Annual Report 2003

The National Committee for Pig Production

Research and Development

Preface

In 2003, the recession really fastened on with negative figures in the accounts and liquidity problems for many pig producers. Furthermore, the Danish price was not competitive compared with that of other countries such as Germany.

Structural development

However, many Danish pig producers are still rather confident about the future, and many renovate and expand their production. These activities also indicate that the structural development continues with undiminished force, and currently, typically very large sow units with sale of weaners for e.g. WTF production are established.
As opposed to many other countries, we have not seen a decrease in the production. The pigs change addresses, and overall the Danish pig production is very stable. The export is increasing. It is therefore crucial that the coming EU transport regulations do not become so extensive that they completely block the indispensable valve that the export to Germany is.

Environmental regulation

The structural development is increasingly controlled by the environmental regulation and the struggle for land, and the pig industry has still not been given a scientific reason for the regulation of max. 140 kg N per hectare from pig slurry.

The National Committee for Pig Production works scientifically and positively for a reduction and for a long term balance in the emission of phosphorus. However, a tough regulation in connection with the Action Plan for the Aquatic Environment III will hardly change anything in relation to the aquatic environment, as the field leaching is relatively modest.

In terms of a reduction of odour and ammonia, the many trials carried out by the National Committee in co-operation with the Danish Institute of Agricultural Sciences and a number of creative companies and inventors prepare the ground for optimism. The technical possibilities are well under way, but much still needs to be clarified. This also applies to the economics and the operational safety, and to how the authorities choose to handle the new options.

Image and animal welfare

No other pig producers can match the Danish ones in terms of the high standards of animal welfare, the low consumption of medication and the efforts in the environmental area. Yet massive press coverage continuously accuses the pig industry of being unscrupulous.

Unfortunately, there are still many herds that do not deal with shoulder sores, tail biting and overcrowding. In the coming months, the National Committee for Pig Production will put extra focus on animal welfare so that pig producers, vets and pig advisors can straighten things out in co-operation. All pig producers must be able to open up their housing units and receive visitors with or without a TV camera. Compared with other countries, the Danish pigs are housed in production systems that highly benefit animal welfare. And the many new pens and housing units that are being built these years create a decisive head start.

The interpretation of the legislation concerning enrichment/rooting materials for all weaners and finishers is clear, and the National Committee for Pig Production works intensively on providing the necessary scientific solutions that are also practically applicable.

Health and breeding

In its breeding work, National Committee's effort within fertility has been an unconditional success. The next step will be selecting for better maternal traits to ensure weaning of large and healthy pigs. The mortality in the weaner unit must be reduced and it will be interesting to see the influence of the new gene technological possibilities. The first step has now been taken in terms of selecting for coli diarrhoea.

The consumption of prescription antibiotics is now stabilised after the antibiotic growth promoters were removed from the feed. PMWS is spreading across most of the country. The National Committee has given top priority to PMWS and we work hard on finding the cause and on coming up with efficient methods of treatment.

Nutrition and reproduction

The scientific work of the National Committee contains many interesting projects concerning nutrition and reproduction. Activities that help keeping the costs down and ensure an efficient production. Large sow units with group-housed sows and batch production requires a lot from the management and a stable, high farrowing rate. In the finisher production, one must keep an open eye on the feed conversion that is among others ensured through the new and more need-oriented feed evaluation system. As with Salmonella, progress in terms of nutrition has been made for Lawsonia. The feed is still the key to a good gastro-intestinal health.

Thank you

Despite the economic crisis there is no doubt that the Danish pig industry stands relatively strong. A unique co-operation has been established concerning the scientific development tasks. Pig producers, advisors, companies and governmental research institutions all contribute to the ongoing development and transition process that is the key to success.
Thank you for the co-operation.

Yours Sincerely,
The National Committee for Pig Production
Lindhart Nielsen / Orla Grøn Pedersen

The National Committee for Pig Production

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

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

Farmer Ole Kappel,
Hurup.
Elected at the annual meeting

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

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

Farmer Jens Ejner Christensen,
Jelling.
Elected by Danish Agriculture

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

Farmer Frede Hansen,
Roslev.
Elected by Region 3
(North and Central Jutland)

Smallholder Søren Hansen,
Snedsted.
Elected by The Danish Family Farmers' Association

Smallholder Aksel Andersen,
Bogense.
Elected by the National Council for Pigs of the Danish Family Farmers' Association

Farmer Boye Tambour,
Søllested.
Elected by the Danish Pig Producers' Association

Director Orla Grøn Pedersen,
The National Committee for Pig Production

Contents of the annual report 2003

Budget and strategy

The National Committee for Pig Production is founded by three basis organisations: the Danish Bacon & Meat Council, Danish Agriculture, and the Danish Pig Producers' Association. Besides representatives from these organisations, the National Committee consists of pig producers elected at the annual meeting and members elected by the regional pig production committees.

The National Committee for Pig Production safeguards strategy, development and information tasks concerning the live pig, and has an ordinary net budget for the year 2003/2004 of DKK93.85 million. Besides this, DKK3.2 million have been set aside for mapping of the pig's genome.

Strategy and new projects of the National Committee

Over the past years, the National Committee has increased the budget to make room for an extra effort in the environmental area on reduction of odour and ammonia.

The Sino-Danish joint venture concerning the mapping of the pig's genome has required a strengthening of the genetic effort under the National Committee.

The removal of antibiotic growth promoters and the need for accurate recommendations for feeding of weaned pigs have also required many resources.

PMWS also requires a great effort, and the National Committee has given top priority to this disease.

On adoption of the budget for 2003/2004, the National Committee decided to initiate the following new projects:

Product safety

- New Brucella/Yersinia 0:9 diagnostic External environment and work environment
- Reduced phosphorus in sow feed
- Collection of outlet air and purification of air
- Reproduction of ammonia from gestation and weaner units

Efficiency and nutrition

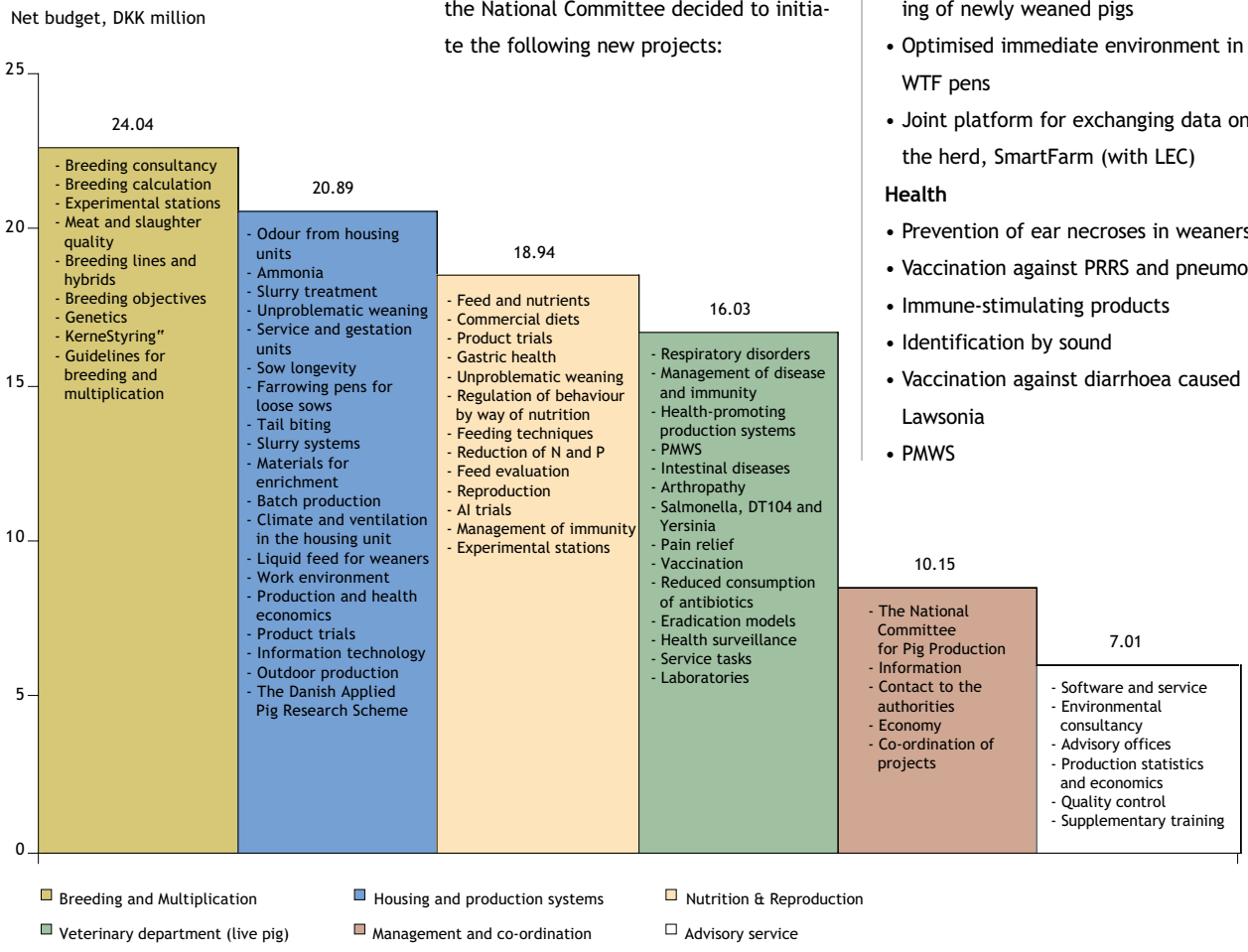
- Increased farrowing rate
- Naked oat for weaners
- Different sources of starch in lactation feed
- Degree of grinding – the path to improved feed conversion with meal feed
- Pellet quality
- ESF – management of feed supply
- Improved longevity of sows/shoulder sores

Housing systems

- Farrowing pens for large litters and pigs
- Feeding techniques for restrictive feeding of newly weaned pigs
- Optimised immediate environment in WTF pens
- Joint platform for exchanging data on the herd, SmartFarm (with LEC)

Health

- Prevention of ear necroses in weaners
- Vaccination against PRRS and pneumonia
- Immune-stimulating products
- Identification by sound
- Vaccination against diarrhoea caused by Lawsonia
- PMWS



Sale of breeding stock

Seasonal fluctuations in weaner prices

Since the autumn 1999, a guiding export evaluation has existed, and in the period up to today the average calculated price was DKK369, the Danish market price (the pool) was DKK361, and the export price DKK356.

It is important, though, to keep in mind that these are guiding figures, and not actual trades with various bonuses and deductions.

A close analysis shows that there are significant seasonal fluctuations every year. From January to the end of May, the market price is above the calculated price, and peaks around March 1, when the average difference is DKK35 in favour of the pool pigs. After this, the pool price drops by DKK2 a week until the end of October, when the calculated price is approx. DKK40 higher than the pool price. This is the same pattern every year, and the fluctuations have not become larger or smaller.

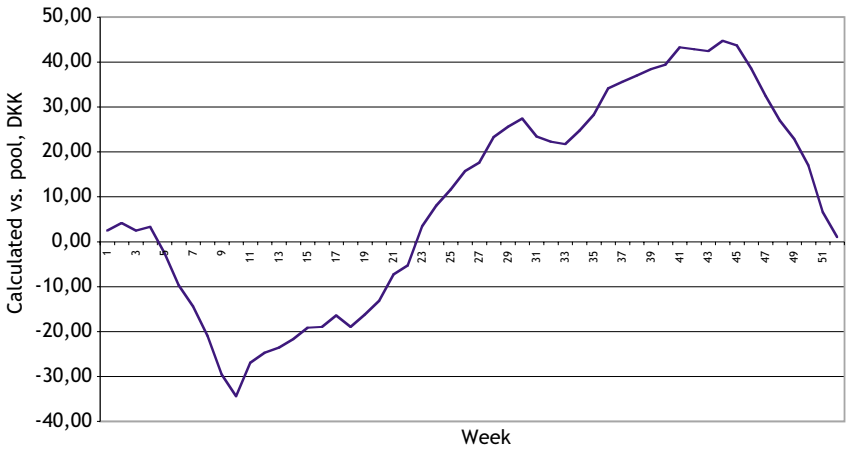


Figure 1. Seasonal changes in the weaner prices. In the spring, the "pool" is higher and in the autumn, the "calculated" is higher.

Table 1. Breeding stock – costs

		Female animals				Boars			
		2001-02		2002-03		2001-02		2002-03	
		DK	Export	DK	Export	DK	Export	DK	Export
Landrace	SPF etc.	3,357	3,016	5,066	4,242	103	409	94	333
	Own sale	348	-	236	-	30	-	10	-
Large White	SPF etc.	926	484	1,807	827	287	383	266	363
	Own sale	330	-	171	-	46	-	28	-
Duroc	SPF etc.	188	186	42	151	1,422	745	265	664
	Own sale	0	-	59	-	101	-	58	-
Hampshire	SPF etc.	106	7	0	33	1	21	4	24
	Own sale	19	-	0	-	4	-	20	10
Purebred	SPF etc.	4,577	-	6,915	-	1,813	-	1,629	-
	Own sale	697	-	466	-	181	-	116	-
Purebred in total		5,274	3,693	7,381	5,253	1,994	1,558	2,226	1,384
Hybrid	SPF etc.	196,826	23,174	225,089	31,630	4,174	180	3,809	147
	Own sale	17,493	-	15,588	-	519	-	254	-
Hybrids, total		246,460	-	272,307	-	4,873	-	4,210	-

SPF, etc. consists of sales from herds with SPF, MS, SKD/SKM status and sales for export and animals born from caesarean incision.

Productivity

Development

Following an increase in the number of sows from 2000 to 2001, the number has now dropped slightly to 1,128,000 sows, and it is expected to remain at that level in 2003. However, the continued positive development in efficiency means a still increasing production, which in 2003 is expected to land at 24.5 million, including export.

Production reports

Sows

The efficiency has increased by 0.4 pigs per sow/year this year. This increase is the result of both 0.2 more liveborn pigs, but fortunately also of 0.2 more weaned pigs per litter. The 0.4 extra pigs per sow/year are thus the result of the genetic progress. The feed consumption is slightly increasing, and this is probably due to the increasing number of group-housed sows.

Compared with the 25% poorest herds, the best 25% have 6.2 more pigs per sow/year. This is achieved by 0.18 more litters per sow/year and 1.5 more weaned pigs per litter. Furthermore, the weaners grow 24 g more a day.

Finishers

The gain is still increasing annually, and has now reached 831 g/day. The feed consumption per kg gain has dropped slightly by 0.02 FUp per kg. However, the number of rejected pigs and pigs with deduction is still increasing.

Among the producers of finishers, there are also great differences between the best and the poorest 25% of the herds. Thus, the best 25% have a feed conversion of 2.65 FUp/kg gain, while the poorest 25% reach 3.11 FUp/kg gain. Furthermore, the pigs in the best fourth grow an extra 109 g a day. Economically, with the average feed price of this year, this means approx. DKK35 in feed costs per finisher.

