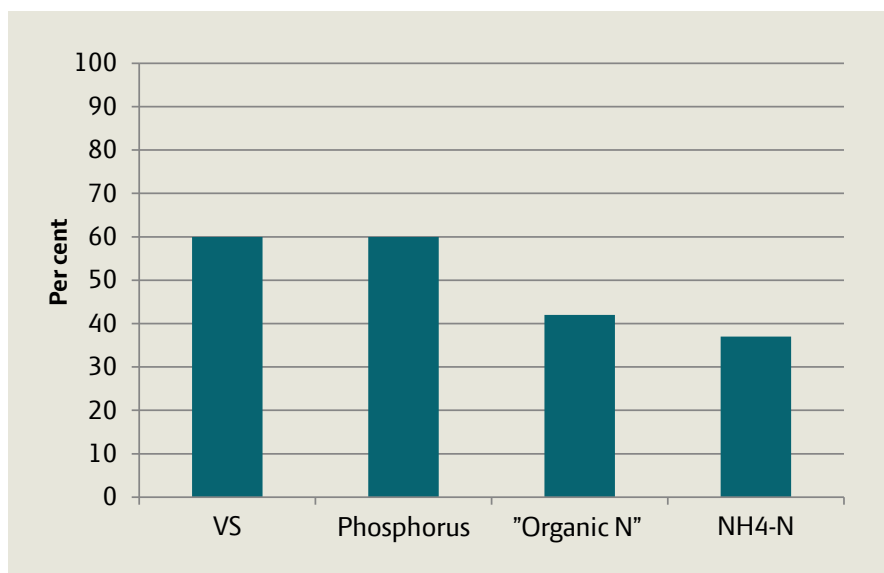
Natural separation (sedimentation) of slurry for 1-2 weeks in 3 m high tanks is shown to concentrate slurry further with the result that the bottom fraction of the slurry contains significantly more volatile solids (VS, organic dry matter) and phosphorus than contained in the slurry at emptying. VS is the part of the dry matter (DM) content of the slurry that can be used for biogasification. By concentrating VS in slurry further, transport and processing costs in biogas systems are reduced.

SEGES Pig Research Centre investigated whether sedimentation of slurry was practicable. This was studied in a wean-to-finish pig herd where slurry was directed to a 600 m³ storage tank, from which the biogas company collected the slurry.

In the trial period, slurry was emptied every third week from the slurry pits. Slurry content was analysed as soon it was removed and also after standing for 1 and 2 weeks; the top fraction (65% by volume) was pumped into a slurry tank and the bottom fraction stirred and the content was analysed.

Figure 1 shows the average content collected in the bottom fraction as a percentage of the total content of the slurry. The bottom fraction (35% of the slurry) contained up to 60% of the total VS and phosphorus content of the slurry, and this was removed for off-site biogasification.

FIGURE 1 Concentrated percentage of total content of slurry in bottom fraction





housing WEANER AND FINISHER FACILITIES

Swedish finisher pens

In Sweden, finisher pens resemble those used in Denmark 40-50 years ago. Swedish records of tail biting amount to just below 2% of the pigs delivered for slaughter, which is slightly above the Danish level of 0.5-1.5%. Pigs are not tail-docked in Sweden, and the pen design may be part of the reason why they are able to produce pigs without practising tail docking. This will be further analysed in a future study.

The Swedish concept is being studied in a Danish commercial herd, where four sections accommodating Danish pigs that are not tail docked are designed along the lines of Swedish finisher pens. Production results and prevalence of tail biting will be compared with production results and tail biting among pigs accommodated in traditional Danish pens. In Swedish pens, the zones are very clearly defined: a dunging area with slatted floor and



Swedish finisher pen.



Traditional Danish finisher pen.

open pen sides between pens. A wall for pen equipment partially separates the dunging area from the lying area. The lying area has a solid floor and pigs are fed in long troughs placed as far away as possible from the dunging area. The pens accommodate roughly 10-12 pigs each, which is fewer than Danish pens. Space per pig amounts to 0.9 m². Pen sides

are partially open to facilitate inspection and to ensure adequate air change between pens. The pens in the trial herd are now finished, and an initial phase is currently being tried.

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

'Moonpig Network ('Månegrøisens netværk')

'Månegrøisens netværk' is a network group established as part of the previous government's innovation strategy, with the declared aim of creating profitable pig production with minimum impact on environment, climate and local surroundings and employing high animal welfare standards. Group members come from nine different universities, research institutes and other interested organisations that are all highly qualified in their understanding of Danish pig production. The aim of the network is to identify innovative and profitable technological solutions, which may be incorporated within pig finishing facilities of the future.

Topics to be included in the forthcoming report from the work groups within the network:

ENVIRONMENT

Feed that minimises nutrient excess of e.g. phosphorus. Ventilation principles that minimise fouling in pens. Frequent emptying of slurry.

ANIMAL WELFARE

Flooring in relation to the use of rooting and enrichment material as a measure to prevent tail biting.

HEALTH

Biosecurity – internal as well as external, including air filters and cleaning-friendly pens.

ECONOMY AND RESOURCES

Profitability calculations for a case-study herd with four sites finishing 120,000 pigs a year. Analyses of transport requirements, labour, different purchase intervals and suppliers of pigs.

RECORDING OF EMISSIONS

Selection and testing of affordable and accurate online measuring equipment.

The project received financial support from the Green Development and Demonstration Programme. Journal no. 34009-14-0831.

Project: Undocked tails and tail biting

Effective prevention of tail biting in a pen demands early identification of signs in pigs' behaviour that may be related to tail biting. This applies both to pigs that are tail docked and those with undocked tails.

In March 2015, a PhD entitled "Tail biting – early recognition and dedicated prevention" was established in co-operation between SEGES Pig Research Centre and the University of Copenhagen, Department of Large Animal Sciences.

The project will investigate whether weaners, that are not tail docked, change behaviour to a degree that is clear to the staff during their daily inspection as tail biting breaks out. Identification of behavioural changes prior to any outbreaks of tail biting arising will enable staff to intervene earlier and prevent tail injuries.

If the study confirms any changes in behaviour, it will be established whether it is possible to reduce the prevalence and the degree of tail biting through supply of enrichment material in the days before an outbreak of tail biting occurs.

The PhD project receives financial support from the Innovation Fund. Journal no. 4135-000818.

Areas of natural beauty

In organic and outdoor pig production, weaners and finishers must have access to an outdoor area. However, the pigs defecate widely over the area. This is undesirable for several reasons: the area loses its 'attractiveness' to visitors; roughage and rooting materials supplied become less valuable to the pigs and it may lead to significant levels of ammonia emissions.

SEGES Pig Research Centre therefore investigated different features of outdoor areas that may motivate the pigs to divide the area into lying and dunging zones.

Observations show that measures that create either "activity areas" or "attractive lying areas in the shade" to some extent reduce defecating in the surrounding area. However, there are no solutions that to a large extent restrict dunging to a "desired area". Equipment placed alongside the building or placed in the centre of the outdoor areas did motivate the pigs to lie down in these areas, probably to take advantage of the shade offered.



Pen provides support for the pigs when they lie down and shade on sunny days.



Laths attached to a chain hanging in the centre of the outdoor area in a finisher pen.



The pigs are weaned in the farrowing pen: the pen is well-functioning and there is no fouling on the solid floor.

>

The project took place in co-operation between SEGES Pig Research Centre and 'Udviklingscenter for Husdyr på Friland', Aarhus University and SEGES Organic Farming.

The project received financial support from the Green Development and Demonstration Programme. Journal no. 34009-13-0693.

Weaning in the farrowing pen

For the last 2-3 years, SEGES Pig Research Centre and equipment manufacturers have worked on developing a farrowing pen where the pigs can remain after weaning. The pens have an area measuring 2 x 3 m for a loose-housed lactating sow. The functionality of this pen and the feeding equipment was evaluated in a commercial herd where eight pens were installed.

When pigs are weaned in the farrowing pen, it will be possible to utilise the pigs' growth potential, reduce the labour required for washing pens and moving the pigs and reduce the use of zinc and antibiotics.

The trial comprised five different designs of dry feeders. Results revealed that the most appropriate feeder for sow and pigs was the FunkiMat model. If it is combined with a trough of the right size, for instance 60 x 35 cm, if water in the trough is shut off once pigs are weaned, and if the pendulum is dismantled during lactation, the result is a fully functional feeder that can be used by sow and pigs alike.

Production results look promising, but these data only include recording of gain in two batches of eight litters. Pigs gained 480 and 455 g/day, respectively, in the 40-day weaning period. Pigs were weaned at an age of 30 days. Average weight at departure from the pen was 28.8 kg and 27.5 kg, respectively. The diet used immediately after weaning did not include zinc.

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.

housing

PENS FOR INSEMINATION AND GESTATING SOWS



Feeding and insemination stalls

Pig houses built or converted after January 1, 2015, must be designed for group-housing of gilts and sows from weaning until no more than seven days before expected farrowing. This requirement will eventually apply to all pig housing from January 1, 2035. It is recommended that the design of insemination pens for group-housed sows should incorporate non-slip flooring in the activity areas and feeding and insemination stalls.

SEGES Pig Research Centre assessed the functionality of feeding and insemination stalls from three manufacturers, Jyden Bur, Vissing Agro and ACO Funki (Egebjerg), for group-housed sows. All stalls were each tested in two herds and six groups in total.

Nine aspects were closely evaluated. They included accessibility and safety for the sow; entry and exit facilities for the sow; restraining of the sow; working conditions during moving of sows; staff access; boar contact; durability and wear and tear.

The functionality of the stalls was assessed during periods of potential stress such as feeding, hierarchy establishment, insemination and moving of pigs.

None of the stalls scored highly on all aspects, but all had good access facilities for the sow. Stalls from Jyden and Egebjerg scored highest on safety. Working conditions during moving of sows were scored low in the stall from Jyden, but the stalls from Vissing Agro and Egebjerg scored well here.

Sows had difficulty exiting the stalls from Jyden and Vissing Agro, and staff entry was difficult in all stalls. The stalls from Vissing Agro and Egebjerg provided the best facilities for restraining the sows for a brief period.

Each brands had its strengths. It is therefore essential that pig producers decide which features are important and less important for them when investing in new stalls. In addition, we can confirm that all the stalls comply with current recommendations for length (inside measurement, 210 cm) and width (inside measurement, 65 cm).

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.

Nesting area and lying area

The aim of this trial was to reduce soiling of the solid floor and thereby reduce labour and improve air quality.

Pens for group-housed shows should be designed to accommodate the sows' natural behaviour. Sows do not defecate where they eat and sleep, and this formed the basis of four different designs of pens for group-housed sows that were studied in a herd with electronic sow feeding.

In one of the pens, low lying walls were erected in the transition between the solid floor in the lying area and the slatted floor in



Lying walls were 5 cm thick, 40 cm high and 2 m long (corresponding to the length of a sow). Sows are able to jump over the walls during establishment of hierarchy without injuring themselves.



The manure hatch must be installed close to the nesting areas. When lying areas are cleaned daily, manure is pushed directly into the slurry pit.

the dunging area. The floor in this pen was significantly less soiled compared with the control pens, which were designed with two large nesting areas and high pen sides. Significantly less soiling was also seen in pens where the feeding stations were placed in the middle of the activity area. However, this position made it difficult to lead sows manually into the feeding station.

Manure hatch

Correct design of gestation pens will not completely eliminate soiling of the lying area. It is necessary to remove manure and wet straw from the slatted floor on a daily basis, but sows do not usually push all through the slots, and the rest is left in the lying area. A dirty floor in the dunging area increases the risk of poor air quality, slipping and leg injuries, chronic mastitis and hoof abscesses. A study demonstrated that a manure hatch makes it possible to completely eliminate dung and wet straw from the pen.

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-13-00235.