Table 1. Development in pig production

Year	1997	1998***	1999	2000	2001	2002	2003*
Sows, 1,000	1040	1070	1080	1070	1130	1128	1130
Prod. million**	21.1	23.0	22.5	22.4	22.9	24.0	24.5
Slaughter weight, kg	76.0	77.2	76.6	77.1	77.9	78.1	78.0
Lean meat %	59.9	60.0	60.0	60.0	60.0	60.0	60.0

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

Table 2. Sows and weaners

Year	Average production results 2000 All	2001 All	2002	2002 Poorest 25 %	2002 Best 25 %
Weight/sold pig	29.5	29.8	29.9	30.8	29.2
Feed/prod. pig, FUp*	99.3	99.3	99.9	107.2	93.6
Prod. pigs/sow/year	22.5	22.7	23.1	19.9	26.1
Litters/sow/year	2.25	2.24	2.25	2.15	2.33
Sows/year	230	246	267	221	325
First parity litters, %	27.8	28.6	33.8	29.6	39.8
Liveborn/litter	11.9	12.1	12.3	11.8	12.9
Stillborn/litter	1.1	1.2	1.3	1.4	1.3
Weaned/litter	10.4	10.5	10.7	9.9	11.4
Age at weaning, days	30	30	30	32	29
Weaning weight, kg	7.3	7.3	7.2	7.6	7.0
Dead post-weaning, %	3.4	3.5	3.6	5.4	2.2
ADG post-weaning, g	410	415	410	399	423
Age at 30 kg, days	85.5	85.5	86	89.9	82.5
Non-productive days/litter	17	17	16	22	12

** Not including feed for young females*

Table 3. Finishers

Year	Average production results 200 All	2001 All	2002 All	2002 Poorest 25 %	2002 Best 25 %
Prod. pigs	3,180	3,290	3,748	3,152	4,068
Daily gain, g	817	824	831	774	883
Feed/kg gain, FUp	2.89	2.89	2.87	3.11	2.65
Weight at transfer to finisher unit, kg	31.3	31.6	31.7	32.9	30.5
Av. slaughter weight, kg	77.2	78.1	77.7	77.9	77.6
Av. lean meat %	60.0	60.2	60.0	59.9	60.1
Dead and rejected, %	3.4	3.6	3.80	4.70	3.20
Incidence of pleurisy rec. at slaughter	19.7	22.8	20.1	21.7	17.9
Total, incl. deductions, %	7.4	8.5	12.0	12.3	11.7

Economy

2002 was a year with losses on the bottom line, both in connection with new establishments and for the average of all producers. Sadly, the outlook for 2003 is a loss of DKK125 per pig in new establishments. One kg pork incl. bonus payment has dropped from DKK11.99 in 2001 to DKK9.59 in 2002, and is expected to land at DKK8.25 in 2003.

Analysis of accounts

Sow units

The gross margin dropped from DKK6,135 to DKK3,801 – a drop of 38% compared with 2001. The feed consumption has increased slightly to 114 FUp per produced pig, and the price per FUp has dropped by DKK0.05 per feed unit.

Finishers

The relatively low settlement prices were also the main reason for the drop from DKK188 to DKK111 in the gross margin for finishers. The feed price dropped and the feed efficiency increased corresponding to a total of DKK6, but that did not succeed in alleviating the consequences of the low settlement prices that meant an entire DKK181 per finisher.

Capacity costs

The capacity costs originate only from the pure sow or finisher premises. The figures originate from part of the herds with production accounts: this explains the differences in gross margins in the two tables. All the capacity costs have increased slightly except for the maintenance costs and interest of the herd. Depreciation and interest are calculated sizes that are calculated on the basis of the invested capital.

Table 1. Barometer for Danish pig production for new establishments

Year	1997	1998	1999	2000	2001	2002	2003*
Price, incl. bonus payment, DKK/kg	11.70	8.32	8.02	10.0	11.99	9.59	8.25
Av. feed price, DKK/FUp	1.37	1.32	1.21	1.18	1.29	1.36	1.25
GM/pig from birth to slaughter, DKK	383	152	159	315	423	226	147
Capacity costs, DKK	118	123	127	125	123	126	125
Financing costs, DKK	187	180	180	162	167	156	147
Result/pig, DKK	78	-151	-148	28	133	-56	-125

** Projection*

Table 2. Average of production accounts for herds with sows and herds with finishers

	Sow units		Finishers	
	2001	2002	2001	2002
Premises	131	121	125	131
Sows/year	250	260		
Prod. pigs/sow/year	23.1	23.7		
Produced finishers			3,316	3,217
Weight, kg/prod. weaner	30	30		
Gain, kg/finisher			70	71
FUp/produced weaner	111	114		
FUp/kg gain			2,98	2,95
Price, DKK/prod. pig	447	351	923	742
Price, DKK/FUp	1.46	1.41	1.19	1.15
Gross profit, DKK	10,549	8,387	444	360
Feed costs, DKK	3,754	3,812	247	241
Vet & medication, DKK	372	414	5	4
Other costs, DKK	335	360	4	4
Gross margin, DKK	6,135	3.801	188	111

Capacity costs	**Per sow/year**		**Finishers**	
	2001	2002	2001	2002
Gross margin, DKK	6,170	3,591	190	93
Maintenance, DKK	221	202	12	10
Energy, DKK	222	245	9	9
Labour, DKK*	1,620	1,666	48	49
Depreciation, buildings/inventory, DKK**	746	793	35	36
Interest, buildings/inventory, DKK***	845	900	42	42
Interest, herd, DKK***	302	270	11	10
Result/sow per year/finisher, DKK	2.215	-485	32	-63

** Labour: DKK128/h in 2001 and DKK132/h in 2002*
*** Calculated on the basis of invested capital*
**** 7% in return on invested capital*
Source: Department of Farm Accounting and Management, Danish Farmers' Union

Genetic progress

Table 1 provides an outline of the genetic progress for the individual breeds over the last four years. Over the past year, the National Committee for Pig Production decided to draw the conclusion from the removal from the breeds in the breeding system of the halothane sensitivity allele and the RN^--allele. After the removal of these gene variants, recent studies have shown that increasing the ultimate pH in the carcass does not have any effect on the meat quality including the processing yield. In May 2003, pH was therefore excluded from the breeding objective for all breeds.

The genetic progress is affected by the fact that last year only includes approx. three months of data (i.e. does not correspond to the progress of an entire year) and that in that four-year period the Hampshire breed has been cleaned of the unwanted RN^--allele.

The value of the progress (measured on a four-breed hybrid) is DKK8.27 per year, of which DKK7.78 are expected to be transferred to the commercial herds.

The value of the progress to which the value of the RN^--strategy in the Hampshire breed was added and measured on a four-breed hybrid, constitutes DKK9.65 per year, of which DKK9.16 are expected to be transferred to the commercial herds.

Table 1. Genetic progress in the last four years, per breed and year. The average genetic progress per year is computed for each breed and as an average of all four breeds.

Breed	Year	Daily gain (30-100 kg), g/day	Feed conversion FUp/kg daily gain	Lean meat, %	Litter size, piglets born/litter	Conformation, points	Daily gain (0-30 kg), g/day	Killing-out percentage, %
Duroc	1999-2000	18.3	-0.03	0.11	0.02	0.05	3.1	-0.07
	2000-2001	19.4	-0.04	0.09	0.02	0.03	2.2	-0.16
	2001-2002	20.6	-0.04	0.13	0.14	0.04	3.3	-0.06
	2002-2003	14.3	-0.02	0.03	-0.01	0.03	2.5	-0.14
Average	4 years	18.2	-0.03	0.09	0.04	0.03	2.8	-0.11
Hampshire	1999-2000	11.3	-0.03	0.07	-	-0.01	2.3	-0.15
	2000-2001	2.1	0.00	0.01	-	-0.02	0.3	-0.02
	2001-2002	10.4	-0.02	0.07	-	0.02	0.3	-0.06
	2002-2003	7.8	-0.02	0.11	-	-0.02	-1.9	-0.11
Average	4 years	7.9	-0.01	0.06	-	-0.01	0.2	-0.09
Landrace	1999-2000	10.8	-0.03	0.05	0.30	0.10	-0.6	-0.04
	2000-2001	11.6	-0.03	0.05	0.42	0.06	-0.7	0.02
	2001-2002	15.3	-0.03	0.08	0.46	0.04	-0.7	0.04
	2002-2003	3.5	-0.01	0.08	0.13	0.04	-1.8	-0.02
Average	4 years	10.3	-0.02	0.06	0.33	0.06	-1.0	0.00
Large White	1999-2000	10.0	-0.02	0.10	0.34	0.08	-0.4	-0.01
	2000-2001	15.1	-0.03	0.07	0.29	0.09	1.5	0.00
	2001-2002	11.0	-0.02	0.04	0.21	0.07	1.6	0.13
	2002-2003	13.4	-0.01	0.11	0.35	0.02	-0.8	0.08
Average	4 years	12.4	-0.02	0.08	0.30	0.07	0.5	0.05
Average 4 breeds	4 years	12.2	-0.02	0.07	0.32*	0.01**/0.06*	0.6	-0.04/-0.05***

: Average of Landrace and Large White. **: Average of Duroc and Hampshire. *: Average of Duroc and Hampshire expressed in the value of a four-breed finisher.*

Production level

Tables 1-4 show the production results achieved at performance test station Bøgildgård and in the nucleus herds in 2002-2003. The number of performance tests in the nucleus herds is still very high. However, this number in Landrace is slightly decreasing in keeping with the decrease in the population of 100 sows carried out by the National Committee for Pig Production a year ago. The test of boars has, however, increased, particularly in the Hampshire breed where the nucleus population has expanded drastically over the past years.

At Bøgildgård approx. 5,000 animals have performed the test, which corresponds to full utilisation of the capacity. As has been the case so far, Duroc boars have been tested when there has been a lack of Hampshire boars for the performance test.

In the past year, a solution was found that ensures transfer of the desired top animals to the performance test at Bøgildgård so that the capacity of the electronic feeding stations is optimally utilised.

Table 1. Average production results of boars at performance test station Bøgildgård, 2002-2003

Breed	Number	Daily gain (30-100 kg), g/day	Feed conversion, FUp/kg gain	Lean meat, %	Killing-out percentage, %
Duroc	1,688	970	2.31	59.9	25.9
Hampshire	793	859	2.41	62.3	24.2
Landrace	1,265	935	2.41	61.1	25.8
Large White	1,245	925	2.33	61.7	25.4
Total	4,991	-	-	-	-

Table 2. Nucleus herds - Average production results for boars, 2002-2003

Breed	Number	Daily gain (0-30 kg), g/day	Daily gain (30-100 kg), g/day	Lean meat, %	Conformation, points
Duroc	10,238	376	1,014	59.5	2.90
Hampshire	2,451	359	852	61.8	2.91
Landrace	17,353	382	969	61.9	2.92
Large White	13,157	363	953	61.4	3.03
Total	43,199	-	-	-	-

Table 3. Nucleus herds - Average production results for female pigs, 2002-2003

Breed	Number	Daily gain (0-30 kg), g/day	Daily gain (30-100 kg), g/day	Lean Meat, %	Conformation, point
Duroc	11,788	373	963	59.6	3.03
Hampshire	3,310	363	818	61.8	3.03
Landrace	20,073	384	936	61.9	3.07
Large White	14,901	364	924	61.2	3.16
Total	50,072	-	-	-	-

Table 4. Litter size of purebred litters produced in the nucleus herds, 2002-2003

Maternal breed	Litter size (purebred litters in nucleus herds)	Percentage of gilts
Duroc	9.8	68.1
Hampshire	8.1	70.7
Landrace	13.9	62.7
Large White	12.9	62.0

Research and development

The "super sow" project

This project has now been underway for almost two years. Since October 2002, all nucleus herds with the breeds Landrace and Large White have delivered data for the project and by the end of August 2003, complete data from 500-600 litters per month has been collected. Thus, there is still some way to go before the goal of collecting a total of approx. 20,000 litters is reached.

Data is analysed on an on-going basis partly in order to adjust the trial if necessary, and partly to be able to utilise the results as quickly as possible if potential breeding objectives arise among the traits.

Currently a data set of approx. 4,000 litters is being analysed, i.e. approx. 20% of the planned extent. The preliminary analyses have shown promising results of several of the traits we are looking at concerning litter size/survival. It furthermore looks as if the litter weight at 21 days can be affected by breeding. There is, however, generally a low or no heritability of the diseases and traits that are recorded among the sows in the lactation period.

The data looks so promising that an adjustment of the breeding objective may be ready by the end of 2003.

It is, however, expected that the project will be completed as planned and that it will result in more changes in the breeding objectives concurrently with the amount of data becoming sufficient for evaluating several traits. These are generally the traits with a low or a very low heritability.

Hernia

Over the past years, the Department of Breeding and Multiplication has co-operated with NorSvin in Norway on a project aimed at clarifying whether one single gene causes hernia in pigs. The project focuses on three defects: umbilical hernia, scrotal hernia, and cryptorchidism.

The preliminary results from the "super sow" project indicate that the litter weight at 21 days can be affected by breeding, and can therefore potentially be included in the breeding objective for Landrace and Large White.

The researchers at NorSvin believe that one gene or very few genes code for these defects. Therefore DNA is analysed from family members with and without the defects with the aim of finding an applicable gene marker/test. Danish breeders contribute with recordings, and they submit blood from families with defect individuals: blood samples from two pigs with hernia and two siblings without hernia and blood from both parents. The analyses will be made in Norway, and we will subsequently gain access to the results for potential use in our breeding populations. In the analysis period, 141 micro satellite markers have been genotyped in 74 families. So far, a number of interesting, possible markers have been found in the offspring, and genotyping of the parents for the same markers is almost complete. The analyses are expected to be completed by the end of 2003.

If we succeed in finding an applicable analysis method for locating a potential single gene responsible for hernia, the next step will be a economic/strategic consideration of how the gene marker is to be used in the breeding system.

In connection with the "super sow" project, information will be collected systematically of all the litters from Landrace and Large White regarding other defects, e.g. splaylegs, with the aim of establishing whether it is possible to reduce the prevalence of these defects through breeding.

Elimination of the RN^--allele

For several years, it has been known that the Hampshire breed has a gene that exists in two versions (alleles): rn^+ and RN^-. Pigs with the genotypes RN^-rn^+ and RN^-RN^- have a relatively low pH after slaughter. This has an adverse influence on the meat quality in the form of increased drip loss and reduced processing yield. Thus, there is an interest both economically and quality-wise in eliminating the unwanted RN^--allele. In mid-1999, the National Committee for Pig Production decided to remove the RN^--allele by way of selection from the Hampshire breed by using DNA tests. It was at that time estimated that only approx. 2% of the animals in this breed were rn^+rn^+; i.e. completely free from the unwanted gene. Now, four years later, we have reached our goal. The allele frequency of the wanted gene has increased to 100%, and the unwanted gene is eliminated from all breeding stock born after April 1, 2003.

This strategy has not come for free. The improvement of the other breeding objectives has been reduced during those years when the elimination of the RN^--allele was given the top priority. However, it is expected that the coming years will see a genetic progress at the same level as before or even higher, as the number of breeding sows in the breed has increased by approx. 50%.

In their Code of Practice, Danish Crown requires that the boars used must be free from the RN^--gene. If in doubt, please contact the Department of Breeding and Multiplication, who can provide information on the RN^--status of older boars.

The National Committee for Pig Production decided to remove ultimate pH as a trait in the breeding objective due to the fact that after eliminating the halothane sensitivity allele and the RN--allele from the breeds in the breeding system, there was no effect on the general meat quality of increasing the ultimate pH in the carcass.

Breeding for longevity

A few years ago, a study was carried out in the nucleus herds where an exterior evaluation was made of the sows in the farrowing unit after their first and second farrowings. The evaluation was made according to the same scale used for the performance test. The exterior evaluation of the sows was compared with their previous evaluation as young females. A very clear correlation was found.

In practice, however, it is not possible to record longevity in the nucleus and multiplication herds after the second farrowing, as most purebred sows will by then have been removed due to a low selection index. We therefore lack knowledge of the genetic variation of longevity, of the correlation between conformation and longevity, and of the correlation between production traits and longevity. A project has therefore been initiated with the aim of collecting information that can answer the above questions.

The project is conducted in commercial herds with female animals of known origin. In practice this means that the herds either buy their replacement females or produce them themselves by way of KerneStyring" (nucleus management in closed herds = known origin). A technician from the Department of Breeding and Multiplication performs an exterior evaluation of all the young females when they weigh approx. 90 kg, and the individual herds submit production results and detailed explanations for removal of the evaluated animals. It is a requirement to the herds participating that the gestating sows are group-housed.

The project is carried out as a PhD project in co-operation with the Danish Institute of Agricultural Sciences in Foulum.

Within two to three years, data will have been collected from approx. 12,000 sows. Then the heritability will be calculated for longevity along with calculations of the correlation between the production traits and longevity, and subsequently the value of the current conformation evaluation in the nucleus herds can be correlated with the longevity of the production sows. It is expected that the project create the basis for evaluating whether the breeding objective can be adjusted to ensure on an ongoing basis that finishers and sows do not encounter welfare problems some day.

By mid-2003, exterior evaluations had been made of 10,000 young females, and the reasons for removal had been recorded for approx. 4,000 of these. Table 5 provides a preliminary overview of the reasons for removal, but no conclusions have been made yet. When all the data material has been collected, a more detailed analysis will be made of the figures that will also include the reproduction data of the sows.

The sow experiment at Grønhøj

The project concerning different recruitment strategies in the sow unit currently running at Grønhøj is now approx. half way in terms of produced litters in the different combinations of breeds.

The aim of the project is to calculate the efficiency of the combinations YL, (YD)L and zigzag sows in the same production environment. Approximately 1,000 litters

Table 5. The most significant causes for the sow leaving the herd in the project Breeding for longevity (preliminary results)

Cause	Number	Per cent
Lack of heat	250	6
Not gestating	887	23
Poor maternal properties	941	24
Disease	493	13
Injuries	655	17

of each combination will be produced, and the project thus runs for a number of years. The preliminary results are presented in table 6, but it is too soon to draw any conclusions.

Osteochondrosis

The leg conformation project, which was carried out as an extension of the sow experiment at Grønhøj, has now been completed in terms of X-rays and evaluation of conformation. The leg joints, from all the animals that have been x-rayed and evaluated, will be removed at slaughter and subsequently evaluated. A total of 580 animals have been evaluated. The project runs for another couple of years, as all the evaluated animals must be transferred from the herd before the results can be analysed.

The project opens up the prospect of assessing the correlation between the conformation evaluation and the degree of osteochondrosis in the evaluated animals. Furthermore, the project makes it possible to study how changes in the joints develop over time and thereby whether animals that do not suffer from joint changes when they are young later in their lives develop changes in their joints and vice versa.

Breeding projects concerning PMWS

In January 2003, the Department of Breeding and Multiplication initiated a project aimed at establishing whether there are any differences in a herd diagnosed with PMWS in the resistance of finishers to the disease dependent on their combination of breed. As of the beginning of January 2003, the sows in the trial were mated with known boars. 130 services have been performed with each of the breeds Duroc, Hampshire and HD. The mothers were YL sows. The last pigs are expected to be slaughtered in December 2003, and then the trial data will be analysed.

Simultaneously with this trial, a project is carried out to collect and analyse DNA material from litters with both healthy animals and animals that have been diagnosed with PMWS with the aim of establishing whether any resistance to PMWS is conditional on one single gene.

Table 6. The preliminary results from the sow experiment at Grønhøj

Breed	Litter 1	Litter 2	Litter 3	Litter 4	Litter 5	Litter 6	Litter 7	Litter 8	Litter 9
LL	12.1 (248)	13.3 (217)	13.5 (171)	136. (123)	13.4 (79)	13.6 (38)	15.5 (11)	-	-
YL	12.5 (443)	14.0 (375)	15.0 (302)	14.8 (228)	14.6 (164)	14.2 (114)	14.5 (69)	13.3 (26)	18.3 (3)
(YD)L	12.2 (431)	13.4 (347)	14.7 (227)	14.3 (223)	14.5 (160)	14.8 (107)	14.1 (68)	13.6 (81)	12.8 (6)
ZZ(L-)	12.6 (110)	14.1 (85)	15.5 (71)	14.6 (44)	15.1 (33)	13.3 (24)	15.3 (12)	15.3 (12)	12.0 (2)
ZZ(Y-)	13.0 (124)	14.5 (98)	15.6 (75)	15.3 (58)	15.6 (34)	16.0 (15)	12.0 (3)	12.0 (1)	-

The number of litters is written in the parentheses.

In herds with PMWS, typically 10-30% of the pigs are hit by the disease. Often the symptoms are seen to develop in the pigs in the period 3-5 weeks post-weaning. In herds diagnosed with PMWS, individual animals in the litters are often seen that are not hit by the disease despite the fact that their siblings are infected. This phenomenon can be regarded as an indicator of a genetic resistance to PMWS and of a theoretical possibility that the resistance is caused by one single gene.

Breeding for disease resistance

The project "Breeding for disease resistance" was initiated in 1999 in co-operation with the Danish Institute of Agricultural Sciences and includes two stages, of which the first was completed in the first half of 2002.

In the first stage, data were collected from 12,481 pigs from 1,126 litters born in three commercial herds. The pigs were offspring of 12 selected AI boars (Duroc) and LY/YL sows. The three herds were selected among herds that were experiencing problems with pneumonia in order to have a fair number of animals with pneumonia.

It can be concluded on the basis of the project that there are great differences in mortality and disease resistance among the offspring of the boars used. It can thus be seen in table 7 that the frequency of the general disease remarks to the offspring at the slaughterhouse varied from 32% to 49% dependent on the boar that fathered the pigs. Furthermore, 90% of the offspring of the poorest boar was slaughtered, and 98% of the best boar. The frequency of pneumonia varied from 18% to 59% for the offspring of the best and the poorest boars, respectively, in this trait. This means that the offspring of the poorest boar has a risk that is three times higher of encountering pneumonia than the offspring of the best boar. On the basis of these results, it was decided to initiate the project "Genome scan".

The pig genome project (the Sino-Danish project)

Phase 1 of the Sino-Danish Pig Genome Project will be completed in the autumn of 2003.

The first phase of the project consists of two parts. The first part is a so-called

Table 7. Completion in the production unit and frequency of disease at slaughter in Breeding for disease resistance

Boar	Survival percentage		Per cent of animals with disease at slaughter		
	Weaning unit	Finisher unit	Recordings at the slaughterhouse	Pneumonia	Chronic adhesive pleurisy
1	96	97	39	18	54
2	96	98	34	27	53
3	95	96	39	33	62
4	95	96	32	44	51
5	94	97	37	42	63
6	97	92	32	36	45
7	94	95	36	39	61
8	95	92	42	36	66
9	96	90	37	37	64
10	97	94	34	32	47
11	92	93	47	59	69
12	90	91	49	49	70

shotgun sequencing (reading of the genetic code). In this project it has been possible to get an overview of approx. 65% of the genetic code of the pig. Further analyses and comparisons with the human genome and the mouse genome clearly show that as expected there is a great similarity between the pig genome and the human genome, while the mouse genome is somewhat more different.

Science has decided that the complete mapping of the genome of a species requires that the genome is sequenced six times, because that way it is possible to piece together more than 95% of the genetic code correctly. So far, we have barely sequenced the genome once. However, the financial consequences of this are so extensive that it is impossible for Danish pig production to conduct such a task by itself. We are therefore currently examining whether it is possible to establish a European consortium so that we together can conduct this task. The solution of this task will give us a better estimate of where the genome of a given gene is located.

The second part aims at obtaining knowledge of as many of the pig's genes as possible. This has been done by constructing and sequencing genes cleared off non-coding elements. It is estimated that through this we have obtained knowledge of 95% of the pig's genes. Until now, the analyses have shown more than 80,000 different variants (these are called Single Nucleotide Polymorphism – SNP). The "quality" of these SNPs varies. Some do not change the code of the protein being built; others change one amino acid to a closely related amino acid, and it is thus not likely to have any great physiological effect. Finally, we have the SNPs that we have our eyes on in particular; they are the ones that change the composition of the amino acids in a given protein to a crucially different one than what we normally know. We can here expect great negative or positive influences on the pig's phenotype.

The results of phase 1 are already being used in a large-scale trial (the genome scan), where we look for connections between the last type of SNPs and the traits of the pig.

Genome scan

It is now possible to conduct a genome scan with the aim of identifying chromosome areas that include genes causing phenotypic differences in the disease resistance and in the meat quality and production traits. The technique includes the use of SNP markers (Single Nucleotide Polymorphism = mutation) for analysis of the genetic variation. When the typing is complete, further comprehensive and complex biometric analyses are required.

It is now attempted to use data from the project "Breeding for disease resistance" in a very costly genome scan. Such a genome scan includes typing of all pigs of a large number of gene markers and subsequent analysis of the heritability of these gene markers. Subsequently the phenotypic results from "Breeding for disease resistance" will be compared with the gene markers in a complex biometric analysis. In this connection, the information is used from the pig genome project.

The work with this project is already well underway, and the calculations of the first SNP-based genetic map were completed by the end of April 2003. It was also shown that it might be possible to identify SNPs with a great effect on traits that are of great interest and are of economic importance.

The project is expected to run for a number of years and is carried out in co-operation with the Danish Institute of Agricultural Sciences, the Dept. of Animal Breeding and Genetics, who possesses the relevant research qualifications within this area.

Artificial insemination (AI)

Semen sale

Approx. 61% of all services in 2002/2003 employed purchased semen. The figures are based on a population of 1,132,000 sows. In 2002/2003 DanBred's AI stations sold 3,674,412 semen doses corresponding to an increase of approx. 9% compared with the previous year. The development in the semen sale over the last five years is shown in figure 1.

Co-operation with other institutions

A joint venture with the Federation of Danish AI Societies and the Royal Veterinary and Agricultural University has been established concerning studies of the fertility of semen. Scientists work on finding a correlation between the condition of the DNA in the sperm cell and the fertility of the individual animal. The aim is to analyse whether fertility can be predicted on the basis of an examination of a semen sample.

Own trials

The above project, which is supported by the Danish Directorate for Food, Fisheries and Agri Business, has resulted in the development of a method for determining the concentration and number of live sperm cells in a semen sample. At the end of 2002, the National Committee for Pig Production and the AI stations decided to purchase such equipment (flow cytometer). The instrument is used in trials concerning semen and AI.

Control of processed semen

The flow cytometer has made it possible to analyse the number of sperm cells in a dose. We have therefore initiated control of processed semen doses. The preliminary results confirm that the content of sperm cells vary. However, there were no indications that the semen doses contained too few sperm cells to get a satisfactory litter size or farrowing rate. In the future, we will study whether it is possible to reduce the variation in semen doses.

New method for determination of concentration of raw semen

A trial with the Nucleocounter" (ChemoMetec A/S), which is used for determining the concentration of raw semen, showed promising results. The results indicate that the instrument is approx. twice as good as the photometer currently in use. This new instrument may become a necessity if the semen doses in the future are to contain fewer sperm cells, e.g. a reduced amount of semen in connection with either normal or post-cervical insemination.

Reduced amount of semen

The end of May 2003 saw the initiation of a trial of reduced semen amounts. This trial compared insemination doses con-taining 1.0 billion with 2.0 billion motile sperm cells as used today. A two-step insemination technique was also studied where the insemination is first performed with 40 ml semen followed by 40 ml pure diluent. If the results show that this is impossible, the amount is changed to 1.5 billion versus 2 billion. The advantages of reducing the semen dose are an increased utilisation of the genetic material and reduced costs in connection with the production of semen doses.

Post-cervical insemination

At post-cervical insemination an extra tube is led through the traditional catheter and in through the neck of the uterus into the uterus. It is expected that placing the semen there will make it possible to reduce the amount of semen used at insemination. There has been some concern that the introduction of an extra plastic tube may damage the neck of the uterus and the uterus. The Danish Veterinary Health Committee has subsequently stated that post-cervical insemination should not be used in Denmark.

Following approval from the Experimental Animals Authority, two studies of catheters for post-cervical insemination have been carried out. The first study showed that introduction of a commercial catheter for post-cervical insemination could cause damages to the mucosa of the uterus neck, but that these damages did not affect the sows. The other study will show whether these damages correspond to the ones occurring during normal mating. Practical studies are likely to be initiated soon.

Process and storage temperatures of Yorkshire semen

The aim of the trial was to establish whether Yorkshire (Y semen) is less stable than Landrace (L semen) when subject to fluctuations in temperature. Nothing in the trial indicated that Y semen is less stable than L semen when subjected to fluctuations in temperature (Report 0306). However, the lowest farrowing rates were reached with semen exposed to the largest fluctuations in temperature. It is thus important to continue to focus on avoiding fluctuations in the temperature and store the semen at a temperature of 16-18 degrees Celsius.

Germ number in the semen production

From June to December 2002, the germ number in tubes for filling of semen doses and in the semen doses was analysed. The trial showed that every 10 submitted sample was positive and that there were no correlations between contamination of the tubes used for filling and the semen doses produced with the tubes in question. The detected bacteria originated from the environment in either the housing unit or the laboratory. The bacteria were all inactive/weakened, but apparently resistant to the antibiotic used in the semen doses. At all the stations, the increased focus resulted in a decrease in the number of positive samples from the AI stations. No

samples were positive by the end of the trial period. The trial is currently being evaluated with the aim of deciding whether the control of the germ number in semen doses is to be continued in its present form.

Addition of antibiotics to semen

Antibiotics are added to the semen from DanBred's AI stations to prevent bacteria from surviving in the semen. A trial was carried out to examine the stability of the antibiotic dissolved in the EDTA diluent. This is important to the staff at the AI stations as the handling of the antibiotics and thereby potential contact with the substance can cause allergy. The results were positive (Note 0242), and it is expected that liquid antibiotics dissolved in the EDTA diluent can be delivered to the AI stations as of the end of this year.

Rest after insemination

Rest in the form of individual housing in feeding and insemination stalls after insemination has an effect on the reproduction results of sows housed in groups in the service unit. Lack of rest for up to two hours after the insemination resulted in a decrease in the farrowing rate from approx. 88% to approx. 83% in young sows, while there were no differences among older sows (Report 586). The results indicate that young sows are more sensitive towards some types of stress compared with older sows. However, it cannot be excluded that e.g. moving the young sows in connection with insemination, which can also be considered as stress, can have a positive effect. This type of "positive" stress is being studied more closely at the moment.

Housing and stress

Stress among sows housed in stalls or in individual pens in the service unit was studied in one trial. Blood samples were analysed for the stress hormone cortisol as well as for the hormone oxytocin before, during and after insemination. There were no differences in the amounts of hormone between the two groups of sows. This trial could therefore not establish that one type of housing was more stressful to the animals than the other. There were no differences in the reproduction results either. The trial was financially supported by Norma & Frode Jacobsen's Foundation and carried out in co-operation with the Swedish Agricultural University in Uppsala.