TABLE 1 Evaluation of feeding and insemination stalls

Brand	Jyden Bur	Vissing Agro	Egebjerg
Access – sow	****	**	**
Safety – sow	***	**	***
Stall – opening and closing	**	***	**
Working cond. during moving of pigs	*/**#	****	***
Access – staff	***	**	***
Tethering – central lock	***	****	****
Tethering – single stall	**	****	****
Boar contact	****	****	****
Durability, wear and stability	****	***	**

#* = stall without front gate, ** = stall with front gate

Although not included in this test, producers are advised to buy bars that may ease the opening of the stall.

* = Poor, ** = Average *** = Good (expected level), **** = Very good

housing

FARROWING AND LACTATION

A 'win-win'

Improving piglet survival rates is 'win-win-win' for pigs, profitability and job satisfaction. In 2015, research looked at piglet energy intake in the first critical days of life and later during lactation as well as piglet safety when sows are not confined.

Piglets with low blood sugar

SEGES Pig Research Centre monitored 158 under-sized, cross-fostered piglets weighing less than 1,050 g at the time of fostering and observed them until two weeks of age. Among these piglets, 30% had low blood sugar levels, whereas this was not observed in 30 piglets weighing 1,200-1,600 g.

Of the under-sized piglets with low blood sugar levels at cross-fostering, 34% died within the first two weeks of the study.

Results showed that by selecting the piglets not seen at the udder during lactation and those weighing 650 g or less, it was possible to pinpoint 24 of the 60 pigs with low blood sugar levels. Only six piglets were mistakenly included in this group. This demonstrates that if staff identify piglets that do not make it to the udder or those which are of a particularly small size, then around 50% of the most vulnerable piglets will already have been given additional attention.

Most piglets are handled at the stage of cross-fostering. Research is being undertaken to establish whether the supply of an energy supplement at this stage may increase survival rates among piglets that weigh less than 1,050 g. Piglets were divided into four groups: control (no energy supplement) and three trial groups, of which two were given a commercial energy supplement. The piglets in the fourth group received milk replacer in a probe.

Results revealed no effect of the extra energy on survival rates among piglets that weighed less than 1,050 g. On average, 76% of the small piglets in this study survived the first two weeks of life.

Milk cups in the farrowing pen

Automatic provision of additional milk may also be helpful in increasing survival rates as well as the number of piglets nursed by the sows. An economic model calculation showed that this requires a drop in mortality of a minimum 2 percentage points, when cross-fostering to 14 rather than 13 piglets per litter. Alternatively, utilisation of farrowing pen capacity must improve significantly for automatic provision of additional milk to be an economically relevant option.

The long-term aim is for sows to nurse more of their own piglets, with the result that the need for nursing sows drops and utilisation of farrowing pen capacity improves.

A pilot study compared 13.6 piglets per litter without additional milk with 16 piglets per litter with additional milk. The tests demonstrated that the provision of additional milk may help nourish large litters. Data shows lower mortality rates and higher gain in the suckling period as well as post-weaning. This will now be investigated in a large-scale trial.

Loose-housed lactating sows

Currently approximately 1.5% of all sows are loose-housed during lactation. Challenges of loose-housing include increased piglet mortality and risk of poor levels of hygiene in pens with partially solid floors.

Research showed that loose-housed sows displayed more active nesting behaviour. However, the farrowing progress i.e farrowing duration and birth intervals did not differ



Loose-housed sow: the solid floor is dry and clean, and piglets thrive.

between sows housed loose from transfer to the farrowing pen and those housed loose during the whole farrowing period, compared with sows confined from day 114 of gestation and during farrowing.



Regardless of whether sows were confined or loose housed the first days after farrowing, sows lay in a lateral position most of the time, particularly during the first day. Cortisol levels in saliva showed no signs of the sows being negatively affected by confinement the first 1-2 days after farrowing.

TABLE 1 Results of pilot study concerning provision of additional milk in milk cups

	13.6 piglets/litter, no additional milk	16 piglets/litter, + additional milk
Litters	24	24
Piglets/litter at cross-fostering	13.6	16
Weaned pigs/litter	12.0	14.3
Mortality + moved, %	11.8	10.6
Weaning weight/pig, kg	7.2	7.6
Post-weaning until 20 kg: Gain/pig/day, g	328	351

Comparison of 13.6 piglets vs 16 piglets from cross-fostering until weaning. Pigs were monitored during the subsequent weaner period.

Total piglet mortality, including stillbirths, differed between the three groups: the significantly lowest piglet mortality of 22% was observed among the sows confined from day 114 of gestation until four days after farrowing. Among the sows housed loose during farrowing and subsequently confined for four days, total piglet mortality increased to 25%, and among the sows loose-housed for the whole period, total piglet mortality reached 26%.



Before cross-fostering, piglet mortality rates were significantly higher for loose-housed sows compared with confined sows.

These results originate from a PhD project undertaken in the period 2012-2015, in co-operation between SEGES Pig Research Centre and the University of Copenhagen. The main aim was to investigate the effect of temporary confinement of the sow on piglets and on sow behaviour and physiology. For more information, see www.iph.ku.dk/swapfaresti.

Climate studies made in February 2015 demonstrated that it was not possible to pinpoint single factors that ensure dry floors in the solid lying areas in all pens. The studies were made on five full-scale sites with loose-housed sows in the farrowing unit. On some sites, where a significant percentage of the floor was solid (>50% of the sow's area), the floor was dry and clean, but on some sites the solid floor was moist or even fouled.

In co-operation with Jyden Bur, SEGES Pig Research Centre is monitoring productivity and hygiene in two full-scale systems in 2015-2016, to evaluate production levels and functionality over an extended period. The project receives financial support from The Danish Market Development Fund under the Danish Business Authority. The aim is to improve competitiveness of farrowing pens for loose-housed sows.

SEGES Pig Research Centre is one of the participants in the EU7FP project PROHEALTH.



The sow's movement is restricted around farrowing and the first days after farrowing as a safety precaution for the piglets.



Piglets have easy access to the sow's udder when she is loose-housed the first few days after farrowing and for the remaining period of lactation.

PROHEALTH aims at improving competitiveness and sustainability of modern pig and poultry farming in Europe. SEGES Pig Research Centre is investigating the effect of sympathetic handling of loose-housed sows in the farrowing unit: soothing music is played and the sows are stroked daily by staff before farrowing. The aim is to calm the sows and reduce the risk of sows crushing her piglets.



Research is also being carried out to establish whether certain features characterise sows with high litter mortality rates, as this may help identify these sows before piglets are crushed. Preliminary results indicate that piglet mortality is higher in litters with more than 17 totalborn piglets and therefore occurring more often in older sows.

During 2015 and 2016, a 'Showroom' will set up at a commercial pig farm, where up to ten Danish and international brands of farrowing pens for loose sows will be exhibited and their functionality evaluated. Visitors are allowed subject to prior agreement with SEGES Pig Research Centre.

Research activities in loose housing of lactating sows received financial support



Loose-housed sow listening to classical music.

from The Danish Market Development Fund under the Danish Business Authority, journal no. 13/06495; the EU and the Rural Development Programme under the Danish Ministry of Food, Agriculture & Fisheries, journal no. 32101-U-13-00240; and 7th Framework Programme for Research and Technological Development, budget appropriation journal no. 613574.

FOR MORE INFORMATION

Scan the QR code for more information on farrowing pens for loose-housed sows at SEGES Pig Research Centre's website (in Danish).



ANIMAL WELFARE, ACTION PLANS AND AUDITS

Welfare Summit Declaration

SEGES Pig Research Centre continues to support the 'Declaration of Intent' made at the Animal Welfare Summit held in March 2014. The seven points included in the declaration were incorporated in an action plan for 2015.

Pig Welfare Conference

In April 2015, the Danish Ministry of Food hosted an international animal welfare conference 'Improving Pig Welfare – what are the ways forward?'



Piglet survival receives a great deal of political attention and remains an important area of focus.

The proceedings at the conference confirmed that pig welfare standards in Denmark remain at a consistently high level. At the conference, the Dutch, German, Swedish and Danish Ministers for Food signed a declaration encouraging improvement in animal welfare standards across Europe. They will encourage the European Commission to ensure compliance with current EU legislation on pig production and implement new initiatives in the following areas:

- Reduction in the number of tail-docked pigs
- Ending of surgical castration without anaesthesia
- Group-housing of sows from weaning until one week before expected farrowing
- Loose-housing of sows during lactation

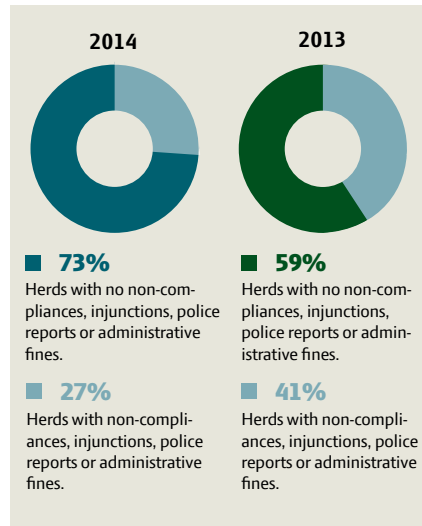
SEGES Pig Research Centre presented eight posters at the conference.

Welfare audits 2014

(source: The Danish veterinary and Food Administration)

Reports from the welfare audits conducted by the Danish Veterinary and Food Administration show clear improvements from 2013 to 2014. In 2014, 660 herds were audited, of which 73% were fully compliant with all relevant legislation compared to 59% in 2013.

FIGURE 1 Fewer sanctions at welfare audits in pig herds (source: The Danish Veterinary and Food Administration)



Non-compliances primarily concerned:

- Inadequate treatment/care of sick and injured pigs
- Design of hospital pens
- Access to rooting and enrichment material
- Records of medical treatments

Audit campaigns

In 2015, the Danish Veterinary and Food Administration launched three special audit programmes:

Piglets – first week of life:

(Source: The Danish Veterinary and Food Administration)

Audits were carried out in 150 herds, of which 108 were fully compliant.

Twenty-seven audits reported non-compliance with medicine use and records of medical treatments, and 22 reported non-compliance with welfare requirements, including permanent access to rooting and enrichment



It is illegal to dock more than half of the tail.

materials, documentation of mortality, and incorrect tail docking procedures.

Piglets – on-farm humane killing

(Source: The Danish Veterinary and Food Administration)

Audits made in 31 herds confirmed that humane killing of piglets in all the herds complied with the procedures, see guidelines from the Animal Protection Agency. Piglets weighing less than 5 kg may be killed with one blow whereby the head and neck of the piglet are hit hard enough on the floor that the piglet dies instantaneously from cranial fracture.

Shoulder lesions

(Source: The Danish Veterinary and Food Administration)

Audits made in 201 herds revealed that low prevalence of shoulder lesions is being maintained. 185 audits revealed full compliance.

Non-compliances were reported for inadequate soft bedding, accommodation in confinement on hard floor, and failure to move sows with severe shoulder lesions to hospital pens.

Evidence of shoulder lesions will remain part of the standard audits carried out by the Danish Veterinary and Food Administration.



Shoulder lesions are assessed with the new shoulder lesion measurement card.

Cross-compliance

As of January 1, 2015, the Danish AgriFish Agency took responsibility for the physical cross-compliance audits related to animal health and welfare.

One per cent of the recipients of direct support and certain area-based funding schemes under the Rural Development Programme will be selected for cross-compliance audits. Non-compliances reported by the local authorities and the Danish Veterinary and Food Administration will now result only in a fine or a sanction pursuant to the national audit.



'Top Five' non-compliances

Analysis of the most frequent non-compliances in the second quarter of 2015 show an increase in the number of cases where pigs should have been moved to a hospital pen. This occupies the second place among the five most frequent non-compliances. This is unacceptable but should be improved without difficulty.

Incorrect documentation of medicine use in the treatment log tops the list. Pig producers who are unsure as to what is correct, should ask their herd vet. Third and fourth on the list are two fairly new check points, and should therefore be rectified fairly quickly.