The surprise effect in the service unit

The importance of the "surprise effect" with the boar in the service unit compared with constant presence of the boar was studied. The surprise effect consisted of moving the boar out of the service unit two days before the expected insemination. The boar was reintroduced in connection with service and the sow had the opportunity for snout contact again (surprise effect). The theory of a benefit with the surprise effect could only be partly confirmed (Report 605). It was not possible to prove an increase in the farrowing rate, and the litter size only increased in one herd. The reason why only a small effect was seen could be that the reproduction results were good already (a farrowing rate of approx. 91 and a litter size of approx. 14). A higher effect can therefore not be excluded in herds with a lower farrowing rate and a lower litter size.

However, when the surprise effect was used, significantly less time was spent as the stimulation of the sows did not take as long; the overall time spent on insemination was thus reduced from 6 minutes per sow to 4.5 minutes per sow.

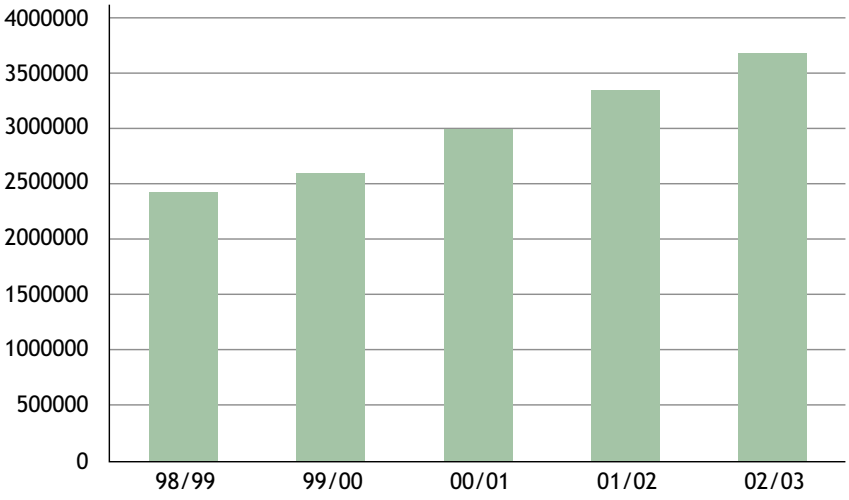


Figure 1. Semen sale of the last five years

Longevity of sows

Many sows are culled from the Danish herds before their usual "retirement age". One of the reasons is leg problems, but it has not been established if this is caused by the joints, the bones or by some third factor. Therefore a method has been developed for scanning the bones of sows that describes the strength of the bones. This is an objective method that can be used for improving the sows' general longevity, for instance through feeding in the growth period.

Bone strength measured by DEXA

A project was carried out of measurement of the bone strength in co-operation with the Royal Veterinary and Agricultural University and Novo Nordisk A/S. DEXA employs two low-energy X-rays, where the X-ray is analysed in an image-processing programme. The result of the DEXA scan is expressed as BMD (Bone Mineral Density). Both forefeet and one caudal vertebra from each sow were used.

The primary aim was to describe a reference area of bone strength expressed as BMD in normal Danish sows. Secondarily, the aim was to correlate the found BMD values with herd data and thereby cover possible risk factors of a low bone strength in the individual herd.

The reference area for BMD in normal Danish sows was 0.76-1.97 g per cm2 when using an average of BMD for the entire left and right forefeet.

Herd factors with a significant influence on the bone strength of the sows were weight, type of housing, and flooring in the gestation unit. The heavier the animal, the higher the bone strength. Group-housing in the gestation units resulted in a higher bone strength compared with sows housed in stalls or in tethers. The sows housed in stalls or in tethers on slatted floors in the gestation units had a higher bone strength than the sows housed in stalls or in tethers on solid floor in the same units.

The trial was completed with analyses of bones from the sows given different amounts of phosphorus and calcium during the entire growth.

Table 1. Back fat measurements, young females

Group	Control	Trial
Number of young females	195	200
Back fat at approx. 90 kg, mm	12.0	12.1
Back fat at service, mm	14.0 a	16.0 b

a, b: p<0.05

Feeding of young females

British studies have shown a correlation between the fat layer of the young females at their first service and the number of pigs produced per sow. It is now attempted to demonstrate these results in a trial with LY young females from DanBred that are assigned to two different feeding strategies in the growth interval 90-130 kg. The control group is given lactation feed, while the trial group is given a diet with a low content of protein and a high content of energy so that the young females have a thicker layer of fat at their first service. The trial is carried out in six herds.

The young females are monitored as sows in the herds until they are culled. The production results and the reasons for culling are being recorded. So far, 800 litters have been recorded in each group, and the trial group has 0.5 weaned pigs extra per sow/year. There are thus no indications of a negative effect on the subsequent reproduction of the young females when they have been given a diet with a low content of protein and a high content of energy.

The mineral content can easily, accurately and objectively be determined at a DEXA scan (Dual Energy X-ray Absorptiometry)

Feeding of gestating sows

Hunger caused by restrictive feeding is expected to be the reason for unrest and aggressive behaviour among group-housed, gestating sows.

The sows were fed ad lib in two trials in an attempt to exclude feed as a limiting resource in the immediate environment of the sows.

ESF and roughage

Restrictive feeding with dry feed via electronic feeding stations (ESF) and ad lib access to roughage was studied in two herds (Report 607). This feeding strategy was compared with restrictive feeding with no access to other feedstuffs. The sows in both trial groups were housed in pens with straw-bedded lying areas. There was a dynamic transfer of sows.

In both herds, pectin feed was used as roughage. Furthermore, HP Pulp (sugar beet waste with 25% DM) was studied in one herd.

The sows preferred roughage to straw. The consumption of straw was halved in one herd when roughage was supplied. This was not the case in the other herd, which is attributed to the location of the roughage feeder immediately next to the lying area.

The sows ate an average of 6 kg pectin feed per day. The pectin feed had a significantly lower content of energy than the HP pulp, and therefore ad lib access worked satisfactorily, while too much HP pulp resulted in a significant growth in the sows. HP pulp should therefore be supplied restrictively. Even though the sows had free access to roughage, they ate the supplied amount via the feeding stations. The sows were given 23% less kg feed corresponding to 17% less energy via the feeding stations when they had free access to roughage. The saved feed costs covered the costs of the pectin feed so that the feed economics of the two feeding principles were identical.

Recordings of the behaviour showed that the supply of roughage had a limited positive effect on the behaviour of the sows, but it had no significant effect on the number of removed or culled sows. Most sows with leg problems were culled from the pen where the sows did not have access to roughage.

There were no differences in the sows' reproduction results, but there was a significant reduction in the weaning weight of the litters of the sows given roughage in the gestation period. This was not seen in previous studies of roughage in the gestation period.

Dry feed ad lib

Dry feed ad lib for group-housed, gestating sows was studied in two herds (Report 625). Ad lib feeding was compared with restrictive feeding via the feeding principles "feeding on the floor" and "bio-fix feeding".

The sows fed ad lib were given a diet with 30% sugar beet pulp, among others, in the first four weeks and in the last three weeks of the gestation period. In the period in between, they were given a diet containing 50% sugar beet pulp among others.

The restrictively fed sows were fed once a day with diets adjusted to the individual feeding principles. The feed dose was adjusted to the body condition of the sows.

The ad lib fed sows ate an average of 3.4 FUp per sow/day (from 2.2 to 4.4 FUp per sow/day).

The trial showed that the sows fed ad lib had 0.3 fewer piglets in total per litter than the sows fed restrictively. This difference was significant. There were no significant differences between the two feed strategies in terms of the farrowing rate, the total number of piglets born per litter, and the litter weight at birth.

The sows fed ad lib had an average gain in the gestation period of 71 kg in herd 1 and 81 kg in herd 2. This was 11 and 19 kg, respectively, higher than the gain of the restrictively fed sows. There were no differences in the spread of the gain.

In both herds, the ad lib fed sows had fewer bites than the restrictively fed sows. This difference was significant. Bites are an expression of the level of aggression among the sows.

Dry feed ad lib for group-housed, gestating sows cannot be recommended due to the risk of reduced litter size, the large feed consumption and the high costs of purchasing the appropriate diets. This is despite its positive effect on the behaviour of the sows and the fact that it is cheaper to establish place units for ad lib feeding of group-housed, gestating sows.

Feeding dry feed ad lib resulted in a reduced litter size and a large consumption of feed. Therefore this feeding principle cannot be recommended even though it resulted in less aggression among the sows.

Sow milk

A litter of pigs reaches a daily gain of 2 kg. The energy for these 2 kg gain passes through the udder of the sow every day where it is excreted in the sow milk in a form that is efficiently used by the piglets. A high milk production requires a lot of the sow and thereby also of the surroundings and the sow's feed. The sow's milk is divided into the colostrum formed immediately after farrowing and the sow milk formed in the remaining period of the lactation period. The transition from the colostrum is gradual, and the colostrum only deviates from the sow milk in the first 24 hours after farrowing.

The colostrum

The colostrum must prepare the piglets for a life outside the protective environment of the uterus. Therefore, the colostrum contains large amounts of antibodies. The antibodies pass the intestinal mucosa and into the blood where they protect the piglets against the first infections until they develop their own immune defence system. When the piglets have enough antibodies, the intestinal mucosa "shuts down" for further intake. The figure shows that 12 hours after birth, the large piglets have on average covered their need, while the smallest piglets still take in extra colostrum after the first 12 hours. However, studies made by the National Committee for Pig Production show that most piglets take in more than twice the colostrum they need meaning that even the smallest piglets are in most cases covered already after 12 hours. This means that there is rarely any reason for giving the newborn piglets colostrum milked from a sow. A normal piglet can be moved from the sow through cross-fostering 12 hours after birth. The smallest piglets should stay with sow for 16-24 hours. Foreign studies show that 12 hours after birth is the earliest point in time to move the piglets.

The sow milk

The sow milk must first and foremost ensure that the pigs receive energy for growth and maintenance in the form of sugar and fat, and building stones in the form of protein and minerals. Studies made by the National Committee showed that a number of piglets had taken in enough colostrum, but that they subsequently died from lack of energy, probably as they lost the battle for an available teat. The smallest piglets are born with low energy reserves and as they have the largest surface in relation to their weight they use relatively more energy for drying and staying warm than the large piglets do. Therefore it is often seen that piglets weighing less than 1 kg die within the first 24 hours after birth if they cannot manage in the competition for the sow milk. Piglets weighing more than 1 kg can often manage without milk for 1-2 days.

Antibodies in sow milk

Even though the sow milk does not have the high content of antibodies of the colostrum, it still has a high content of the antibodies IgA (immunoglobolin A). IgA handles the bacteria that are present in the intestinal tract. The special feature of the IgA in the sow milk is that it can handle exactly the types of bacteria that are present in the herd in which the piglets are born. It is therefore not likely that a commercial sow milk substitute can be made that can substitute the sow milk. In turn the piglets can utilise a milk contribution and reach extra growth as long as the intestinal tract is also protected by an ongoing supply of sow milk with IgA. This implies that the contribution is of good quality and that the herd manager is aware of the importance of a good hygiene.

Growth factors

The colostrum and the sow milk contain a number of substances essential to the optimum development of the piglets. A trial measuring the overall effect of the growth factors showed that there is a difference in the level of the sows' excretion of growth factors. Future studies will clarify whether the difference in the content of growth factors between sows and herds can explain the difference in the well-being and survival of the pigs.

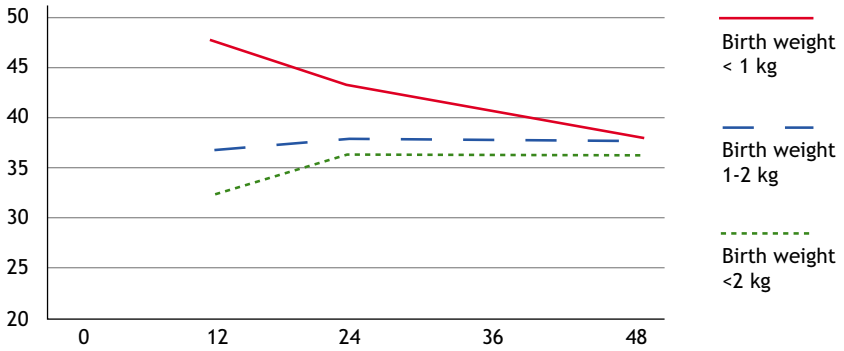


Figure 1. Piglets' intake of colostrum antibodies

Dosing and segregation of feed

Inaccurate dosing, faulty mixing and segregation can be reasons why feed mixed on-farm does not always contain the expected amount of nutrients when it lands in the trough. Consistent under- or oversupply of nutrients can reduce the productivity.

Accuracy when dosing

The accuracy when dosing mineral diets was studied in seven herds (Report no. 597).

In six of the seven herds, a significant correlation was found between the amount of dosed mineral diet recorded by the mixing computer and the amount that was actually dosed (control weighing). This correlation means that the difference between the computer data and the control weighing can be removed by adjustment, as the error apparently is constant.

In five of the seven herds, a significant difference was found in what the mixing computer had dosed and what had actually been dosed. The largest deviations in per cent varied from an overdose of 7% to an underdose of 10% on average. In some herds, there were large differences in the dosed amounts from portion to portion. In the worst case, 10% too much was dosed in one mix and 25% too little in the following. The trial showed that not all the ingredients in a portion of feed were over- or underdosed, which resulted in a deviation in the diet's content of nutrients compared with the expected content. Control of the dosing systems should be routine in herds that mix their own feed. When checking the system, one must focus on deviations compared with the average of 10 to 15 portions and deviations between portions in the dosed amount. The latter may be due to incorrect function of the load cells.

Effect of admixture percentage

The ability of mixers to make a homogenous diet with admixture percentages of 0.5, 2 and 4% was studied in six herds (Report no. 595). Three mixing principles were studied: the paddle mixer, the diagonal mixer and the horizontal mixer. No differences were found in the mixing accuracy between the three admixture percentages.

It turned out that the three mixing principles had very different abilities for mixing premixes into the feed. The diagonal mixer mixed the premix homogenously into the feed. The diets from the paddle mixer and the horizontal mixer were not homogenous, which was probably caused by a too short mixing time. A too short mixing time can be a general problem for farmers mixing their own feed. More attention should be directed to the mixing time both when the equipment is delivered (supplier) and during its operation (herd owner/manager).

Segregation of dry feed

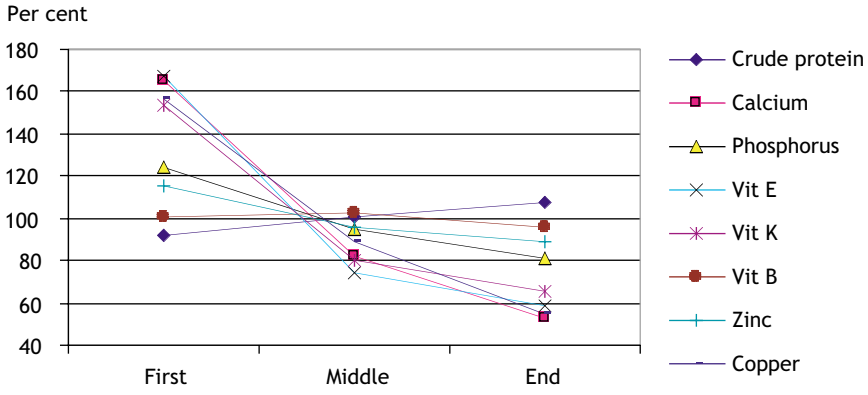
A current trial is studying the risk of segregation of dry feed mixed on-farm in connection with feeding from ad lib feeders.

The trial is now completed in two of the three participating herds and shows a very large risk of segregation of minerals and vitamins when the feed is produced with dry mineral feed mixes. The content of e.g. calcium, copper, vitamin E and K was in some cases two to three times higher in feed from the first feeder compared with the expected content and correspondingly lower in the last feeder. Segregation occurred during each feeding. Segregation of crude protein was also observed, as the soybean meal was not ground. The highest content was found in the last feeder, as soybean meal is mainly found in large particles that to a large extent are led towards the end of the pipeline.

Grain particles of different sizes were also segregated. At the beginning of the pipeline, grain with a small particle size was primarily found, and the large particles were found at the end of the pipeline. This means that the pigs at the end of the pipeline were given very coarsely ground grain. The preliminary results show that liquid vitamins and minerals significantly reduce the risk of segregation.

Application of the liquid components in dry feed can lead to bridging in the silo and feeders if grain with a very high content of water is used (stored gastight).

Segregation is expected to have a significantly negative influence on the productivity. Future activities will clarify this and clarify how segregation can be reduced or avoided.



Segregation in connection with feeding of dry feed mixed on-farm can be rather extensive and can cause large deviations in the feed's content of vitamins, minerals, etc.

Feeding of weaners and finishers

Commercial products for weaners and finishers

Eleven trials have been carried out of commercial products: ten products for weaners and one for finishers. Three of the products for weaners had a positive effect on the productivity: the combination of half lactic acid/half formic acid; 0.5% benzoic acid; and Pioner Feed ADD-S. Finisher feed to which Pioner Feed ADD-S was added did not show any effect on the productivity.

In May 2003, benzoic acid was approved for use in finisher feed with a dose of 0.5-1%, but it is not approved for weaner feed yet. Citric acid is an organic acid that is used in many European weaner diets, and studies have shown a positive effect on the feed conversion and daily gain. A trial where 4.5% citric acid were added to diet 1 (weeks 4-7), and 1% was added to diet 2 showed no effect on the productivity compared with the control group.

Weaning age

A low weaning age results in more litters per sow/year, and more pigs are produced per farrowing pen. If the weaning age is increased, the weaned pigs have higher requirements to the housing unit, feed and tending. A trial running in three herds will clarify the advantages and disadvantages of weaning at 27 days and 33 days, and the overall economy of the two strategies will be calculated.

The preliminary results from one herd show no differences in the mortality in the lactation period between the two weaning ages. The pigs weaned at 33 days weighed 1.9 kg more than the pigs weaned at 27 days – corresponding to a daily gain of 270 g in the last week with the sow. At the age of 11 weeks, the pigs weaned at five weeks weighed 0.7 kg more than the pigs weaned at 27 days. This difference was significant.

The number of treatments for diarrhoea post-weaning was reduced to one third, and the mortality was halved among the pigs weaned at 33 days compared with the pigs weaned at 27 days. In both cases, the differences were significant. By increasing the weaning age, the pigs apparently became more robust in the weaner period.

The pigs will be monitored until slaughter to study how long after weaning the weaning age affects the growth. The sows' reproduction in the subsequent litter is

Table 1. Commercial products for weaners and finishers tested in 2002/2003

	Company	Product name	Product type	Dose, %1	Index, based on 5 years prices (97-02)	Report no.
Weaners	Ringsted & Semler	Ropadiar + Greenacid	Aromatic compound Acid product	0.12/0.07 0.4/0.4	108	577
		Ropadiar	Aromatic compound	0.12/0.07	110	
	Brøste	Pioner Feed ADD-S	Aromatic compound	0.2	118*	
	DSM Holland	Benzoic acid	Acid product 2)	0,5	116*	
	-	Citric acid	Acid product	4.5/1.0	99	615
	-	Lactic acid/formic acid	Acid products	0.6+0.6/0.3+0.3	112*	623
	Alltech	BioMos + Lactic acid/formic acid	Oligosaccharide + Acid product	0.3+0.3 and 0.2/0.15+0.15 and 0.05	108	
	Alltech	BioMos	Oligosaccharide	0.4/0.1	99	
	Chr. Hansen3)	BioPlus 2B (unit 1)	Bacteria spores	0.04	99	616
		BioPlus 2B (unit 2)	Bacteria spores	0.04	99	
		BioPlus 2B (unit 3)	Bacteria spores	0.04	99	
	Alltech	Nupro 2000	Protein source [34])	5	97	624
Finishers	Brøste	Pioner feed ADD-S	Aromatic compound	0.9	96	604

*The effect on the productivity is compared with the control group. *=Significant difference. Index values can only be compared within the same trial (report).*

1) If two doses are stated, the first one is the dose in diet 1 (4-6/7 weeks) and the other the dose in diet 2 (6-10/11 weeks).

2) Only approved for finishers in doses of 0.5-1%.

3) The trial was carried out in three different types of weaner housing.

4) Replaced 3% soy protein concentrate and 2% wheat in the diet.

also studied to see whether the prolonged lactation period affects the farrowing rate and the litter size.

CLA for finishers

Conjugated linoleic acid – also called CLA – is a group of isomers of linoleic acid. Foreign studies have shown that addition of CLA to finisher feed significantly increases the meat percentage and makes the fat firmer when compared with addition of vegetable fat sources (vegetable oil).

In one trial, animal fat was partly replaced by CLA, and the control group was given 1.5% pure animal fat (table 1).

The result of the trial showed that addition of 0.5% or 1% CLA resulted in a significantly improved production value as a result of an increase in the meat percentage of approx. 1 percentage unit. There were no differences between the groups where CLA was added to the feed in doses of 0.5% and 1.5%, respectively. Addition of CLA did not affect the daily gain or the feed conversion.

Forty pigs were selected from the control group and from the group given 1% CLA for analyses of fat quality and sensoric quality. Addition of CLA improved the fat quality as the iodine number dropped from 73 to 63. A drop in the iodine number indicates that the fat is more saturated and thereby has e.g. a better shelf life. The sensory analyses showed that chops from the pigs given 1% CLA in the feed were slightly harder and less juicy than chops from the pigs given pure animal fat in the feed. These differences were so small that they will probably not have any effect on the consumer.

Today, CLA costs DKK80-90 per kg, and it is thus not profitable to add 0.5% to the finisher feed. Future trials may clarify whether the same effects can be achieved with addition of CLA in a lower dose for a short period of time before slaughter.

Natural vitamin E

Natural vitamin E is an expensive product and should therefore only be used for weaners in the first 14 days post-weaning.

Newly weaned pigs easier absorb natural vitamin E than synthetic vitamin E. Despite this, large amounts of synthetic vitamin E are today added to most weaner diets. The content of vitamin E in the body of weaners at weaning can be increased by increasing the content of vitamin E in the lactation feed. As vitamin E is not really a vitamin that is deposited in large amounts there is no point in employing shock dosing (Note 308, the National Committee for Pig Production).

In the spring, we analysed the different types of vitamin E on the market. All the purchased products except two had a content of vitamin E that corresponded fairly to the declared. The products Toconat Nutriscan and Toconat E40 from Nutriscan only contained 38% and 73% natural vitamin E compared with the declared content (Note 316, the National Committee for Pig Production). The two products have now been taken off the market.

Table 2. CLA for finishers

Group	1	2	3
Animal fat %	1 1/2	1	1/2
CLA %	0	1/2	1
Daily gain	868	894	876
FUgp/kg	2.65	2.64	2.61
Meat %	59.7a	60.7b	60.9b
Productivity	756a	808b	802b
Index	100	108	107
Iodine number	70	-	60

Newly weaned pigs easily absorb natural vitamin E.

Lean meat percentage

Has the lean meat percentage dropped?

The lean meat percentage, which is apparently numerically lower than previous years (cf. figure 1), has received a lot of attention, particularly at the beginning of the year. The relatively large fluctuation in April 2002 was primarily caused by a change in the rules of the calibration system that will help ensuring that the pig producers reach largely the same lean meat percentage level regardless of slaughterhouse. Seen over a long period of time, the change in rules did not affect the lean meat percentage level.

A low lean meat percentage can be caused by several factors, which are briefly touched upon below.

Protein in the feed

The meat percentage is highly influenced by the feed's content of protein. A deficiency of the first limiting amino acid of 5% reduces the lean meat percentage by 0.3 percentage units, and the daily gain and feed conversion are affected negatively, too. A deficiency of amino acids thus has great economic consequences.

As the new feed evaluation system was introduced, the standard for minimum content of digestible crude protein was maintained at 130 g per FUgp. This resulted in a slightly lower content compared with the recommendation of the old feed evaluation system. It is, however, important to notice that the standards of the individual amino acids were converted and are thereby at the same level as in the old set of standards.

When formulating feed, the new feed evaluation system finds the cheapest mix with a low content of protein. Thus the feed price will increase if the content of digestible protein is increased. In practice, this means that the content of digestible protein in finisher feed is often identical to the standard or slightly below. The safety margin is thereby reduced, and mixing inaccuracy, incorrect evaluation of an ingredient, and segregation become more influential in terms of the production economics – and also in terms of the lean meat percentage.

Problems with diarrhoea at weaning and Lawsonia also result in a significantly lower content of protein in the weaner feed and thereby of amino acids than stated by the standards. Together with a relatively low content of protein in the finisher feed, this may contribute to a low lean meat percentage. Several trials have shown that the pigs are able to compensate for a too low supply of protein during a period of time if they are subsequently given more protein.

It is therefore likely that the lean meat percentage can be positively affected by an increased supply of protein and amino acids in the finisher period (e.g. 7.8 g digestible lysine per FUgp) in cases where the weaners have been given feed with a protein content of approx. 140 g digestible per FUgp. This will be studied in a future trial.

The set of standards is revised on an ongoing basis. It is currently being studied in a finisher trial whether the standards for lysine and threonine should be revised.

Liquid feed

Trials have shown that lysine that is added to the feed synthetically is easily lost during the fermentation process taking place in the liquid feed. It can therefore not be recommended to use feed with a low content of protein and a high content of synthetic amino acids in liquid feeding systems.

Feeding strategy

The lean meat percentage is negatively affected by a too high feed intake particularly in castrates in the last part of the growth period. If a herd is having problems with a low lean meat percentage, the feeding strategy should be included in the troubleshooting. Housing of castrates and young females according to gender and simultaneous use of different feed curves in the last part of the growth period is recommendable. This practice ensures that the pigs' different appetites and predispositions for meat production are utilised.

The lean meat percentage and feed conversion can be affected negatively when tube feeders are used. This is caused by an increase in the feed intake when dry feed is supplied with water, and in such cases it is often relevant to limit the feed intake so that in particular the castrates do not eat more feed than can be used for lean growth.

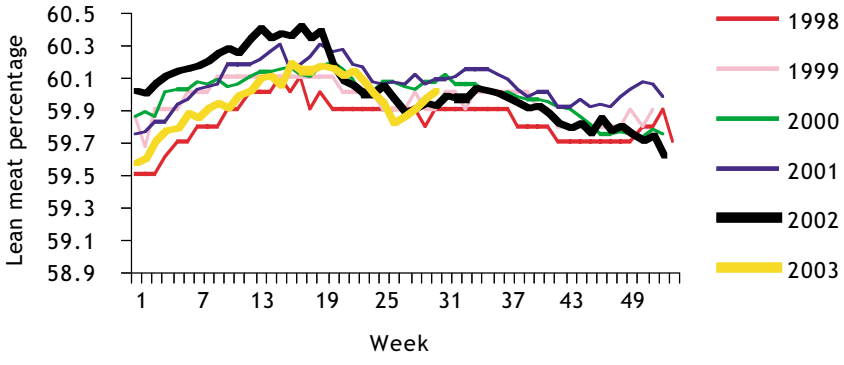


Figure 1. Development in the lean meat percentage, 1998-2003

Liquid feeding - a check-list

A new check-list concerning liquid feed for pigs aims at ensuring accurate use of existing systems and prevent mistakes when establishing new systems.

In the Work Group for Nutrition under the National Committee for Pig Production, a working party consisting of two region-ally employed advisors and two advisors from the National Committee for Pig Production has collected all the information and experiences available on liquid feeding. The recommendations of the party are summarised in a check-list on liquid feeding. The list focuses on both the technical use of and on feeding via the liquid feeding system. The list also deals with the conditions to take into consideration when establishing new systems.

Optimum use of the system

Liquid feeding is a feeding principle with many technical possibilities. However, making sure that the pigs are fed optimally is sometimes difficult in practice with this technique. This is either because the system is not correctly projected or dimensioned or that it is used incorrectly. Correct use of the system implies that the user has a solid knowledge of both the needs of the animals and of the technical possibilities of the system.

The check-list briefly deals with the nutrient requirements to the liquid feed of each individual animal group, such as requirements to the energy concentration, adjustment of the feed curve, feeding strategy after penning, frequency of feeding, etc. Pros and cons of liquid feed are also outlined for each animal group. For weaners, there may be problems e.g. with residues in the pipeline making the feed too acid and increasing the risk of loss of amino acids during fermentation.

A liquid feeding system functions both as a mixing system and as a feeding system. It requires technical knowledge, good data discipline and systematic follow-up to ensure that the pigs actually get the correct feed in the trough. The check-list suggests how to handle the follow-up on accuracy of mixing and feeding, adjustment of the feed curves, and data discipline. Follow-up on the mixing accuracy can be carried out together with the feed statement for the productivity control.

Formulation of liquid feed

The person formulating the liquid feed should have knowledge of the options and limitations of the system in question. Regard should be made to e.g. whether the amounts of whey and brewer's yeast available vary. When mixing prescriptions are handed out, they should be adjusted so that one can immediately type them in without having to make recalculations first. Data for the individual ingredients should be included so that it can be checked that the formulation and the liquid feeding computer correspond.

CONTRACT FOR
PURCHASE OF A
LIQUID FEEDING SYSTEM

Between: Company (Seller)

And: Herd owner (buyer)

Contains a description of requirements, delivery, etc.

The check-list contains suggestions for a contract for purchase of a liquid feeding system.

Suggestion for a contract for purchase of the system

Many of the problems and errors seen in practice could have been prevented during the installation.

Therefore the check-list contains a section dealing with the dimensioning phase and a suggestion for a contract for purchase of a feeding system.

The aim of the contract is to ensure that the parties agree on the requirements to be met by the system and to ensure that they are put down in writing so that the requirements are maintained. One section of the contract must ensure that the system is delivered properly and that a thorough training in how the system works is included.

Using the check-list

The check-list is primarily a tool for pig producers and nutrition advisors. However, building advisors and companies are encouraged to use it to make sure that already during the installation regard is made to the feeding requirements that the system must meet. The check-list is available from the database INFOSVIN (Note 248) and on www.landscentret.dk under "pigs, nutrition advice".

The check-list provides suggestions for various strategies for changing to liquid feed.

The new feed units

Control of the new feed units FUgp and FUgs requires the same analyses as for FUp and an analysis of the ileal digestibility (EFOSi). In order to be able to switch to the new feed units in the official control of energy, it is required that all feedstuff laboratories are capable of analysing the new feed units. Therefore, as part of this, seven laboratories have introduced the method in practice. The first analysis round resulted in a slight adjustment of the analysis method, and subsequently analyses were carried out with 12 feed samples at the seven laboratories. The aim was to establish the analysis accuracy partly of the new EFOSi and partly of the new feed units FUgp and FUgs. The results can be seen in table 1.