However, despite massive attention in the media and information from the industry, auditors still report too many incidences of tails that are docked beyond the 50% mark. Even though this is a special Danish requirement, it must nonetheless be followed.

TOP-FIVE NON-COMPLIANCES 2ND QUARTER 2015

1. Inaccurate documentation of medicine use in treatment log (17.9%)
2. Failure to move sick or injured pigs to hospital pen or provide the necessary treatment (16.7%)
3. Spray-colour not FDA approved (15.3%)
4. No zoonotic biosecurity protocol (14%)
5. Tails docked by more than 50% (13%)

(Percentage of audits where non-compliances were reported in 2nd quarter of 2015)

Quantification

In order to estimate how many pigs are in fact affected by the non-compliances reported during audits, the exact number of pigs affected by each non-compliance is counted in the second quarter each year.

An example of this is the audit point identifying "pigs that should be humanely killed": this was reported a non-compliance in 9.1% of the audits undertaken in the second quarter of 2015. Auditors counted the actual number of pigs concerned, and the result was that 91 pigs that should have been killed before the audit took place. A total of 1,655,603 pigs were audited in the second quarter of 2015, and 9.1% thus corresponds to 5 in 100,000 pigs that ought to have been humanely killed.



Always ask for wash certificate before a vehicle approaches the loading ramp. If the certificate is red, the 48-hour quarantine rule must be met – for the sake of your own unit's security and for the whole industry.

Your responsibility

The DANISH Product Standard also includes transport of pigs. In 2015, the export of weaners was expected to increase to 12 million head. This increases the risk of introducing exotic diseases into Denmark as many transport vehicles cross the Danish border over the year. All parties are therefore jointly responsible to take the necessary precautions to prevent this.

Less bureaucracy

DANISH approved pig producers who deliver weaners to a collection point or directly across the border must use a QS approved haulier. The haulier is responsible for complying with that part of the DANISH scheme that concerns transport. DANISH approved hauliers are automatically QS approved. However, it is the pig producer's responsibility to check that quarantine rules for the lorry are met, which can be confirmed from the 'wash certificate' that must always be present in the lorry.

A guarantee for all

All Danish pig producers are offered certification pursuant to DANISH Product Standard, which provides access to all major export markets. In 2015, 95% of pig production is expected to be DANISH approved.

International recognition

For pig producers to be able to export weaners to Germany and to be able to gain access to all major export markets for pork, production conditions must be documented and approved by an independent third party. This is the essence of the DANISH Product Standard and the standard is approved by German QS and other international standards.

Key areas

The independent third party audit is undertaken by Baltic Control, who are an accredited certification body. The overall aim is to ensure high standards of animal welfare and food safety and full traceability in Danish pig production.

The scheme has industry support

The overall framework of the DANISH Product Standard is laid down by a committee of representatives from the pig industry (farmers, cooperative slaughterhouses, private slaughterhouses, hauliers and SEGES Pig Research Centre). The group meets twice a year and their work includes analysis of audit results and to identify priority areas for the future.

welfare

MORTALITY AND DAILY GAIN

Weaner units with low mortality rates typically have well-designed entry rooms, diffuse ventilation, partly slatted floor, floor heat and pigs are fed dry feed.

Potential in Danish herds

SEGES Pig Research Centre analysed risk factors for pig mortality in a comprehensive study comprising data from nine herds, 566 litters and around 10,000 pigs, who were monitored from birth to slaughter. Results demonstrated that:

- Causes of death vary from herd to herd
- Post-mortem examinations may point to herd-specific interventions
- Management around farrowing may reduce stillbirths by up to approx. 36%
- Pigs with a low birth weight may be worth saving as records show that they perform well if they survive
- Management routines in the farrowing unit may lower mortality by up to 55% - this applies in particular to handling of pigs with a low birth weight
- An increase in weaning weight may lower mortality by 50%

Factors affecting gain

The pigs in this study were weighed at birth and at departure from the finisher unit, which made it possible to analyse the factors that affect gain from birth until slaughter. Daily gain from birth until slaughter averaged 621 g/day: the bottom quarter gained less than 569 g/day, compared to the group average of 555 g/day, and the fastest growing pigs gained on average 688 g/day.

If no pigs in a litter had a birth weight below 1 kg, the percentage of pigs with a daily gain below 569 g/day would fall by 18%. This reduction is attributed to the elimination of the risk factor called Population Attributable Risk (PAR) that is obtained by combining the excess risk with the frequency of the risk factor (in this case, the percentage of pigs with a birth weight below 1 kg).

Calculations only include the effect of risk factors (PAR) that had a significant effect. If piglets were only born in litters with fewer

than 19 pigs or only born from sows older than third parity, the percentage of slow-growing pigs dropped by 9% and 11%, respectively. Castrates grow faster than females, and, if all pigs grew at similar rates, the percentage of pigs with a daily gain below 569 g/day would fall by 8%. If pigs were not moved or treated in the farrowing or weaner unit, the corresponding figures would have been 9%, 3% and 4%, respectively.

TABLE 1 Possible reduction in stillborn percentages

Monitoring of sows with stillborn in previous litter	13 %
Obstetric aid not required or optimum obstetric aid provided in due time	27 %
Overall effect	36 %

TABLE 2 Possible reduction in mortality rates in the farrowing unit

Hygiene during castration	6 %
Obstetric aid not required or optimum obstetric aid provided in due time	5 %
Save pigs below 1 kg	50 %
Overall effect	55 %

Risk factors at herd level

The impact of differences in housing, feeding, management and health between different herds was analysed in 89 farrowing units, 60 weaner units and 43 finisher units. Preliminary analyses demonstrate that herds with low mortality rates in the farrowing units tend to be large herds with a high number of weaned pigs per litter and per sow/year and that have SPF status. Soaking, high-pressure cleaning, immediate obstetric aid, routine checking of creep areas during inspection rounds and

tooth grinding are often incorporated routines in herds with low mortality in the farrowing unit.

Weaner units with low mortality rates typically have well-designed entry rooms, diffuse ventilation, partly slatted floor, floor heat and pigs are fed dry feed. They are free of PRRS, only few pig suffer from hernia, hospital pens are correctly designed and pigs have access to straw.

Finisher units with low mortality rates typically have a high daily gain, are free of PRRS, and only few pigs are treated for cerebrospinal meningitis and pneumonia. High-pressure cleaning using soap and drying are routinely performed. Pigs are not moved once they are penned.

The preliminary analyses describe significant correlations that are not necessarily causal factors. The final analyses will be complete by the end of 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-12-00229.

health

SERIOUS PIG DISEASES

African Swine Fever and PED

African Swine Fever (ASF) and Porcine Epidemic Diarrhoea (PED) made many headlines in 2015.

In the course of just one year, ASF spread to the entire Baltic area, and records show a significant frequency of PED in several EU countries south of the Danish border.

African Swine Fever is spreading

In just a few years, African Swine Fever (ASF) has spread from the Caucasus to most of Russia, Belarus, the Ukraine, the Baltics and Eastern Poland near the border to Belarus.

ASF primarily spreads among wild boar herds and from there to small 'backyard' pig farms. A few rare cases of infection of large, professional pig farms were also confirmed.

In the Baltic countries, ASF has spread dramatically among wild boar in 2015, while the frequency in Poland remains moderate. Overall, outbreaks recorded among wild boars in the Baltics and Poland increased from 264 in 2014 to 822 by September 6, 2015 (see table 1).

Poland: a positive development

Polish authorities have for two years succeeded to contain ASF in the border areas close to Belarus and Lithuania.

TABLE 1 Outbreaks of African Swine Fever in Estonia, Latvia, Lithuania and Poland in 2015 – up to and including September 6

Country	Pigs	Wild boars
Estonia	17	267
Latvia	9	444
Lithuania	12	65
Poland	1	46
Total	39	822

Source: The Danish Veterinary and Food Administration/OIE

This indicates that it is in fact possible to prevent ASF from spreading among the extensive wild boar population in Poland. Two years ago, Poland and the EU established a restriction area that was kept under strict supervision that included wash and disinfection procedures for all animal transport.

AFRICAN SWINE FEVER

- Virus
- No vaccines available
- Mortality: 50-99% of all infected pigs die
- Statutory notifiable disease
- May survive for months in salami, prosciutto and other processed meats
- Spreads with animal transport
- External biosecurity essential

from the EU Commission on PED in EU countries is expected by the end of 2015. Speakers at congresses and seminars in 2015 reported of high prevalence of PED in Spain, Germany and the Ukraine and a small sporadic prevalence in the Netherlands, Belgium, France, Austria and Italy. In these countries it was mainly the less aggressive variant reported with limited piglet mortality or diarrhoea in older pigs.

Monitoring PED in Denmark

Since October 2014, PED in Denmark has been subject of routine serologic monitoring. All blood samples were negative, and PED virus has not been detected in material from Danish pigs.

Monthly, around 350 blood samples are collected selected sows at slaughter and submitted for analysis at the National Veterinary Institute. Analysis costs are paid by SEGES Pig Research Centre.

PORCINE EPIDEMIC DIARRHOEA

- Virus
- No vaccines available in the EU
- Mortality rates of 20-90% among newborn piglets
- No legislation on PED
- May survive for up to one month in faeces
- Spreads with animal transport
- External biosecurity measures are essential

PED in Europe

Porcine Epidemic Diarrhoea (PED) is a virus found in pigs' intestines. The disease has been the subject of attention in Europe following its emergence in the US, where it caused huge losses among newborn piglets.

The disease developed in England in the 1970s and was often diagnosed in a relatively mild version with mortality rates of 10-20% among newborn piglets. Records show no incidence in Denmark.

In 1990s PED spread to Asia, and in 2010 new aggressive variants were seen in China showing mortality rates of 50-90% among newborn piglets within the first week of life. These highly aggressive variants were the types that subsequently emerged in the US in 2013.

PED is not a notifiable disease in the EU; veterinary laboratories in the EU are therefore not obliged to report PED incidences. A report



Stop the spread of ASF. Poster from the campaign launched by the Danish Veterinary and Food Administration and the Danish Agriculture & Food Council.

BIOSECURITY AND SAFETY WASH

Transport, wash and disinfection

The Danish export of live pigs to primarily Germany and Poland continues to increase; in 2015, the export is expected to reach roughly 12 million pigs, which is an increase of 1 million from 2014. The pigs are transported in specially designed trucks from the farm to the destination. Many animal transport trucks cross the Danish border and this increases the risk of introducing exotic pig diseases into Denmark.

Consequently, biosecurity at herd level and wash and disinfection of vehicles used for livestock transport are essential at a time when African Swine Fever has spread to the Baltics and Eastern Poland. Porcine Endemic Diarrhoea (PED), which is apparently common in Central Europe, must also be kept out of Denmark. Each and every pig producer and carrier are therefore responsible for maintaining our high veterinary level that is the foundation of a profitable export of livestock as well as pork.

DANISH Transport Standard

The industry's guidelines, DANISH Transport Standard, ensure optimum biosecurity levels, including wash as disinfection of livestock trucks entering Denmark.

In 2014, roughly 24,000 pig transport vehicles were washed and disinfected; in 2015 this number is expected to increase to around 25,000.

All expenses relating to DANISH Transport Standard are paid by SEGES Pig Research Centre, and are expected to amount to approx. DKK 12 million in 2015, corresponding to around DKK 1 per exported pig.

New disinfection procedure

On January 1, 2015, stricter disinfection procedures were introduced for transport vehicles. Prior to January 1, 2015, the driver performed the disinfection of the vehicle, but this is now handled by trained staff at the five wash sites approved by DANISH Transport Standard. As a result, disinfection has improved which has reduced the risk of introducing exotic diseases into Denmark.

APPROVED WASH SITES

- Padborg, DANISH Safety Wash
- Padborg, MegaWash
- Nakskov, Lars Fugl
- Nakskov, John Maj
- Rønne, BHJ

There are currently no appropriate wash sites in Padborg to safety wash all transport vehicles, and the implementation of the safety wash model requires construction of a new wash site in Padborg.

Biosecurity in pig herds

In addition to wash and disinfection of transport vehicles, it is crucial that all pig producers comply with all biosecurity guidelines on their farm. This includes correct and consistent use of an entry room with change of clothing and boots, thorough wash and disinfection of hands – every time.

This also applies to visitors, craftsmen etc. entering the site.

Foreign visitors and staff who return from abroad must comply with certain rules. Food – in particular meat of all kinds – must not be introduced from other countries to the herd site as African Swine Fever can survive for months raw meat and processed smoked meat (prosciutto, serrano ham, salami etc.).



As of January 1, 2015, disinfection of pig transport vehicles is handled by staff at the wash sites.

Improvement needed

African Swine Fever and PED developed dramatically in 2015, and SEGES Pig Research Centre therefore analysed whether it was possible and necessary to develop an improved model for wash and disinfection. One model, in particular, was analysed: the so-called safety wash where all internal and external surfaces of the vehicles are washed thoroughly with soap and water. All surfaces are subsequently disinfected, as is the case today, by the staff of the wash site. Safety wash must take place in a closed garage to ensure a wash temperature of minimum 5°C – also during winter time.

This procedure takes 2-3 hours depending on the design of the vehicle. The estimated cost is DKK 1,500 per vehicle whereas the current procedure that costs roughly DKK 600 per vehicle.

Wide range of analyses undertaken

The Laboratory conducts extensive diagnostic analyses for a wide range of pig diseases.

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

Estimated number of examinations carried out in 2015:

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

Close contact with veterinarians and producers

Professional advice on diseases, interpretation of lab analyses and short response time are the main criteria for veterinarians' and pig producers' use of the Laboratory. The veterinarians employed at the Laboratory are therefore in close contact with the majority of pig veterinarians in Denmark.

Monitoring of Swine Fever and PED

The Laboratory is the only facility in Denmark receiving pigs for post-mortem examination. In agreement with the Danish Veterinary and Food Administration, the laboratory monitors

symptoms and pathological changes that may indicate African Swine Fever, Classical Swine Fever or foot-and-mouth disease. The Laboratory collects relevant organ material, if they suspect virulent diseases, and forwards the material for analysis at the National Veterinary Institute at Lindholm.

In 2014, attention to Porcine Endemic Diarrhoea (PED) was increased as the disease was reported in Europe, but at the time of writing (August 2015) no PED outbreaks have been detected in Denmark.

Returns to service

The Laboratory also participates in solving the problems of sows returning to service. Fortunately, the frequency of 'returners' is fairly low, but the consequences for an affected herd are grave.

Preliminary results indicate that several factors may be at play. Analyses revealed *Chlamydia pecorum* in a few aborted foetuses in some cases. It is still too soon to conclude whether *Chlamydia pecorum* constitutes a risk of 'returners' and miscarriages in sows. The analyses will be completed in 2016.

PCR diagnostics now available

In 2015, the Laboratory introduced Polymerase chain reaction (PCR) diagnostics on the most essential intestinal pathogens in pigs. From October 2015, customers are offered PCR examination for the bacterium *Lawsonia Intracellularis* in faecal and intestinal samples. This cost of this analysis is DKK 550, a very competitive price.

PCR diagnostics on more intestinal pathogens are expected to become available throughout 2015. The importance of PCR diagnostics on intestinal pathogens was underlined in 2014, when new legislation came into force requiring lab diagnostics before medicines can be prescribed for group-medication of pigs.



Post-mortem examination of pig with enteritis at the Laboratory for Pig Disease.



Examination of foetus at the Laboratory for Pig Disease.

Bacteriological analysis of semen

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

Only a very small percentage of the samples are found to contain bacteria. Quantitatively, the number is very low and considered insignificant.



Bacteriological examination of material submitted to the Laboratory.

SPF HEALTH SERVICE INSPECTION, SPF HEALTH DEPARTMENT AND SERVICE CHECK

The SPF system

Since its establishment 44 years ago, the SPF system has greatly benefited Danish pig producers. The SPF Health Department manages all herds affiliated with the SPF system – a total of 2,948 CHR numbers of which 2,697 commercial herds are ranked as having 'Blue SPF' status, which is a small decline on the previous year.

SPF Health Inspection

SPF Health Inspection has two office locations: in Vejen and Kjellerup, with a total of 15 employees. Their main tasks include health inspection of all breeding and multiplication herds with 'Red SPF' health status. This involves monthly clinical examinations and blood sampling and nose swabs for relevant diseases. The inspection also includes biosecurity and monthly inspections with focus on a specific topic.

Nationally, around 251 herds are classified as 'Red SPF Herds'. On these farms, inspection also includes appraisal of animal welfare parameters such as shoulder lesions, stocking density and the condition of hospital pens. SPF Health Inspection has Health Advisory Agreement with approximately 20% of the breeding and multiplication herds.

Seminars on biosecurity continued in 2015 as the threat of infectious disease remains imminent.

SPF Service Check

The SPF system dates back to 1970s and in spring 2013 it was therefore decided to give the system a 'service check'. The purpose was to ensure that the SPF system is up to date in terms of the diseases the system includes, the diagnostics applied and the rules that apply. Three work groups were established: one analysed whether the system covers the right diseases; one analysed diagnostics and whether improvements were possible; and one examined the comprehensive SPF rules. The group focusing on diseases analysed the existing SPF diseases, and whether the SPF system ought include other diseases, concluded that the current SPF diseases should be maintained in the system with the exception of oedema and there was no need to include new diseases.

An additional outcome was the discontinuation of declaration for oedema for all SPF herds. From May 18, 2015, Supplementary Health Information was cancelled.

More adjustments of the SPF Health Rules will follow, and all relevant parties will be notified of implementation with appropriate notice.

SPF Health Department

The SPF Health Department works on developing systems that will benefit farmers and veterinarians. A new website, compatible with smart phones as well as tablets, was launched in 2014 to ensure that all relevant information is available in an easy and accessible manner. Health status information for all herds is found at the top of the website and the tool for planning the visits schedule is found further down on the website. For the benefit of the increasing export markets, the website is now available in English, German and Polish, and a Russian version will soon also be available.

Despite a small drop in the number of herds affiliated to the SPF system, the percentage of affiliated sows has increased: in April 2015, 78% of all Danish sows were SPF declared compared to 70% at the end of 2008. The percentage of finishers with an SPF declaration has remained largely stable at 36% in April 2015 compared to 37% at the end of 2008.

In recent years, the percentage of Danish herds declared free of *Mycoplasma Hyopneumoniae* (Myc) has remained fairly stable. Despite the fact that each year more herds are eradicated for Myc, the percentage has remained at 33% of the SPF declared herds since 2011. This indicates that the percentage of herds that become infected or re-infected with Myc largely corresponds largely with the numbers eradicated, and that there is a certain dynamic relating to the infection prevalence.

A similar scenario is seen for herds declared free of Ap2 as the percentage of herds free of Ap2 does not increase despite routine eradication of this disease. In April 2015, 83% of all SPF herds were declared free of Ap2.

However, the percentage of herds declared free of Ap6 and Ap12, respectively, is increasing: in April 2015 they constituted 75% and 51%, respectively, of all SPF declared herds.

The percentage of herds declared free of Danish PRRS (DK) continues to increase: since 2008, records show an annual increase of around one percentage point. In April 2015, the herds declared free of Danish PRRS accounted for 81% of the SPF declared herds.

The percentage of herds declared free of Vaccine PRRS is also increasing although not as fast. In April 2015, 84% of all SPF declared herds were free of Vaccine PRRS.

Partial eradication of SPF diseases

In some herds, partial eradication has been achieved for one or more unwanted diseases or full eradication, where entire sections were emptied, washed and disinfected before a new batch of pigs was transferred. Table 1 shows the number of herds that were eradicated within the last 1½ years.

In the first half of 2015, 35 herds were 'partially' eradicated. Many of these comprise multiple CHR numbers and also involve multiple diseases. In that same period, 48 'full' eradications were completed.

TABLE 1 SPF herds where 'partial' or 'full' eradication was completed as of May 31, 2014, December 31, 2014, and May 31, 2015.

Disease	1st half 2015	2nd half 2014	1st half 2014
Myc	5	12	18
Ap2			
Ap6	3		7
Ap7			1
Ap12	1		3
DK	30	66	49
Vac	15	35	21
Dysentery		4	
Rhinitis	1	1	2
Green to blue SPF		6	2
Total eradication	48	37	24

FIGURE 1 Distribution of SPF declared diseases in 'Red' and 'Blue' herds, as of April 15, 2015.