The difference between EFOSi and the enzyme digestibility of organic matter (EFOS) is the part that is digested in the large intestine. It can be seen in table 1 below that there are significant differences between the feedstuffs in how much is digested in the small intestine and in the large intestine, respectively. The most extreme feedstuffs are on the one side fishmeal, where the entire digestion takes place in the small intestine (EFOSi and EFOS are identical) and on the other side sugar beet pellets, where more than half of the digestion takes place in the large intestine. As the new feed evaluation system sets the value of the nutrients digested in the large intestine to only 60% of the value of that digested in the small intestine, the feed value of sugar beet pellets becomes too low, cf. table 1.

The accuracy of analysing feed units was higher for pelleted, ready-mixed feed than for ingredients. Furthermore, it was seen that the accuracy was slightly better for the new feed units (FUgp and FUgs) than for the old FUp. In 9 out of the 12 samples, the smallest spread was seen among the new feed units.

The accuracy of the analyses of pelleted feed was generally very satisfactory as no laboratories experienced deviations from the average value of more than 3 FUgp per 100 kg. However, the accuracy of the ingredients is smaller: approx. 20% of the analyses deviated more than 3 feed units per 100 kg from the average – regardless of whether FUp, FUgp or FUgs were analysed.

Table 1. Results from 7 laboratories

Ingredient	EFOSi	EFOS	FUgp/100 kg, av.	FUp/100 kg, av.	FUgp, min-max	FUp, min-max
Weaner feed	84.0	90.9	116	115	115-117	113-117
Finisher feed 1	80.7	88.8	106	106	105-108	104-108
Finisher feed 2	77.0	86.0	103	103	101-106	100-106
Gestation feed	70.1	81.3	94	94	93-97	91-97
Weaner supplement	82.1	94.5	108	124	106-109	122-127
Finisher supplement	73.5	91.2	83	103	80-84	98-105
Fishmeal	94.8	94.8	125	141	122-128	139-143
Soybean meal	69.9	89.4	89	113	85-92	108-119
Rapeseed cake, rich in fat	60.6	80.3	102	112	100-104	108-113
Wheat	86.1	90.8	116	109	111-119	105-113
Wheat bran	50.8	62.6	64	63	61-67	57-66
Sugar beet pellets	37.2	87.5	62	100	58-66	97-102

Phosphorus in feed and slurry

Pig herds that spread livestock manure from 1.4 AU per ha may have a significant surplus of phosphorus compared with the need of the plants. This results in an accumulation of phosphorus in the ground, and it is estimated that the phosphorus surplus is an increasing environmental problem. It is therefore necessary to make an effort to reduce this surplus of phosphorus, and phytase can be an important help in this connection.

The use of phytase is being implemented in practice and the latest computation of the basic numbers of livestock manure shows a significant drop in the content of phosphorus, cf. table 1.

The basic numbers are the result of the feed conversion in the national average of the production control and the computation of the current phosphorus content in feed in 2002. Table 1 furthermore shows the reduction in the phosphorus content in the manure found in a recently finished trial.

Table 1. Phosphorus in feed and pig slurry, basic numbers and current trial

	Feed, in 2000, g P/FUp	Feed in 2002, g P/FUp	Pig manure from from 1.4 AU in 2000, P/ha, kg	Pig manure from from 1.4 AU in 2000, P/ha, kg
Sows, basic numbers	6.3	5.6	44	40
Weaners, basic numbers	6.4	5.9	43	37
Finishers, basic numbers	5.5	4.9	36	30
Finishers, trial 2002/03		4.2		21*

** 50 finishers, 31-101 kg, 2.74 FUp/kg weight gain (basic number = 2.88 FUp/kg weight gain)*

Phytase in pelleted finisher feed

Addition of phytase to pelleted feed and a corresponding reduction in the content of phosphorus and calcium was studied in two herds (cf. table 2). Two phytase products were studied: Natuphos from BASF and Ronozyme P from Roche/NOVOZYMES. Natuphos was sprayed onto the feed after pelleting, and Ronozyme P was added in its dry form before pelleting. Phytase analyses showed that 14-37% less Natuphos phytase was found than planned, while the content of Ronozyme P was higher than planned. There were furthermore large differences between feedstuff factories in the amount of the natural phytase in the feed that was deactivated during the pelleting process (30-70%).

The trial showed that when phytase was added to the feed it was possible to obtain an unchanged productivity when the total phosphorus content of the feed was reduced from 5.2 to 4.2 g per FUp as long as there was sufficient phytase in the feed.

The trial furthermore showed that the production results are reduced if there is not sufficient phytase in feed with a low phosphorus content. In one herd, where the natural content of phytase was low and a large part of the phytase that was added to the feed could not be found in the analyses, the productivity was significantly reduced. Overall, the trial showed that it is possible to greatly reduce the phosphorus content, but that it is important to make sure that the phytase that is added to the feed can be found in the analyses.

Table 2. Trial with phytase added to pelleted finisher feed

	Total P, g/FUp, analysed	Ca, g/FUp, analysed	Planned addition of phytase, units/kg	Analysed content of phytase, units/kg	Calculated addition of phytase [1] units/kg	Productivity, index
Herd A						
Group 1 (control)	5.2	7.5	Nothing	473		100
Group 2	4.7	7.4	Nothing	503		103
Group 3	4.2	6.2	Natuphos, 500	916	428	100
Group 4	4.2	7.0	Natuphos, 500	906	418	101
Group 5	4.2	6.2	Natuphos, 750	1109	621	104
Group 6	4.1	6.1	Ronozyme P, 750	1650	1162	102
Herd B						
Group 1 (control)	4.8	7.3	Nothing	171		100
Group 2	4.5	7.4	Nothing	149		96.4 #
Group 3	4.0	6.5	Natuphos, 500	476	317	95.6 *

1) The natural content of phytase in the feed for groups 1 and 2 has been deducted from the analysed content

* Significantly different from the control group

\# Tendency to difference from the control group (P=0.08)

Slurry separation and economy

During slurry separation, the slurry is divided into an aqueous faction and one or several nutrient-rich factions. New legislation allows a reduction in the land requirement for a pig herd if the slurry is separated and the nutrients used on another property.

Several technical options for slurry treatment are being developed. It is essential to their success that the costs are not higher than the advantages gained with the treatment.

Legislation on land requirements

In the legislation, slurry separation systems are divided into two categories:

- High-technological systems, where the nutrient-rich faction contains more than 70% of the slurry's N and more than 70% of the slurry's P.
- Low-technological systems, where the nutrient-rich faction contains more than 20% of the slurry's N and more than 60% of the slurry's P.

If the slurry is treated high-technologically, the land requirement to the spreading of slurry can be reduced by 50%, and by 25% with low-technological treatment.

It is a prerequisite that at least 75% of the slurry produced at the premises is treated.

Slurry separation systems

Even though several slurry separation systems have been developed or been in operation for some years, it is not possible to recommend specific systems due to scarce documentation of their technical function.

This lack of documentation applies to both the technical reliability and the economy. There is only sufficient documentation for the Funki Manura, and the according to the results of the farm trial made by the Danish Agricultural Advisory Service, National Centre, the system fulfils the expectations.

Most types of systems will only be economically sensible in large herds. In order to consider the need for slurry separation in the small herds, a project is being carried out in co-operation with Research Centre Bygholm that will establish whether slurry separation with a mobile system has any economic and practical advantages.

Economics of slurry separation

The economic comparison of slurry separation models is based on information from the companies involved and is desrcibed per tonne of crude slurry. The costs of interest payments and instalments of the separation part and the storage, and the technical performance and maintenance are included in the comparison in the table below.

The cheapest method is to handle the slurry in the traditional manner. The decanter centrifuge represented the largest investment among the low-technological systems. The technical performance of Ansager's Sep Tec and the treatment levy of mobile decantation are significantly higher than the operation of the stationary decanter centrifuge.

Mobile decantation requires a larger buffer tank than the stationary decanter cen-

Ansager Sep Tec: flocculants are added prior to separation on a belt.

Table 1. The table shows the direct treatment costs per tonne of crude slurry for pig producers with 250 and 1,000 animal units when 100% of the slurry is treated

Costs per tonne, DKK	Pig producer with 250 animal units				Pig producer with 1,000 animal units			
Low-technological systems	**Sep. equip.**	**Op./maint.**	**Storage**	**Overall**	**Sep. equip.**	**Op./maint.**	**Storage**	**Overall**
Traditional slurry handling	0	2	10	**12**	0	2	10	**12**
Mobile decanter centrifuge	0	12	14	**26**	0	12	11	**23**
The cheapest decantation	16	2	13	**31**	4	2	12	**18**
Ansager Sep Tec	11	13	14	**38**	3	11	13	**27**
High-technological systems	**Sep. equip.**	**Op./maint.**	**Storage**	**Overall**	**Sep. equip.**	**Op./maint.**	**Storage**	**Overall**
Staring Maskinfabrik	24	22	9	**55**	21	24	5	**50**
Echberg Manutech	67	9	11	**87**	31	7	10	**48**
Funki MANURA COMPACT	65	24	16	**105**	12	17	12	**41**
Funki MANURA 2000	127	51	14	**192**	8	36	8	**52**

trifuge does, as an efficient utilisation requires enough slurry for treatment for e.g. two days. A buffer tank can be used in connection with a stationary centrifuge. Ansager Sep Tec adds 6% water to the process, which requires a correspondingly larger storage capacity.

The high-technological systems generally require a large capital outlay. The operational costs are also much higher than those of the low-technological systems, with the exception of the system from Echberg.

The storage of concentrates from Staring Maskinfabrik's system is advantageous. Only few concentrates are produced together with an aqueous product that can be watered onto e.g. a meadow or a willow bed. The Manura 2000 also produced an aqueous product that could be used for watering, but it also produced several different concentrates, which makes the storage more expensive.

The storage facility of Echberg's system is partly included in the separation part.

Mobile slurry separation is studied in five herds in Salling.

The direct costs per tonne of slurry (interest, depreciation, technical performance and storage) illustrate the differences in treatment costs, but there are also differences in the cost structure in terms of the spreading, transport and the nutrient value of the concentrates led on to one's own fields. There are furthermore differences in the land requirements that can be an economically decisive factor in areas where the prices on land are high. If these factors are included in the expression net costs, the mobile decanter centrifuge is the solution with the lowest costs for pig producers with up to 400 animal units, while the stationary decanter centrifuge has the lowest costs beyond this.

Whether slurry separation is an actual alternative to the traditional slurry handling methods depends on the access to land and the price of this, and therefore the legislation and the conditions on the individual herds determine whether slurry separation is an applicable alternative.

Staring Maskinfabrik's concept with acid treatment and flocculation has the lowest costs among the high-technological systems. However, the figures are uncertain, as this concept is not yet sold in its full version.

The Funki MANURA Compact belongs to the high-technological group. The slurry is separated into concentrated nutrients and "pure" water.

Table 2. Net costs of low-technological slurry separation, sales price of the products DKK0 (DKK/tonne of crude slurry)

	250 AU	500 AU	750 AU	1,000 AU
Mobile decanter centrifuge	59	46	42	34
Cheapest decanter centrifuge	64	45	38	29
Ansager Sep Tec	67	48	42	35

Table 3. Net costs of high-technological slurry separation, sales price of the products DKK0 (DKK/tonne of crude slurry)

	250 AU	500 AU	750 AU	1,000 AU
Staring Maskinfabrik	63	51	49	46
Echberg Manutech	117	79	70	64
Funki MANURA COMPACT	133	82	67	58
Funki MANURA 2000	198	116	89	73

Ammonia and odour

It is increasingly important to the pig production that the neighbours of the herds – and the owner's family – are not inconvenienced by odour from the housing units. Emission of ammonia is not recorded as a direct nuisance, but it can affect the flora in very sensitive areas.

Sulphuric acid in slurry

A study of sulphuric acid treatment of slurry in two finisher herds where the pens had two thirds slatted floor and one third drained floor, and partially slatted floor, respectively, is nearly finished.

Ammonia

The emission of ammonia is markedly reduced in both herds. In the herd with drained floor in the lying area, the reduction of the ammonia evaporation is so far 70-80%. In the herd with partially slatted floor the reduction is 60-70%.

In practice, this large reduction means that flushing with slurry treated with sulphuric acid largely eliminates the emission of ammonia from the slurry surface. Thus, the remaining ammonia emission originates from the dirty floor, from equipment and pigs.

Odour

The efficient reduction of ammonia emission is not found in the measurements of odour. The techniques that can reduce ammonia do apparently not necessarily reduce the odour as well.

Operation

Several operational stops have been tried in the trial period, in particular of the pumping and pipe system that returns the treated slurry to the housing unit. Changes were therefore made to the flushing system where the original 110 mm pipes for flushing were replaced by a system where the slurry from the process tank can be returned to the housing unit in traditional 315 mm slurry pipes by pumping the slurry from the process tank.

The new method where the flushing of the slurry channels can be done using the existing pipe system also allows for introduction of sulphuric acid treatment of slurry in existing housing units.

Some conversions were made during the trial of the technical control. The treatment with sulphuric acid and the aeration is technically simple, but controlling them is complex. The durability of the technical control is not known.

The pictures show untreated slurry and slurry treated with sulphuric acid. During treatment of slurry with sulphuric acid where 5 kg sulphuric acid are added per tonne of slurry followed by aeration, the slurry is changed: for instance a large part of the dry matter is used, and the slurry does not develop a floating layer. Storage trials made by the local advisory centre LandboNord have so far shown that pH remains at approx. 5.5 for the entire storage period. This provides the basis of a dramatic reduction of the ammonia evaporation during the storage and in connection with spreading of the slurry.

Durability of concrete

Aalborg Portland A/S has carried out a series of trials where concrete blocks made of different types of cement were placed in the slurry treated with acid. The study was aimed at clarifying whether the high content of sulphate causes corrosion. After the first year, no corrosion was observed. In the "Byggeblad" from the National Department of Farm Buildings and Machinery, there are thus no extra requirements to the concrete quality besides the ones applying generally for bottoms and walls in slurry containers.

Cooling of slurry

Cooling of the slurry channels under the wire-type barn cleaner is studied in two types of housing unit: a gestation unit and a finisher unit.

In the gestation unit, two sections with a wire-type barn cleaner with and without cooling of the slurry channels, respectively, were compared. Upon cooling, 25 mm PEL tubes were cast into the floor of the slurry channels with a distance of 40 cm. The tubes are connected to a heat pump that transfers the heat to floor heat in the covered creep areas in the farrowing unit.

The preliminary results show that the high ammonia concentrations in connection with the daily operation of the wire-type barn cleaner are distinct without cooling, while they are highly reduced in the housing unit with cooling.

W-shaped slurry channels

W-shaped slurry channels with a wall slope of 45 degrees were studied in two sections for finishers. There was no reduction in the ammonia emission, i.e. the w-shaped slurry channels did not reduce the slurry surface.

Other studies of differently shaped slurry channels show that the slope must be at least 55 degrees to keep the manure off the sloping sides.

Open housing unit with a wire-type barn cleaner

For one week during the winter season and one week during the summer season, the odour was measured in two identical finisher units with a wire-type barn cleaner.

The housing units differed in terms of ventilation. One had mechanical ventilation with air intake via wall inlets, while the other had natural ventilation via automatically adjustable curtains and an opening in the ridge.

There was a significantly lower concentration of ammonia and odour in the unit with curtains, while the emission of ammonia and odour was not reduced.

Purification of air with sulphuric acid

Purification of the air with a system from ScanAirclean A/S takes place through an exhaust pipe. The air passes through a set of lamellas that are constantly sprinkled with a sulphuric acid solution absorbing a great deal of the ammonia in the air, the content of dust in the air and part of the odorants.

The measurements have so far shown that more than 90% of the ammonia is retained in the sulphuric acid solution. The nitrogen is collected as ammonium sulphate that can be used as fertilizer. However, too few odour measurements have been made to be able to evaluate the possibilities of the system of reducing odour.

Biological purification of air

A biological air purification system from SKOV A/S and Perstrup Beton Industri A/S is being tested. The outlet air is collected centrally and passes through at set of lamellas that are constantly sprinkled with water. The lamellas have a large surface on which a mass of bacteria is built that decomposes organic matters from the air and retains dust.

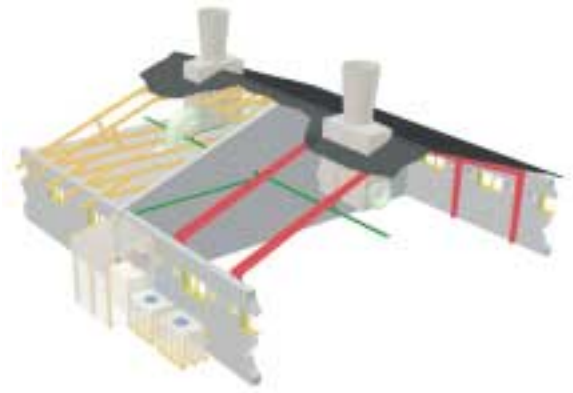
The preliminary results show that biological purification of the air is the most promising method in terms of reducing odour. Furthermore, part of the ammonia of the air is retained. The system is still being developed to among others clarify how often the water needs changing to obtain optimum function.

Ozone for the exhaust air

A trial was carried out of an air purification system from the companies BioAqua A/S and DHIAA KLIMABLOCK A/S. The air filter, which was installed after the air exhauster, consisted of a humidifier where the nozzles atomized water to which sulphuric acid had been added, followed by some UV pipes that release ozone.

In the first stage of the trial, the air samples were analysed in terms of odour the following day. The analyses showed that the concentration of odour was 150-300 LE/m3 before the air purifier and 50 LE/m3 after the air purifier. Thus, the ozone was able to reduce the odour, but there was doubt as to whether the decomposition of odorants continued after the samples were collected and until the time of analysis. Therefore, in the second stage of the trial the odour samples were analysed within an hour after collection.

The results showed that there was no reduction of the odour, despite the fact that in the subjective evaluation, the outlet air at the herd was evaluated as more "fresh" by everyone. The ozone may blur the odour.



The system for chemical purification of the air is constructed with a central dosing and control unit from which the sulphuric acid solution is pumped to the exhaust pipes and is returned for collection.

The system from Perstrup Betonindustri and Skov A/S transfers the outlet air via floor exhaustion to the biological purification system, where the air passes through the bacteria-coated lamellas.

Odour and feed

The emission of odour from housing units must be reduced. The possibility of doing this though a change in the composition of the feed was studied, and the following factors were analysed in the following priority: protein digestibility, addition of benzoic acid, amount of fibre, feed texture, composition of fatty acids, and sulphur.

The studies were carried out in a climate laboratory with two identical climate chambers where the pigs stayed from approx. 30 kg until slaughter. Each chamber had three finisher pens with 12 pigs/pen. There was drained floor in two thirds of the pen and slatted floor in one third.

Every 14 days air samples were collected and analysed for odour concentration. Furthermore, ammonia and carbon dioxide were recorded every half hour, and the consumption of water and feed were recorded continuously.

When the pigs were slaughtered, the amount of slurry in each chamber was recorded and slurry samples were analysed for content of nitrogen and dry matter.

The pigs were given "control feed and trial feed" for two weeks in order to accustom the gastro-intestinal system to the diet in question before the first odour samples were collected.

In the first round, the chambers were tested with the same diets (control) in order to prove that the chambers were identical.

In the second round, the effect of a reduced content of crude protein was studied. The trial diet contained 15% less protein than the control diet. The results showed that with the trial diet the ammonia concentration was 40% lower in the outlet air.

The difference in the ammonia concentration between the two chambers was, however, minimal in the last part of the production process. This was caused by the fact that the difference between the diets in the content of protein was only 7% in the last half of the growth period. The reduced protein content had no effect on the release of odour.

Individual substances

The Danish Meat and Research Institute is highly experienced in determining individual substances in connection with e.g. preparation of meat. They are currently determining the concentration of individual substances in housing unit air. Knowledge of the individual substances and their effect on the odour enables us to target the effort on odour nuisances. The substances are collected in the housing unit on an absorbent material and are subsequently identified in the laboratory with gas chromatography and mass spectrometry (GC/MS).

Table 1. A reduced level of crude protein reduces the ammonia emission

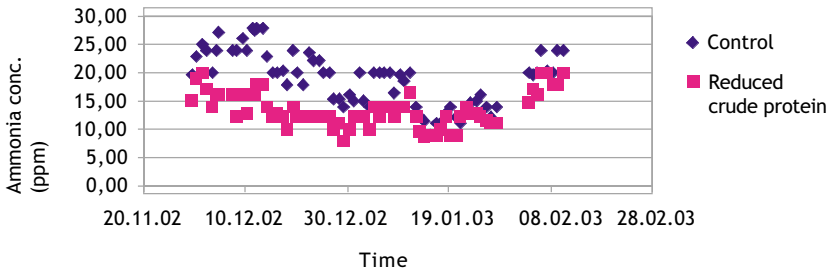
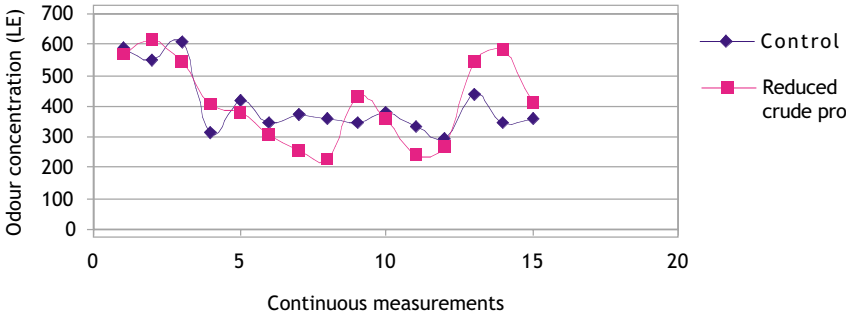


Table 2. A reduced content of crude protein has no significant effect on odour



Gas chromatograph with mass spectrometry (GC/MS). As a novelty, the GC/MS at the Danish Meat & Research Institute has been equipped with two odour gates. While the individual substances from the housing unit air are being analysed at mass spectrometry, two persons can smell the same substances individually and describe the intensity and the characteristic odour concentration of the substances.

Climate and immediate environment

Heat in controlled environment units for weaners

A trial that is nearly finished will clarify whether installing heat in the solid floor in weaner pens with controlled environment can improve the hygiene and the production results.

The preliminary results show that the same production results were achieved in pens without heat, but with bedding, compared to the pens with floor heating without bedding in housing units with diffuse ventilationion when the pigs' requirements to the immediate environment were met.

In order to avoid fluctuations of temperature and to maintain an air quality that benefits the pigs all year, it is recommended to establish floor heating in minimum one third of the pen and to supplement with room heating in the controlled environment units. The floor temperature must not be higher than the pigs' body temperature to ensure that the pigs can adjust their temperature if their lying behaviour changes. The trial showed that floor heating must be dimensioned for 5 W/place unit and that there is a need for supplementing with 15 W/place unit as room heating in order to maintain an air quality that benefits the pigs. In existing housing units without floor heating, it is recommended to establish a 15 cm high straw board beneath the bent front of the cover and to strew once at weaning with 250-350 g cut straw/place unit.

Earth rays

Behavioural problems such as tail biting have by many been associated with earth rays. Experiences from climate studies made by e.g. the Danish Applied Pig Research Scheme have shown that in an attempt to reduce a problem with tail biting, some people purchase a so-called earth ray apparatus, but the tail biting has stopped after potential differences had been eliminated by counterbalancing leading parts in the housing unit and in the pigs' immediate environment. In order to cover the problem of earth rays, the Danish Applied Pig Research Scheme examined two "earth ray apparatuses" at the Institute of Data Technology at the University of Aalborg. Both apparatuses are sold and installed with the aim of eliminating negative effects from earth rays and thereby stop behavioural problems among pigs, including tail biting.

The pigs' requirements to the immediate environment have been met when the pigs lie closely together in partial lateral position, without huddling together in the lying area.

The measurements of the trial did not provide any basis for believing that the apparatuses had any noticeable effect on the electromagnetic environment of a building.

Nozzles for sprinkling

Calcified nozzles in the sprinkling system is a huge problem, particularly in areas with hard water. The nozzles quickly start spreading incorrectly or even worse they block up completely.

A trial is currently testing two types of nozzles for sprinkling:

- Dan-sprinkler 180∞
- Hardi 4665-12

The aim of the trial is to clarify the effect of hard water on the sprinkling function of the nozzles. The trial is carried out in a herd with hard water (the hardness is approx. 16).

Based on the results of the trial, it is recommended to select a nozzle with a bent, fan-shaped sprinkling function corresponding to the nozzle from Hardi for sprinkling of weaner and finisher units.

The preliminary results show that some of the nozzles of the type Dan-sprinkler was completely blocked up and that the water output drops over a normal production period of 12 weeks in a finisher unit. Correspondingly, none of the nozzles from Hardi had blocked up after 12 weeks, and the water output was still the same.

	Dan sprinkler	Hardi 4665-12
No. of nozzles	76	76
No. of blocked up nozzles after 12 weeks	12	0
Water output at the beginning, l/min	0.51	0.47
Water output after 12 weeks, l/min	0.16	0.44

Housing of sows

Gestating sows must be group-housed from four weeks after service. The legislation regulating housing of gestating sows was changed as of May 15, 2003, and in the future, the requirements to design and management will be tightened in some areas. There is no legislative requirement of group-housing in the service unit, but pigs produced for the British market must be group-housed.

In both service and gestation units, it is necessary that group-housing systems are further developed to ensure a high efficiency and rational work routines.

There is an increasing interest in loose housing of lactating sows, and it is expected that the development in this area may also improve the potential of the traditional farrowing pens.

The service unit

There is no legislative requirement of group-housing in the service unit, but pigs produced for the British market must be group-housed.

The Danish Applied Pig Research Scheme is carrying out a trial where the sows are either sorted according to age at transfer to the service unit or transferred randomly. The advantage of sorting the sows is that the small sows are not strained in connection with mounting. On the other hand, it can be difficult to establish a stable hierarchy in a group of sows of equal sizes.

The Danish Applied Pig Research Scheme has over the years carried out several trials in relation to group-housing in the service unit. The trials indicate that group-housing works, but many questions still need answering.

In order to optimise the service strategy, the design of the service unit must provide opportunities for:

- Stimulating the sow according to the guidelines of "extended human stimulation"
- Strategic use of the boar, i.e. only boar contact at weaning and insemination
- Limiting the access of the boar to only include the sows that can be inseminated within approx. 30 minutes

Flooring and bedding

A recent trial showed that sows housed on sawdust in the service unit had a significantly lower farrowing rate than sows housed on straw. The sows housed on sawdust had a farrowing rate of 77 compared with 87 for sows housed on straw. It is therefore recommended to use barley straw/wheat straw/rape straw in the service unit.

Experiences with drained deep litter mats in pens with group-housed sows and feeding and insemination stalls show that it is possible to halve the consumption of litter, i.e. a consumption of approx. 400 kg straw per place unit per year.

A drained deep litter mat is established by distributing the bedding across a slatted floor that covers the entire activity area.

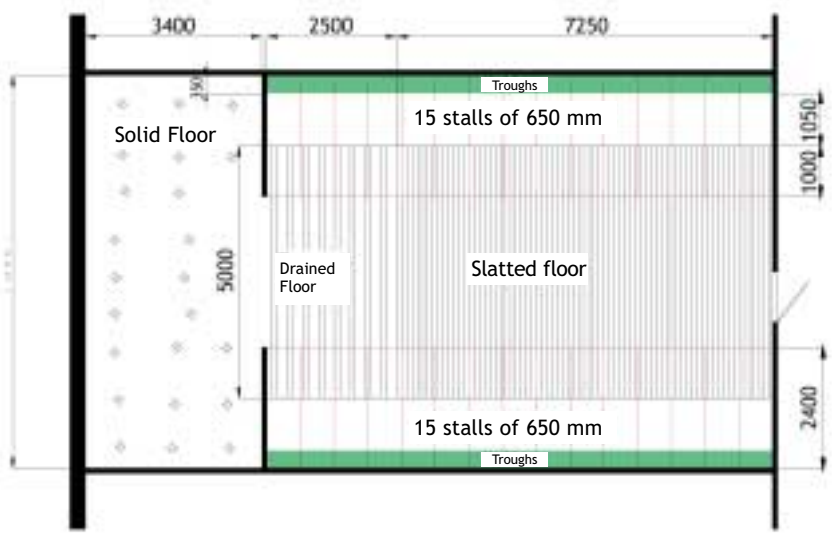
The slatted floor is lowered 20-30 cm compared to the stalls. Beneath the slatted floor there is a wire-type barn cleaner.

In order to reduce the consumption of bedding, time must be set aside for maintenance of the deep litter mat (_ minute per place unit/week). Maintenance of the mat consists of removing moist straw with a fork from the dunging area behind the stalls. Presently, very positive experiences are seen when rape straw is used in pens with drained deep litter mats.

Gestating sows

Flooring

The floor in pens for group-housed, gestating sows is often a combination of a lying area with solid floor with limited bedding and a dunging area with slatted floor. The floor must be slip-resistant, as the sows otherwise risk leg injuries during ranking



An example of a T-pen with continuous solid and drained floor.

fights. According to the legislation it is possible for the drained floor to constitute the solid floor or part of this with an opening of max. 10%. The solid/drained floor must be continuous and must have bedding.

A trial has been initiated to examine how the drained floor can constitute part of the solid floor in pens with one feeding and resting stall per sow. The trial focuses on conditions concerning the pen hygiene, the sows' use of the area outside the stalls, labour and consumption of bedding.

One feeding and resting stall per sow
This feeding principle provides a good overview in connection with the individual feed intake and the sow is protected while eating. Another advantage is that all the sows in the pen can eat at the same time, which is part of their natural eating behaviour.

The investment in stalls and feeding systems, combined with the legislative requirement of 3 m as the shortest distance in the pen, amounts to approx. DKK10,000 per place unit. This makes it the most expensive feeding principle today.

Experiences from various studies of the Danish Applied Pig Research Scheme show that in pens with limited bedding, the sows use the area outside the stall very little.

The effect of optimising the lying area outside the stalls was studied in three herds. The trial focused on where the sows chose to stay and on the pen hygiene. The study was made in pens with two rows of stalls with 3, 4 or 6 m, respectively, from the rear edge of the stalls in one row of stalls to the rear edge of the stalls in the other row. During the trial, equipment that the sows could lean against was installed in various places in the pen.

The results of the trial varied in the three herds that each represented one size of pens. The pen hygiene could be improved significantly in the herd with the largest distance between the rows of stalls as several of the sows used the area outside the stalls as lying area. Labour for cleaning the pens was therefore more than halved. In the other two herds, the labour was not affected.