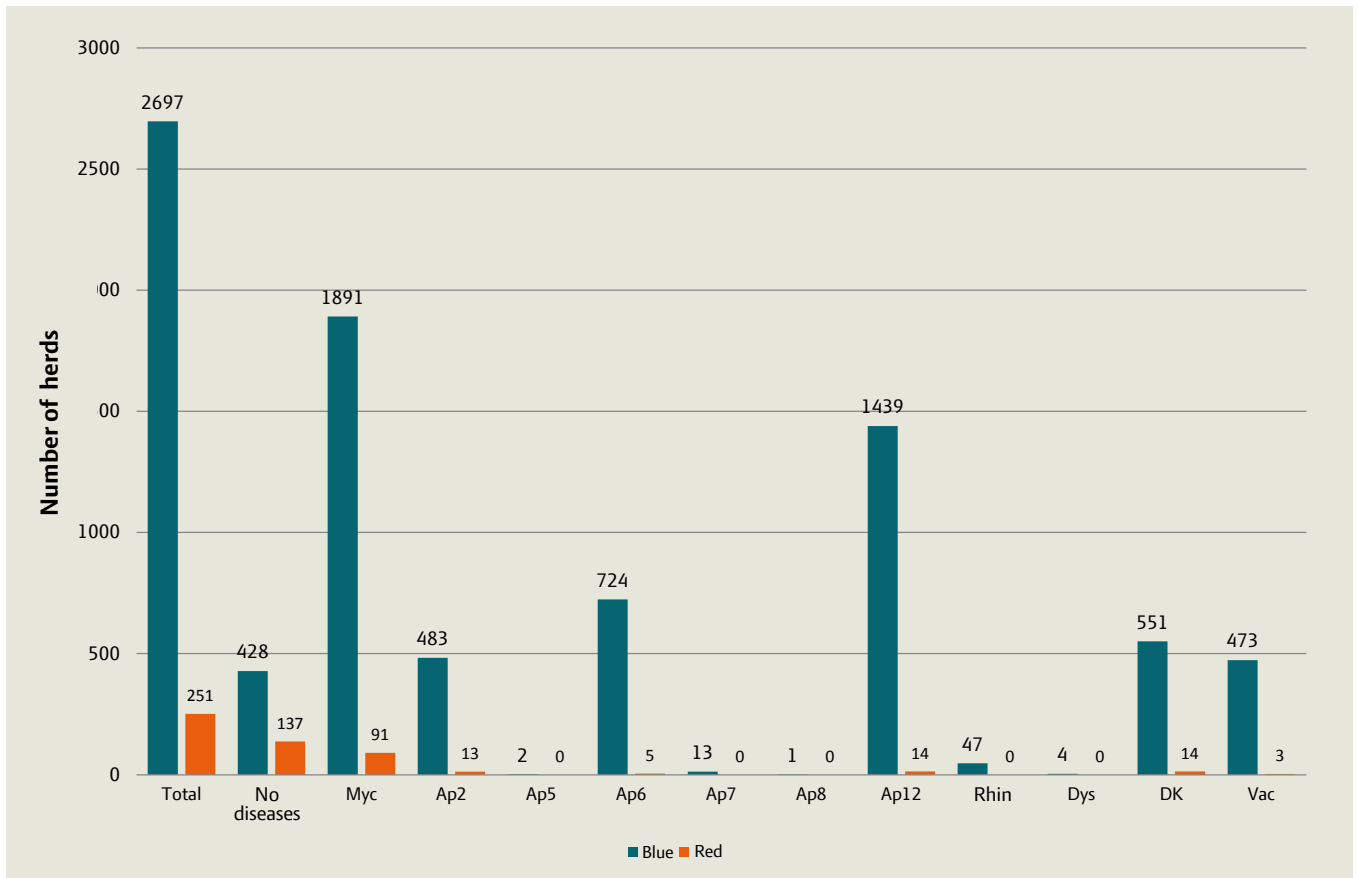
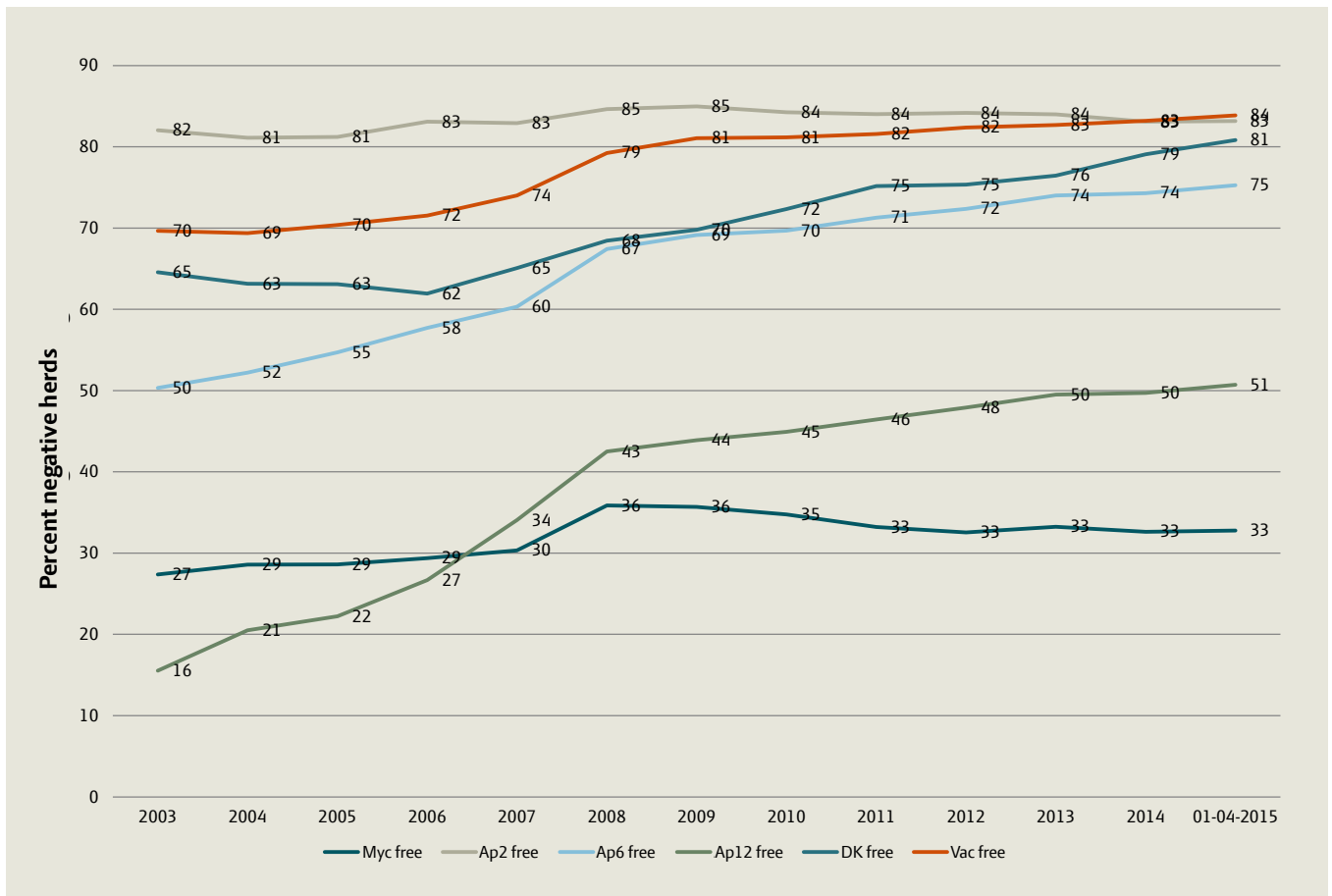


FIGURE 2 Trend in percentage of selected SPF declared diseases in all SPF herds





health

AI SEMEN CONTROL – 'RETURNERS' AND HYGIENE DURING INSEMINATION

AI semen control

Semen quality is regulated by legislation (declaration of 'notifiable diseases') and by DanAvl (genetic quality of the boars), whereas the quality of each individual semen dose is agreed between Danish AI stations and SEGES Pig Research Centre. Quality is audited by the AI stations (in-house quality control) and by SEGES Pig Research Centre upon submission of semen samples and at audits of semen doses delivered to Danish pig farms.

Unannounced audits

SEGES Pig Research Centre routinely analyses the sperm concentration of multiple semen doses without the AI stations' knowledge. The results are conveyed to the AI stations and published on the SEGES Pig Research Centre website.

AI projects

The AI companies and SEGES Pig Research Centre co-operate across several projects aimed at improving the economy of using AI.

Returning to service

The majority of sows returning to service in Denmark can be explained by factors related either to the individual sow or to the farrowing progress. However, in spring 2013 a sudden dramatic increase in return rates in single batches was reported from well-run farms in Denmark. Investigations revealed that these herds had all used semen from the same batch. The AI stations immediately implemented a range of measures to solve this problem and the number of customer complaints fell. It remains unclear whether the problem was started and ended by coincidence or whether one or more the measures implemented solved the problems.

Still a few cases of 'returners'

However, a few incidences remained where semen was still suspected of causing some sows to return. These incidences have probably always occurred, but, as the return problem became increasingly prevalent, more attention was paid to the fact that the presence of 'returners' was not always linked to factors in the herd.

Follow-up

In 2014, the AI companies reported suspicious cases to SEGES Pig Research Centre, who then implemented follow-up analyses in the herds. Stomachs and uteruses of 'returners' and 'empty' sows that were destined for culling were examined at the Laboratory for Pig Diseases in Kjellerup. The follow-up analyses also in-

HYGIENE DURING INSEMINATION

- Only inseminate sows that pass the back-pressure test
- Do not examine heat mucus
- Make sure that sows are clean in the insemination unit
- Keep AI tools and equipment away from stains and dust
- Do not touch the mucosa of the vagina during insemination
- Do not touch the part of the catheter that is introduced into the sow
- If you wear gloves during insemination, put these on after heat check just before handling the catheter and sperm tube

cluded submission of miscarried foetuses from weekly batches and records of observations in the affected herds.

Cases vary

The follow up on the cases in 2014 demonstrated that no two cases are completely identical. In some cases, only a few 'returners' were reported and, in these cases, any factor that affects sperm fertility (including lack of sperm in the doses) may be to blame. In other cases, high miscarriage rates were reported, which indicates that the sperm is active, but that another factor may have triggered the miscarriages in the affected herds. In other words, the semen seems to remain the link between the herds.

Identical symptoms between cases

In some herds, vulval discharge was observed, whereas other herds did not seem to experience this, which may be attributed to failure to detect 'empty' sows before scanning. In most cases, yellow discharge was observed in 'returners', but white discharge was observed in two herds. Some pig producers reported vulval discharge among 'returners' as well as an increase in miscarriages.

'Returners' in individual herds

In cases where only one of the producers received semen from the same batch and reported problems of 'returners', attention turned to hygiene during insemination. There are indications that viruses may transmit from one infected sow to other sows during insemination. Consequently, hygiene during insemination in such herds was scrutinised, and measures were implemented to prevent transmission of infection between sows.

Denmark still among the lowest users
Antibiotic use for treatment of livestock animals in Denmark remains one of the lowest in the EU.

FIGURE 1 Overall use of antibiotic for livestock in selected countries in 2012



Source: ema.europa.eu

20% drop in tetracycline use

In 2014, SEGES Pig Research Centre encouraged a reduction in the use of tetracyclines. In the first half of 2015, records show a reduction of 20% compared with 2013.

Guidelines for treatment

When faced with an outbreak of disease in a herd, vets often prescribe antibiotic treatment. The treatment guidelines published by the Danish Veterinary and Food Administration provide an assessment of the effect of various medicines and the risk of development of resistant bacteria through their use. These guidelines do not restrict the vets' right to prescribe particular antibiotics. The complete list is available at www.medicintildyr.dk – an example is provided in the box below.

THE DANISH VETERINARY AND FOOD ADMINISTRATION TREATMENT GUIDELINES

Recommended for treatment of *Lawsonia diarrhoea*:

- Denagaard® Vet (inj.)
- Tiamvet
- Vetmulin/Vetmulin inj.
- Econor®

Recommended for treatment of *E.coli* diarrhoea:

- Colicol
- Coliplus
- Colivet®

Resistance in *E.coli* bacteria

Over a period of 18 months, the Laboratory for Pig Diseases examined 660 isolates of haemolytic *E.coli* from diarrhoea outbreaks. Results show full susceptibility to colistin that is recommended for treatment.



A notice on the door may help meet withdrawal periods.

TABLE 1 Antibiotic resistance in 660 *E.coli* isolates from 2014-2015

Antibiotic resistance in <i>E.coli</i>	% resistant
Ampicillin	47
Colistin	0.5
Tetracycline	64
Ceftiofur	1

Delivery for slaughter

To maintain the quality reputation of Danish pork, it is vital that withdrawal periods are observed. Animals treated with medication should not reveal any residues of antibiotics when examined at slaughter. Producers should be aware of industry guidelines that lay down a 30-day retention time for all tetracyclines used for treatment. However, treatment of sick animals with tetracyclines should be kept to a minimum and alternative medicines should be used if they can achieve the same effect.

Administration of drugs in cold water

Research shows that cold and lukewarm water delivered the same concentration in the stock solution of a variety of water soluble antibiotics. For treatment of pigs in groups to be efficient, active matter must be present in the drinking water for the entire treatment period. SEGES Pig Research Centre therefore analysed six broad-spectrum penicillin (amoxicillins) and eight tetracyclines (doxycyclines) at the University of Copenhagen under standard conditions. Results demonstrated that stock solution must be used within 12-24 hours, depending on the product used, as the concentration may otherwise reduce. It is therefore crucial to vary stock solutions to ensure optimum effect.

Group treatment is best

SEGES Pig Research Centre co-operated with University of Copenhagen and the Technical University on a four-year project that is now close to completion. One element of this project was a PhD-study made in four herds by Inge Larsen on *Lawsonia diarrhoea*. The results show that group-treatment of pigs with the recommended dosage of tetracycline (10 mg/kg for five days in water) has the best effect on treatment of the disease, compared with whole pen treatment administered via water and injection. The development of antibiotic resistance under different treatment strategies was also studied, but results are not yet available.

MINAPIG

Pig producers and veterinarians in six European countries participated in a survey on the use of antibiotics. In Denmark, 263 pig producers and 56 practising vets answered a questionnaire giving their opinions on antibiotic use. Results show that Danish and Swedish pig producers have lower expectations regarding a reduction in antibiotic use than pig producers in Belgium, Germany, France and Switzerland, which is probably the consequence of years of strict antibiotic policy in Denmark and Sweden. Danish and Swedish vets report that they feel less pressure from producers to prescribe antibiotics – perhaps because vets in these countries are not allowed to generate income from the commercial sale of antibiotics.

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

health

VACCINATION

The use of vaccines

Vaccination of pigs is common practice on Danish pig farms. SEGES Pig Research Centre routinely tests available vaccines and issues recommendations for their use. It is then up to the farmer and the herd veterinarian to evaluate the vaccines used in the herd. In recent years, research activities have focused on vaccination against pleuropneumonia and PRRS.

Pleuropneumonia

Pleuropneumonia (*Actinobacillus pleuropneumoniae* serotype 2) is known to cause problems in finisher herds from time to time. Acute outbreaks lead to mortality, increased antibiotic use, lower daily gain and poor feed conversion. At the slaughterhouse, pigs that display acute symptoms of pleuropneumonia are rejected and persistent disease leads to an increase in the percentage of pigs with chronic adhesive pleurisy.

There are vaccines that are effective against pleuropneumonia: pigs must be vaccinated twice in intervals of 3-4 weeks to be immune. They must therefore be vaccinated early, preferably at the weaner stage, but this is rarely an option for producers who purchase 30 kg pigs for finishing.

SEGES Pig Research Centre therefore studied the effect of vaccinating finishers against

pleuropneumonia. The study was conducted in a herd where pigs were infected with pleuropneumonia halfway through in the finishing period, and there was therefore time to vaccinate the pigs against pleuropneumonia before they were infected. Two different vaccines were compared with a control group that was not vaccinated. Data relating to feed consumption, mortality, daily gain, antibiotic treatment and lung examinations were recorded.

However, results revealed no difference between the two vaccines when they were compared with the control group. An explanation may be that the point in time when pigs became infected with pleuropneumonia shifted during the trial and, as a consequence, the remaining half of the pigs became infected before they were vaccinated the second time.

PRRS

There are two types of PRRS in Denmark: type 1 (EU or DK) and type 2 (US or VAC), and different vaccines against type 1 and type 2 are available. Often both vaccines are used in herds with both types of PRRS, but it has not been established whether an optimum effect is achieved when both vaccines are used simultaneously. In addition, only few studies have looked into whether the vaccine effective against type 1 may also be effective against type 2 and vice versa. SEGES Pig Research

Centre investigated this in a study where the use of the two vaccines at the same time was compared with use of one of the vaccines. The study was made in isolation on the island of Lindholm where infecting the pigs with PRRS virus from a laboratory is allowed.

Results indicate that immunity was obtained against both types of PRRS when both vaccines were administered simultaneously. However, there were no indications that the vaccine against type 1 also protected the pig against type 2 and vice versa. Consequently, pig producers battling both types of PRRS should administer treatment against both types to be on the safe side.

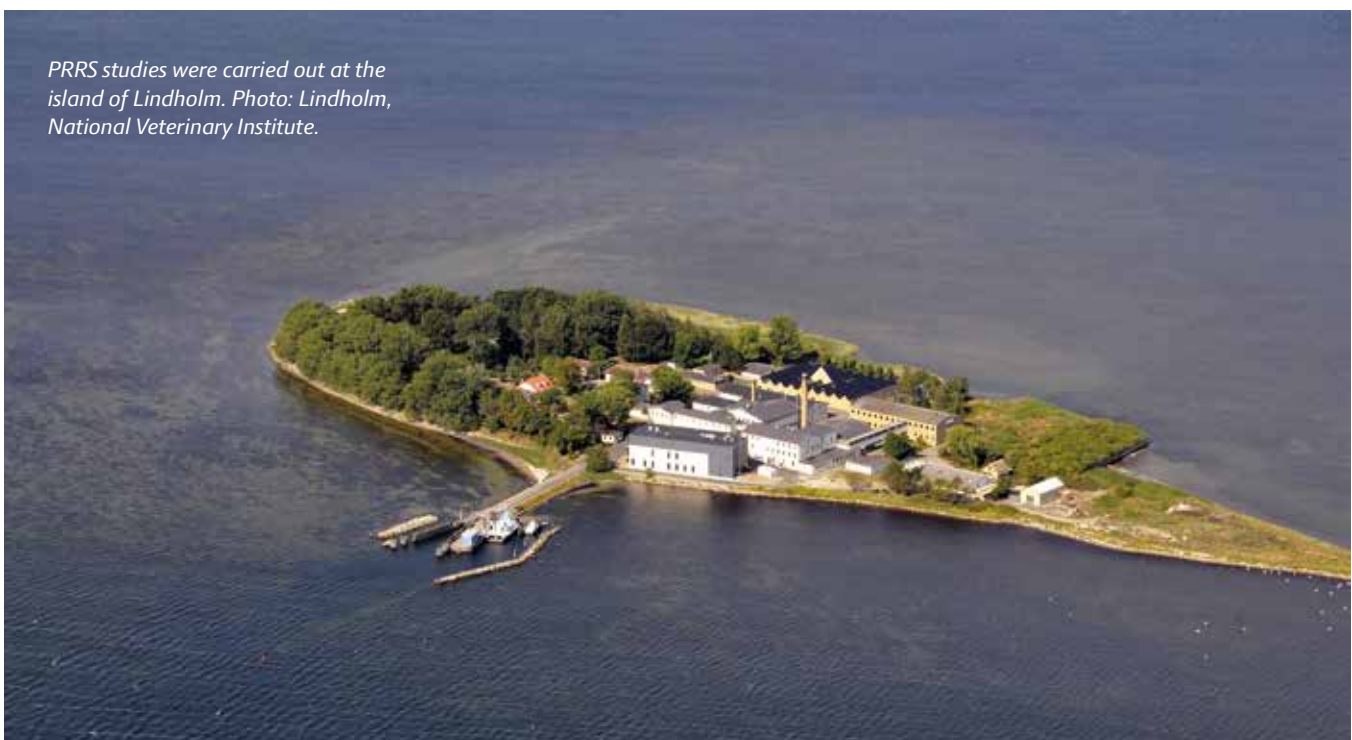
The project received financial support in the form of European PRRS Research Award 2014.

VACCINATION ROUTINES

Evaluation of the use of vaccines in the herds:

- Are we using the right vaccines?
- Is the timing of vaccination correct?
- Are the vaccines stored and handled correctly?
- Are we achieving the desired effect?

PRRS studies were carried out at the island of Lindholm. Photo: Lindholm, National Veterinary Institute.





Resistant staphylococcus

The term MRSA covers a range of staphylococci that are resistant to certain types of antibiotic. However, there are several types of antibiotics that are effective against MRSA. Most animals and humans who carry MRSA in their nose or on their skin are healthy. A report published in 2014 by the Danish Veterinary and Food Administration estimated that a particular type of animal-related MRSA called 398 is currently present in seven out of ten Danish herds. In other countries, this type of MRSA is also found in other animals, and the National Veterinary Institute is therefore currently investigating its presence in horses and calves in Denmark.

MRSA strategy

SEGES Pig Research Centre takes very seriously the increased prevalence of antibiotic resistant bacteria, and launched a three-point MRSA strategy in 2014:

1. Lower antibiotic use in Danish pig herds
2. International knowledge exchange
3. More funding directed at research

The main aim of this strategy is to lower overall antibiotic use by 10% by 2020. Another aim is to reduce the use of tetracyclines by 50% by 2015. To facilitate this, SEGES Pig Research Centre suggested the rapid introduction of a 'smart' Yellow Card scheme, which will help lower the risk of new resistant bacteria developing. However, there is some doubt about its effectiveness, as no direct correlation between antibiotic use and MRSA prevalence in Danish herds has been established. Further research will point to the best options for reducing the prevalence.

Reduction in tetracyclines

Together with some of the large veterinary practices in Denmark, SEGES Pig Research Centre is currently investigating the effect of reducing the use of tetracyclines. Tests are being carried out in a large number of herds that have stopped using tetracyclines, to study how this was carried out and what the consequences were for pig health and performance.

International problem

Problems relating to the development of antibiotic resistance cannot be solved in Denmark alone; it is a global problem that requires a global solution. To help share knowledge on antibiotic resistance internationally, SEGES Pig Research Centre and the University of Copenhagen hosted an international conference on antibiotic resistance in Copenhagen in 2015 (www.icohar.org). Topics included the

The main aim of this strategy is to lower overall antibiotic use by 10% by 2020.

importance of antibiotic use on human health and Dutch and Danish experiences in handling MRSA 398 in the national health services and in agriculture.

Research

In addition to participating in a comprehensive project aimed at evaluating the importance of hygiene to the spread of MRSA 398 from livestock housing, SEGES Pig Research Centre is also co-operating with the Technical University of Denmark on analysing how resistant bacteria spread and how to lower their prevalence. In addition, methods for more efficient disease prevention are being studied, so that antibiotics may eventually become fully or partially superfluous for use in particular treatments.

Information

SEGES Pig Research Centre participated actively in several 'information sharing' meetings on MRSA held across the country in 2014 and 2015. The main take home messages included acknowledgement of the MRSA challenge among Danish pigs and that people who work with live pigs must be educated about the implications for working in this environment. At doctors' appointments or visits to the hospital, they must inform the staff that they work with pigs in order to receive the correct treatment. Information about MRSA is available at SEGES Pig Research Centre's website (www.vsp.lf.dk); some of the material is also available in English and Russian. The site also provides find links to other websites containing information on MRSA and contact information for the new MRSA advisory service related to livestock (mrsaidyr@ssi.dk).

'Åbent Landbrug'

In 2014, the event 'Åbent Landbrug', where farms are open to the public, did not include pig farms, as the Danish Minister for Health had expressed concerns in relation to MRSA. Following dialogue with the Danish authorities, Danish pig farms are now again represented at the event and, in September 2015, eight pig farms participated.

Public MRSA action plan

In 2014, Danish politicians agreed on a four-year MRSA action plan in relation to the agricultural industry. This plan includes development of a revised version of the Yellow Card Scheme, in which various types of antibiotics will be weighted differently. The aim is to replace antibiotics currently used for treatment of pigs with alternative antibiotic treatments that do not adversely affect humans. This will also ensure increased focus on the use of vaccines. SEGES Pig Research Centre is currently involved in constructive dialogue with the Danish Veterinary and Food Administration on the development of this new Yellow Card Scheme.

CHLAMYDIA AND LEPTOSPIROSIS

Chlamydia

During 2014, chlamydia was diagnosed in aborted piglets. This bacterium has since been detected in every third case of abortion examined at the Laboratory of Pig Diseases. Investigations showed that there are two variants of chlamydia in Danish pigs: *Chlamydophilus (Chl.) pecorum*, which is the variant observed in the aborted fetuses, and *Chlamydia (C.) suis*. Neither variant is infective to humans.

The pathology of Chlamydia is unknown. Chlamydiae multiply in genitalia cells and are transmitted during mating, obstetric assistance and at heat check. There are indications that chlamydia is unable to survive for long outside the sows, and direct transmission between group-housed sows is therefore a rare occurrence. Chlamydia has been detected in the Fallopian tubes of sows from high performing herds as well as those achieving poor reproduction results. We should therefore assume that the disease is prevalent in all herds. Close attention to hygiene during insemination is the primary factor in preventing the spread of infection with Chlamydia. Staff must be particularly careful not to transmit infection from the vaginal mucosa between the sows during insemination.

CHLAMYDIA

- New disease in Denmark
- May result in abortion
- Infection pathways unknown
- Does not transmit to humans
- Important to maintain a high level of hygiene during insemination
- No vaccines available
- No experience with treatment yet

Leptospira abortion

Leptospire are spiral-shaped bacteria that do not survive drying. There are more than 200 serovars of Leptospire, and each has a preferred reservoir host. A number of serovars may be transmitted to pigs or to humans.

Leptospira pomona

L. pomona is transmitted from the *Apodemus agrarius* mouse that lives in southern Jutland, Lolland and Falster. Outbreaks have not been reported in southern Jutland, but on Lolland and Falster it is likely that outbreaks are triggered by infection transmitted from mouse to sow. Analyses of urine samples from 55 sows demonstrated that 35 were excreting leptospire in the urine. This indicates that group-housed sows do transmit disease to



A sorry sight when sows abort due to a leptospirosis outbreak.

one another. Irrespective of the timing of the infection, infected sows will abort in the final two weeks of gestation. Foetuses are non-uniform and partly decayed as some die before they are actually aborted. In these cases, the proportion of 'returners' did not increase nor were sows seen to develop endometritis. However, vaccination did terminate an *L. Pomona* outbreak.

Leptospira bratislava

L. bratislava has been found in hedgehogs in Denmark, and a Canadian report describes symptoms similar to those observed of *L. Pomona*, which has not been reported in Denmark. Sows seropositive to *L. bratislava* are often detected, but antibody titres are lower than those following *L. Pomona* infection. Titres may be attributed to *L. Bratislava* infection, cross-reaction to other leptospire or other factors. SEGES Pig Research Centre monitored 21 herds for a year before and after all sows were vaccinated. An increase in litter size of 0.3 piglet after vaccination was probably attributed to genetic progress. Prior to vaccination, the average farrowing rate was slightly higher than the general average in Danish pig production. Post vaccination, farrowing rates increased significantly by 1.2%, which may, of course, be attributed to other changes made in the herds. In the majority of the herds, antibiotic treatment was started at the same time as vaccination. Vaccinating against *L. Bratislava* did not affect litter size, and the possible positive effect on the farrowing rate was 1.2%.

Leptospira in aborted foetuses

In recent years, Leptospire of unknown serovars have been observed in a few aborted foetuses. Analyses revealed high immunoglobulin levels in the thoracic cavity fluid. This indicates that the foetuses had died from infection. In one herd, Leptospire were found in aborted foetuses twice, only one month apart. It is unclear which of the 200 serovars caused this. Analyses for *L. Bratislava* were negative.

3 VARIANTS OF LEPTOSPIROSIS (L)

L. pomona

- Only observed on Lolland and Falster
- Abortions in later period of gestation
- Infection spreads in the herd
- Clear effect of vaccination

L. Bratislava

- Unspecific symptoms
- Infection pathways unknown
- No clear effect of vaccination

Unspecific Leptospira infection

- Observed in Jutland only
- Abortion in mid-late gestation
- Infection does not spread
- Unknown variant, ie. vaccination not an option

health

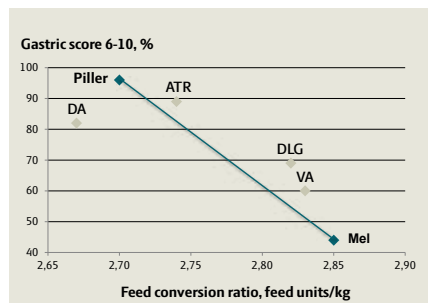
GASTRIC HEALTH

'Stomach-friendly' diets

Many pig feed manufacturers advertise products that are targeted at producers with herds struggling with a high prevalence of gastric ulcers. SEGES Pig Research Centre tested diets from the following feedstuff producers:

- Vestjyllands Andel
- Danish Agro
- DLG
- ATR Landhandel

FIGURE 1 Correlation between gastric ulcers and feed conversion

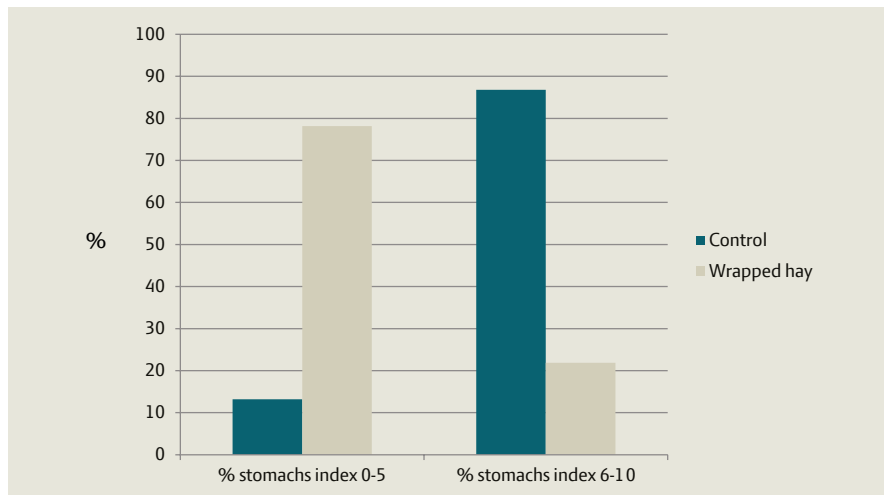


Results demonstrated that feed may improve gastric health, but it was not possible to achieve the same level of gastric health as with meal feed, without adversely affecting feed conversion ratio. The addition of rolled grain to pelleted feed was seen to reduce the prevalence gastric ulcers or scars (score 6-10) by around 15 percentage points, without a negative impact on feed conversion ratio. Other types of diets were seen to have a much more positive impact on gastric health, but also reduced feed conversion ratios. The best level of gastric health, but also with the poorest feed conversion, in numerical terms at least, was obtained with meal feed, which corresponds with findings in previous trials. The trial was conducted in one herd with a high prevalence of gastric ulcers and scars but low mortality rates.

SOUND GASTRIC HEALTH (*vsp.lf.dk*)

- Coarsely ground meal feed (sows: >15% above 2 mm)
- Finely ground meal feed
- Purchased feed with around 20% grain added after pelleting
- Expanded diet
- Pelleted feed with large particle size
- Wrapped hay
- High-fibre ingredients
- Straw

FIGURE 2 % indexed gastric ulcers when pigs were fed wrapped hay



Wrapped hay for finishers

The effect of giving ad lib access to wrapped hay to finishers fed pelleted feed was studied in one herd. Results showed a significant improvement in gastric health when finishers were given wrapped hay. In the control group, 87% of the pigs scored 6-10 in gastric index versus 22% in the group with access to wrapped hay. The wrapped hay was not chopped, and pigs were seen to pull out large chunks of the hay from the straw racks, which led to significant wastage and soiling of the pen. Extra labour must therefore be expected not only for supplying the hay but also for removing soiled wrapped hay from the pens.

Wrapped hay is one of several possible tools for solving gastric ulcer problems in a herd.

Mortality and gastric health

A study involving 36 finisher herds revealed no correlation between high mortality rates and gastric ulcers. Examination of 20 stomachs submitted at slaughter for gastric examination revealed that high mortality rates (above 4.2%) are not significantly correlated with poor gastric health.

Sham chewing in sows

Sham chewing in sows is not related to gastric health. This was the outcome of a study made by SEGES Pig Research Centre in one herd, where incidences of sham chewing were recorded during the daily supervision. Forty-one sows that exhibited sham chewing for three



Examination of gastric health.

days were compared with 41 other sows. The sows were slaughtered two weeks post-weaning. The sows were fed liquid feed mixed on-farm and had an average gastric index of 5.

production management

CAMPAIGN: 'PATTEGRISLIV'

Improving piglet survival

The PattegriseLIV ('piglet LIFE') campaign is aimed at improving survival rates among piglets. The campaign includes development of new tools for practical use in the herds and an advisory course has been carried out in 30 herds across the country.



The PattegriseLIV campaign focuses on piglet survival in the farrowing pen.

The campaign

Improving piglet survival rates is a hot topic and it was one of the priority areas of the declaration signed by the participants at the Welfare Summit held in 2014.

The aim of the campaign is to disseminate knowledge and direct attention to routines and management on Danish farms as well as generating profit for individual farmers.

On PattegriseLIV's website (in Danish) www.pattegriseliv.dk existing knowledge is collected and, on the Facebook page, producers and their staff enthusiastically discuss problems they encounter in their daily work.

Tools

In PattegriseLIV tools will be developed that are easily applicable in the herds to lower or maintain low mortality overall.



The electronic F chart is available for Android and iOS.



Piglet survival is increasing.

Tools developed in 2015 include a calculator that shows the economic potential for each herd in increasing survival rates.

An electronic version of the well-known F chart, used in many herds today, was also developed in 2015.

Electronic work planning has long been an aspiration on many farms, and with the Wunderlist programme it is now possible to make planning of work routines even more dynamic and flexible. This programme can be used for register tasks for staff and colleagues and it can be used to incorporate routine as well as ad-hoc tasks. A list of typical tasks related to the farrowing unit is available on the website.

Three models for advice

Thirty pig producers are participating in an advisory course aimed at improving piglet survival.

In April and September 2015 all farms started an advisory course in one of the following three courses:

1. Management – with farrowing unit advisor and herd veterinarian
2. Management – with farrowing unit advisor and consultant
3. Mentorship – the herd owner is assigned another producer as a mentor

Reports and action plans are prepared for all participating herds. These have shown the following key areas:

- Examination of daily, established routines

such as cross-fostering, shift suckling and nurse sows

- Piglet environment
- Feeding in the farrowing pen

Piglets have been submitted for gastric analyses at the Laboratory for Pig Disease and all pig producers have completed an obligatory post-mortem examination class. These proved to be an 'eye opener' to many of the participants, and most agreed that their daily routines are in need of revision.

The project received financial support from the EU and the Rural Development Programme under the Danish Ministry of Food, Agriculture and Fisheries. Journal no. 32709-14-0012.



Work routines related to care of piglets are examined.

production management

MINUS 30 FODERENHEDER

Project: 30 feed units less

Project 30 feed units less per finished pig' In January 2014, the project '30 feed units less per finished pig' began, involving 50 pig producers with the aim of significantly reducing overall feed consumption. Staff, advisors and veterinarians were involved, and the first results were seen by the end of 2014. However, as in all competitions, contestants have to qualify for the next round, and only the 80% best ranked herds qualified for the next round in 2015. A few herds exited the project due to other reasons. At the time of writing, 35 herds are still in the competition to reduce total feed consumption by 30 feed units per finished pig.

PROJECT '30 FEED UNITS LESS'

- 35 besætninger deltager i projektet i 2015
- Næste kvalificeringsrunde er marts 2016, hvor 80 pct. af besætningerne vil fortsætte til projektets afslutning i juni 2016.

The most recent performance chart revealed that the 35 pig herds remaining had an average feed consumption of 302 feed units per finished pig, which is a reduction of 10 feed units. Overall, the herds participating in the project have saved around 5,200,000 feed units, which corresponds to 180 truckloads of feed, worth approximately DKK 9,000,000 a year.

The performance chart ranks herds according to total feed consumption and improvements they have achieved. An average performance is not good enough nor improving for a short while and then falling back again. Of the remaining herds, 80% have improved their total feed consumption.

THE 2014 LAP WINNER was Team Pilegaard with a drop in total feed consumption of 24 feed units per finished pig in 2014, from 313 to 289 feed units per finished pig. The herd owner Kristen Pilegaard attributes this to a much needed renovation of two on-farm mills.

Analyses of particle size made at the beginning of the project revealed around 60% of particles below 1 mm – the aim was to achieve an 80% target.

Overall, the herds participating in the project have saved around 5,200,000 feed units, which corresponds to 180 truckloads of feed, worth approximately DKK 9,000,000 a year.

The practical steps taken to achieve these results were as follows:

- Examination of diet formulations – curves and strategies: this is routine in the best herds. Knowledge of feeding curves and questioning the feed formulations are both applied strategies in the best herds. Specifically, this has resulted in one case in an increase in protein content in the finisher feed and in a switch to a finer particle size to improve feed consumption during the Wean-to-Finish (WTF) stage.
- Checking the feeding system - cleaning as well as calibration of load cells: the best herds recognise the importance of this. Pig producers who mix their feed on-farm may tend to neglect the feed mixing facilities from time to time, but poor hygiene may contaminate the feed, lower the feed intake on account of poor taste, and, in the worst case, toxins may develop in the feed. Inadequate calibration of weighing cells may lead to inaccurately composed diets.
- Management of body condition – either back fat scanning or manually. Management of body condition must start just after weaning to ensure sows are fed correctly during gestation. It is easier to feed sows correctly when they are housed according to body condition.
- Environment in the weaner unit – it is crucial that weaned pigs get off to a good start. In the best herds, routine procedures

are in place for wash and preparation of the facility for a new batch of pigs. Pigs must be moved to dry pens at optimum temperatures.

- Data quality – the best herds demand correct data recording and routinely review efficiency control reports and AgroSoft data entry with their advisors. As a result, energy levels of ingredients and diets are routinely adjusted.

Other common features for the best herds include perseverance and the will to improve productivity continuously in co-operation with their advisors.

HIGHEST AND LOWEST

- The lowest feed consumption: 282 feed units per finished pig
- The highest feed consumption: 321 feed units per finished pig
- The greatest reduction in feed consumption throughout the project: 36 feed units per finished pig

production management 'THE PIG ACADEMY'

No two days are the same when you work with pigs; it brings a lot of responsibility, but also job satisfaction.

The Pig Academy

The Danish pig industry still faces challenge in attracting qualified employees.

In co-operation with agricultural colleges in Denmark, SEGES Pig Research Centre has introduced a range of initiatives to promote farming as an attractive career path.

Effective 'succession planning' requires action to provide students with the necessary skills to work in Danish pig production.

Recruitment

A successful plan also requires a wider 'talent pool' than we have today from which to recruit future leaders. We should also enable producers who prefer to employ Danish staff to do so.

We therefore need to attract more young people to the industry, including those not from agricultural backgrounds. Research will be undertaken to ask both students in general education as well as those attending agricultural colleges to give their impressions of working in pig production.



SEGES Pig Research Centre works on attracting more young people to the industry.

We hope this will allow us to communicate the 'good news' stories about working with pigs, such as:

- The Danish pig industry is among the world's best, with high standards of animal welfare.
- No two days are the same and working hours are good
- A career with a huge amount of responsibility is on offer
- There is a need for all personalities
- Skilled leaders will have job security for life

All this will be creatively communicated at a dedicated website at www.pigacademy.dk.

Educational material

In co-operation with Danish agricultural colleges, educational materials will be developed for practical use, with the aim of delivering a consistent message across institutions and streamlining the basic knowledge available to students who choosing to specialise in pigs.

In 2015, the material mainly focused on animal welfare. For years, 'animal welfare' was taught in other related subjects; for instance, design and use of hospital pens was included in the subject heading of 'production systems'. This may make sense to teachers and students, but, from an outsider's point of view, it makes teaching in animal welfare less visible.

SEGES Pig Research Centre therefore prepared material aimed at all teaching modules within agricultural education.

Course for biology teachers

In spring 2014, the Danish Association of Biologists, who organise supplementary training for grammar school-level biology teachers, contacted SEGES Pig Research Centre.

A one-day course was arranged with a focus on modern pig production and sought to address some of the prejudices held by students and teachers alike. Fifteen biology teachers attended the course, which also included discussions on specific topics such as MRSA, tail docking, castration and loose-housing of lactating sows.

The day finished with a visit to a pig herd, and the course feedback showed that the participants now had a more balanced view of Danish pig production.



Educational material in 2015 focused on animal welfare.



REPORTS

- No. 1410: Knowledge for sale
- No. 1411: Electronic ID of outdoor sows
- No. 1412: Nursing sows among loose lactating sows
- No. 1413: Baffle plates in gestation units with radiant ventilation
- No. 1414: Analysis of radiant heat sources in creep areas
- No. 1415: Roughage for restricted fed, group-housed gestating sows
- No. 1416: Sham-chewing unlikely to affect gastric health in sows
- No. 1417: Large variations in costs for on-farm mixing
- No. 1418: Effect of 'active NS' on ammonia and odour emissions from finisher pens
- No. 1419: Responsible use of antibiotics in Danish pig production
- No. 1420: Are pigs infected with PRRSV pre- or post-weaning
- No. 1421: Water consumption among weaners
- No. 1422: High survival rates in the farrowing pen
- No. 1501: Danish ingredients and byproducts for liquid feed
- No. 1502: Possible to diagnose Leptospirosis in urine samples from sows
- No. 1503: Amoxicillin and doxycycline products for administration of drugs in water
- No. 1504: Growth potential in FIF pens – management and design
- No. 1505: Position of air inlets in combination with point extraction
- No. 1506: Identical fertility rates with TRIXcell+ extender as with EDTA extender
- No. 1507: No effect of xylanase on decomposition of fibre during fermentation of wheat
- No. 1508: Feeding of organic outdoor piglets
- No. 1509: Diagnostics of disease in sows' kidneys

TRIAL REPORTS

- No. 1009: Testing of base in a chemical air cleaner
- No. 1010: Boar taint: Effect of slaughter weight and of feeding chicory and lupine
- No. 1011: Housing of gilts in stable or dynamic groups
- No. 1012: Fine grinding of wheat and barley improves productivity
- No. 1013: No correlation between sows' gastric health and feed intake during lactation
- No. 1014: Feed strategies may affect gastric health
- No. 1015: Gastric health in gilts
- No. 1016: Lesions on sow pasterns heal post-weaning
- No. 1017: Failed attempt to eradicate PRRSV using a vaccine in an entire herd of weaners and finishers
- No. 1018: Entire males: Effect of feeding grain for two days before slaughter
- No. 1019: Weaning of runts
- No. 1020: Organic entire males: Effect on boar taint of lower slaughter weight in combination with grain fed the last 4 days before slaughter
- No. 1021: Analysis of compound feed 2014
- No. 1022: Small genetic variation in PRRS over time in growing pigs
- No. 1023: Liquid feed or dry feed for female pigs, castrates and entire males
- No. 1024: Dutch finisher feed: improved productivity, but poorer economy
- No. 1025: Point extraction in farrowing facilities with partially slatted floor
- No. 1026: 20% point extraction through extraction point below lying area in finisher facility with solid floor in the lying area
- No. 1027: Feed dose towards the end of the growth period with liquid feeding of finishers
- No. 1028: Genomic selection as a way to reduce boar taint in Danish pig breeds
- No. 1029: Data analysis: Subsequent reproduction of nursing sows
- No. 1030: Test of commercial weaner diets 2014/2015
- No. 1031: Lower productivity in weaners and finishers with rape-seed cake
- No. 1032: Costs of national PRRS eradication strategy
- No. 1033: Productivity drops with frequent, sudden changes in ingredients in feed for finishers
- No. 1034: Energy levels in feed for weaners
- No. 1035: Commercial feed – positive effect on either gastric health or feed conversion
- No. 1036: Danish vs Dutch feeding regimes - sows
- No. 1037: Ideal protein levels in feed for finishers
- No. 1038: Wrapped hay lowers prevalence of gastric ulcers
- No. 1039: Importance of SPF diseases to productivity, antibiotic use and health
- No. 1040: Test of two vaccines against pleuropneumonia
- No. 1041: Feed supplement in late gestation reduced stillborn rates in one herd
- No. 1042: Effect of straw on gastric ulcers in finishers
- No. 1043: Pelleted dry feed improves feed conversion
- No. 1044: Brief confinement of loose sows lowers piglet mortality
- No. 1045: Xylanase positively affects EDOMi in pig feed

BRIEFS

- No. 1429: Structural development in Danish pig production 2014
- No. 1430: Basis of calculating bonus on outdoor weaners – as of week 40, 2014
- No. 1431: Evaluation of methods for administration of drugs in water for weaners and finishers
- No. 1432: Nutrient content in grain 2014
- No. 1433: Basis of calculating bonus on organic weaners – October 2014
- No. 1434: Basis of theoretical weaner prices, organic weaners – October 2014
- No. 1435: Projections for financial results of Danish pig producers 2013-2016
- No. 1436: Variations in batch sizes must not interfere with productivity and economy
- No. 1437: Prerequisites for income prognosis 2015
- No. 1438: Production price, grain
- No. 1439: Rental of pig houses
- No. 1440: Projections for financial results of Danish pig producers 2014-2016
- No. 1441: Basis of calculating bonus on outdoor weaners – December 2014
- No. 1442: Basis of theoretical weaner prices, organic weaners – December 2014
- No. 1443: Economy in grain maize for pig feed – case 1
- No. 1501: Cost-effectiveness in Danish pig production – December 2014
- No. 1502: Product outline: Rooting and enrichment materials
- No. 1503: Basis of calculating bonus on organic weaners – December 2014
- No. 1504: Economy in grain maize for pig feed – case 2
- No. 1505: Critical measuring points in pig production
- No. 1506: Preliminary results for pig producers 2014
- No. 1507: Effect of new settlement for lean meat percentage
- No. 1508: Investments in pig facilities 2006-2013
- No. 1509: Estimation of odour-reducing effect of frequent slurry removal in finisher facilities with partly solid floor
- No. 1510: Case study: feed mixed on-farm
- No. 1511: Economy in grain maize for pig feed – case 3
- No. 1512: Co-integration between the global markets and Denmark – and between ingredients
- No. 1513: Revision of nutrient standards for weaners and finishers
- No. 1514: Gross Margin check sow units, 7 kg, 30 kg and finishers 2014
- No. 1515: Business Check Pigs 2014
- No. 1516: Projections for financial results of Danish pig producers 2014-2016
- No. 1517: Cost-effectiveness in Danish pig production – May 2015
- No. 1518: Health status of organic finishers and outdoor finishers compared with conventional finishers – based on findings during meat inspections
- No. 1519: Financial feasibility studies 2015
- No. 1520: Basis of theoretical weaner prices – June 2015
- No. 1521: Revision of breeding objectives 2015
- No. 1522: Trend in sow mortality – data from DAKA 2014
- No. 1523: National pig productivity average 2014

SUBJECT INDEX

'Månegrís'	33	Framework	7	Sham chewing	51
'PattegriseLIV'	52	Gain	40	Shoulder lesions	38
'Åbent Landbrug'	49	Gastric health	51	Showroom	37
Abortion	50	Genetic progress	17	Slurry removal	30
Additional costs	10	GenSap	18	Sow feed	24
African Swine Fever	41, 43	Gestation	26	Sow herd	6
Agricultural colleges	54	Gilts	26	Sow production	8
Agricultural trades	6	Gross margin	10, 22	SPF	43, 44
AI	15, 18, 46	Grønhøj test station	20	Statistics	10
Air intake	29	Health inspection	43, 44	Stillbirths	40
Amino acids	21	Herd structure	14	Strategy	4
Animal welfare	38	Housing systems	26	Structural development	6
Antibiotics	1, 47	Innovation	4, 5	Swine fever	1
Beet pellets	27	Insemination	35	Tail docking	38
Behaviour	17	Laboratory for Pig Diseases	43, 50	Tetracycline	47, 49
Biosecurity	42	Labour	54	Transport	5
Birth weight	40	Leptospirosis	50	Vaccines	48
Blood plasma	22	Lindholm	48	Vitamin D	24, 25
Body condition, management	53	Liquid feed	23	Weaners	19
Breeding objectives	16	Liquid feeding	22	Weaning	34
Breeding stock	15	Litter size	15	Wean-to-finish	31
Broad beans	23	Longevity	16	Withdrawal period	47
Business	4, 5	LP5	17, 18		
Børgildgård test station	14	Manure hatch	35		
Chlamydia	50	Marketing	4		
Chlamydia Pecorum	43	Milk cups	36		
Commercial diets	21	Modernisation	7		
Competitiveness	1, 11, 13	Mortality	40		
Copper	22	MRSA	49		
Corn silage	27	Multisite	6		
DanAvl	5, 13	Nesting area	35		
DANISH	5, 39, 42	Nutrients	21		
DB	10	On-farm mixing	23		
Development	11	Organic	5		
Dry feed	23	Outdoor area	33		
Duroc	16	PED	41, 42, 43		
Educational material	54	Pelleted	23		
Energy content	22	Pig diets	51		
Energy efficient	29	Pig price	11		
Environment	33	Pneumonia	48		
Environmental approval	28	Point extraction	29, 30		
F chart	52	Production levels	14		
Farrowing pen	34	Productivity	9		
Farrowing unit	36	Profitability	9, 11		
Feed consumption	53	Resistance	47		
Feed conversion ratio	51	Returns	46		
Feed costs	10	Roughage	26, 27		
Feed efficiency	17	Rural Development Programme	7		
Feed supplement	26	Safety wash	5, 42		
Feeding stall	35	Sanctions	38		
Finisher herd	6	Semen	15		
Finisher production	8	Semen doses	46		
Finishers	19	Separation	31		

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