From a professional point of view, it is recommended to establish the so-called T-pens where the lying area is separate from the stalls/dunging area so that there is a continuous area with solid floor and walls that the sows can lean against. The lying area could be lowered approx. 25 cm - other pen concepts for gestating sows have good experiences with this.

Electronic sow feeding
Together with one feeding and resting stall per sow, electronic sow feeding is one of the most wide-spread feeding principles for group-housed, gestating sows. The Danish Applied Pig Research Scheme has planned and initiated trials focusing on training of young females, security during separation and utilisation of data from the feeding stations to illustrate changes in behaviour due to heat, disease, etc. It is thereby easier to step in and help animals requiring a special effort in order to be able to contribute positively to the productivity. The aim is to make better use of the potential connection with electronic supervision of the individual.

In a recent trial, three types of floor around the feeding stations were studied: 1) solid floor treated with a spiked roller, 2) slatted floor, or 3) asphalt mastic.

Provided that sprinkling was established in this part of the pen also, the frequency of sows that had to be culled due to leg problems was no higher in the pen with slatted floor compared with the pens with solid floor and asphalt mastic.

Fit-mix
Fit-mix is a relatively new feeding principle for group-housed sows. The principle largely has the same management possibilities as electronic sow feeding, but does not give the sow any protection while eating.

The Danish Applied Pig Research Scheme collected experiences and data from two herds using Fit-mix. The results showed that the sows divided their feed dose over significantly more visits than what is normally seen with electronic sow feeding. This was probably caused by the fact that

Establishment of "lying walls" aims at improving the pen hygiene. There are 6 m between the rows of stalls in this example where a good effect has been achieved.

Experiences from a herd with T-pens have shown that 50-75% of the sows use the solid floor outside the stalls in the resting periods.

the unprotected feeding point caused disturbances to the sows during their feed intake. On this basis, Fit-mix cannot be recommended at the same level as electronic sow feeding.

Feeding robot

Together with the Danish Institute of Agricultural Sciences, the Danish Applied Pig Research Scheme has tested a feeding robot for individual feeding of sows in large groups. By hooking up to the computer in the herd, the daily gain, and feed and water supply of the sows can be monitored.

The experiences have been reported in an internal report (no. 181) from the Danish Institute of Agricultural Sciences. Overall, it is estimated that technically the feeding system works, but there is a need for further development of the handling of and using the data collected. Furthermore, an adjustment is necessary of e.g. the location of the feeding system and of its accessibility in order to minimise aggression among the sows.

In the feeding principle "Fit-mix" the sows had an average of more than 50 visits during the day and behavioural observations showed that the sows were active at the station from the day started at 5 o'clock and until 23 o'clock.

The sows are identified at the entrance where after they are weighed and given feed and water. Feed intake takes place on a carousel where nine sows can eat at the same time.

Handling of bedding and manure

Three methods for handling straw were studied. The three methods were: mini truck, cable railway, and a fully automatic straw robot.

The trial showed that there was not necessarily any correlation between the type of machine used and the amount of labour required per kg supplied straw and per place unit. When choosing which principle to use, one must e.g. decide whet-

Mini truck

- Can be used for handling both bedding and manure
- The amount of straw that can be transported at a time is limited
- The sows in the pen can interrupt the transport
- The width of the inspection alley determines how much straw can be transported down the alley
- Requires a slatted floor solid enough for driving on it

Cable railway

- The straw can be thrown a maximum of 5-6 m from the cable railway
- The sows can be monitored/tended to from the cable railway during the supply of straw
- The rails must be adjusted to the housing unit so that the distance of throwing is as short as possible
- A long distance of throwing results in a considerable development of dust

Fully automatic straw robot

- Provides an equal distribution of the straw
- Straw with wet tufts, grass or weeds can get stuck around the straw scarifier
- Requires thorough instruction in the use of computer management
- Considerable development of dust – it should be adjusted to supply straw when there are no people in the housing unit. Alternatively, use breathing masks.

Experiences with three different principles for supply of bedding in pens with group-housed sows emphasised that already when planning the project one must decide how to supply straw. The practical conditions, i.e. the task of supplying bedding and labour can be difficult to assess beforehand.

her to invest in machinery for combined bedding and manure handling and whether the supply should be automatic. The width of the inspection alley, the free height above the equipment, etc. are important to the installation and the function, so the decisions must be made at an early point.

Handling manure via a belt canal as often seen in cattle units was studied in one herd with group-housed, gestating sows. The system cannot be recommended as the floating layer could not be broken and it was furthermore impossible to handle the manure in the housing unit. Furthermore hydrogen sulphide developed in the housing unit, and there were considerable problems with odour in connection with stirring.

Lactating sows

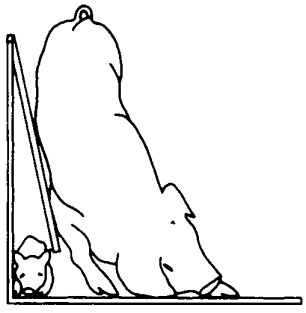
Experiences from practice indicate that the sows have grown bigger over the last years. Preliminary results from a study of sow dimensions carried out by the Danish Applied Pig Research Scheme comparing measurements from 1986 confirm this tendency. For instance, fourth parity sows are approx. 10% longer than before.

The litter size has also increased. In 1991, there were 10.7 liveborn/litter, while in 2002 there were 12.2 liveborn/litter. The aim is to produce pigs with a high weaning weight. A high weaning weight is among others conditional upon the sows having a high production of milk and on good opportunities for the piglets to nurse. Observations in herds indicate that the piglets have difficulties nursing at the same time after four weeks already. The reason is that the equipment reduces the space so that there is not sufficient room for the piglets between the sow's udder and the sides of the pen. The future tendency of increasing the weaning age to five weeks will only increase this problem. Furthermore, the farrowing crate can limit the sow's freedom of movement when she rises and lies down.

The Danish Applied Pig Research Scheme will therefore initiate a trial that will determine whether farrowing pens and farrowing crates increase the weaning weight of the piglets at four as well as five weeks and improve the well-being of the sows. The production results from two sizes of farrowing pens will be compared where the width of one of them is increased by min. 20 cm compared with the usual 1.60 m.

Loose, farrowing and lactating sows

In order for pens for loose, farrowing and lactating sows to be able to compete with the traditional farrowing pen, the piglet mortality due to crushing must be avoided or at least be reduced to the same level as in the traditional farrowing pen. The behaviour of the sow when she lies down is the most dangerous movement for the piglets. This behaviour is affected by a number of factors such as the sow's options for leaning against the equipment. By way of support devices, it is expected to be possible to influence how the sow lies down so that the risk for the piglets is minimised. No previous trials have identified what elements the sows prefer as support.



The mechanisms of the sow's behaviour when she lies down are not known, but it is obvious that the risk for the piglets is reduced if the sow is supported when she lies down. It is therefore an advantage to include elements in the pen that the sow would prefer as support in these situations.

The Danish Applied Pig Research Scheme will therefore carry out a project with the aim of developing a support wall that can prevent crushing of and stepping on piglets when she lies down and at the same time consider the sow's need for freedom of movement. The study is part of a comprehensive joint venture with the Danish Institute of Agricultural Sciences and the Royal Veterinary and Agricultural University.

Pen types – loose, lactating sows

The Danish Applied Pig Research Scheme is studying experiences and data from herds that have already established various farrowing units with loose, lactating sows. The aim is to establish whether the same productivity can be reached in farrowing pens with loose sows as in traditional farrowing pens.

Scanty experience indicates that some types of pen work well, while others cause problems in that the design of the pen restricts the movement of the sows and have considerable lacks in relation to ensuring good conditions during lactation. Furthermore, most systems for loose, lactating sows require more space and labour than traditional systems.

There is great focus on developing applicable farrowing pens for loose, lactating sows. It is important that the comfort of the sow is good and that the piglets have good access to the udder.

Housing of weaners and finishers

Supply of feed for weaners and finishers in the best possible way in relation to their age and development is an issue that is constantly addressed by the Danish Applied Pig Research Scheme.

Tube feeders for finishers

The Danish Applied Pig Research Scheme has tested four tube feeders for finishers:

1. Faaborg 3-in-1 from Durofarm-Faaborg
2. FunkiMat from FUNKI
3. Ergomat from TH-Klimateknik
4. Ergomat XL from TH-Klimateknik

The trial showed no significant differences in gross margin per place unit.

The evaluation of the technical performance of each feeder was summarised in a technical performance index. The check points most important to the production economics and the pigs' opportunities for using the feeder were given the highest weighting in the technical performance index.

Faaborg 3-in-1 and Ergomat XL received three out of four stars and were evaluated as "good". FunkiMat and Ergomat received two stars and were evaluated as "below average". The difference between Ergomat and Ergomat XL is that Ergomat XL has a larger trough than Ergomat.

Freshly mixed, liquid feed for weaners

Allotment of freshly mixed liquid feed for newly weaned pigs often causes problems as the amounts are small and it is difficult to distribute the feed in the trough if all the pigs must be able to eat at the same time. There is also a risk of microbial turnover of the synthetic amino acids due to residues in the feed pipes and in the mixing tank.

In order to address these issues, a system has been developed that automatically feeds an optional number of times during the day and that subsequently cleans the pipes with water and air under pressure. One of these systems, the Babyfeeder marketed by Domino A/S, was tested by the Danish Applied Pig Research Scheme.

The preliminary results showed that this method of feeding increased the gain and reduced the mortality in the weaner unit in one of the herds that participated. In this herd, the level of production was low and the variation in the pigs' weaning weight high. This feeding method could therefore prove advantageous in herds with a low gain and a high mortality.

The system furthermore reduced the labour compared with manual feeding of gruel feed. Automatic supply typically results in more frequent feedings than when manual feeding is used.

Pens with feeding via the Babyfeeder are often equipped with a long trough where the pigs can all eat at the same time the first weeks post-weaning.

Liquid feeding for WTF (weaning to finish)

It is difficult to handle liquid feeding in pens for WTF production if one wants to be able to feed restrictively and only have a trough in one side of the pen. The reason is that pens for double WTF production with a length/width ratio of 2:1 only allow all the pigs to eat at the same time until they weigh approx. 20 kg. In pens for single WTF production, the pigs can all eat at the same time until they weigh 60-70 kg.

In an attempt to solve the problem, the Danish Applied Pig Research Scheme has initiated a study where a long trough is divided into two and it is possible to feed ad lib in one half of the trough in parts of the growth period. It is also possible to feed restrictively in both halves in other periods. The preliminary experiences show that it can be difficult to maintain a good hygiene in the one half where restrictive feeding is used. The problems could probably be solved by establishing head partitions above one half of the trough. This is unfortunately not possible as the trough is used for both weaners and finishers and for both restrictive feeding and ad lib feeding.

Table 1. Test of four tube feeders for finishers, production results and productivity.

	Faaborg 3-i1	FunkiMat	Ergomat	Ergomat XL
No. of blocks	12	12	12	12
Daily gain, g	958	927	910	918
Feed consumption, FUp/day	2.74	2.63	2.52	2.47
Feed conversion, FUp/kg gain	2.86	2.83	2.77	2.69
Lean meat %	59.9	60.2	60.4	60.5
GM, DKK/place unit	772	756	780	829
Index	100	98	101	107

Ventilation and energy

Energy used for ventilation

In co-operation with the Danish Institute of Agricultural Sciences, Research Centre Bygholm, the Danish Applied Pig Research Scheme has analysed the consumption of energy for ventilation in a WTF housing unit and in a finisher unit with production of heavy pigs. The trial is the first part of a research project on energy-saving ventilation systems.

A frequency-regulated motor

One of the aims of the first part of the project was to compare the energy consumption of the traditional triac-regulated motors with the new frequency-regulated motors under Danish production conditions.

Subsequently, data was collected for calculating the energy signature of the ventilation system, i.e. the system's consumption of energy in relation to the degree of ventilation. The data material was used for simulations in the StaldVent programme.

Energy in WTF housing units

A WTF unit with six identical sections was monitored over a period of two years. The power consumption per section was measured with secondary meters.

Table 1 shows that the power consumption was halved when the frequency-regulated motors were used instead of the triac-regulated motors.

Table 1. Consumption of energy per produced pig (av. over two years)

	Power consumption kWh	
	Triac motor	Frequency motor
Per section	11,296	5,878
Per produced pig	9.37	4.87

Damper strategy

The entire energy-saving in the above trial cannot be attributed to the use of frequency motors alone. The strategy of using the exhaust damper is also important to the energy consumption.

It is recommended to always use an automatically regulated damper in the exhaust units partly to control the minimum ventilation optimally and partly to increase the pressure stability. If the minimum stability is not controlled, there is a risk of the housing unit being drained of heat, and if the system does not have a good pressure stability, external wind conditions may determine the ventilation in the housing unit.

Therefore, the next part of the project aims at studying the potential for saving via an optimisation of the pressure stability and the damper strategy.

Energy in the finisher unit

The consumption of energy for ventilation was monitored in a finisher unit with six sections. The preliminary results can be seen in table 2.

The energy used for ventilation was almost halved with the frequency-regulated motors. These motors distinguish themselves by having a significantly lower effect consumption in the low ventilation area (the energy used in block 2 is somewhat higher than the average as it was measured during a hot summer period).

A typical system runs with a ventilation percentage of less than 50 for more than half of the hours of the year. This is the reason why energy can be saved by using frequency-regulated motors.

Table 2. Consumption of energy per produced finisher

Block	Power consumption kWh	
	Triac motor	Frequency motor
1	12.4	
2		8.4
3		4.7
4	8.3	
5	12.7	
6		4.6
7		4.2
8	10.6	
9		4.2
10	8.4	
11	10.3	
12		5.5
13	10.8	
14		6.7
Average	10.6	5.5

Legislation on animal welfare

The new EU directives have resulted in new Danish legislation:

- Act on change of the act on indoor keeping of gestating sows and gilts and of the act on indoor keeping of weaners, breeding stock and finishers (Act no. 295 of April 30, 2003)
- Order on protection of pigs (Order no. 323 of May 6, 2003)
- Order on tail docking and castration of animals (Order no. 324 of May 6, 2003)

Sows

Space requirements

The space requirement is the same as previously for group sizes up to and including 17 sows, but it has been increased for group sizes above this.

The space requirement is defined as the total free floor area, i.e. excluding troughs and equipment. The space below a suspended trough is not included in the accessible floor area.

Flooring

A drained floor is defined as a solid floor with a maximum opening of 10% aperture. Drained floor is therefore compared to solid floor, i.e. bedding must be supplied in part of the lying area. The drained floor is an area from which humidity can be drained to improve the hygiene of the lying area. The area with solid or drained floor or a combination of these must be continuous.

Relief pens

It is no longer possible to place sows and gilts in stalls in connection with relief. The space requirements and the requirement to group size in relief pens have not been changed by the new legislation.

Materials for enrichment and rooting

Young females and boars in all housing units (existing ones and new ones) must have permanent access to straw or some other manipulable materials as of May 15, 2003. In existing housing units for gilts and sows, the requirement of straw or some other manipulable material must be met by January 1, 2013. In new housing units for gilts and sows (including service units, gestation units and farrowing units), straw or other manipulable material must be supplied as of May 15, 2003.

It is recommended to have 5% relief pens in systems with group-housed, gestating sows.

Weaners, breeding stock and finishers

The legislative requirement of enrichment and rooting materials came into force on May 15, 2003, and applies to both existing and new housing units for weaners and finishers. Weaners, breeding stock and finishers must have permanent access to a sufficient amount of straw or other manipulable materials that meet their requirement for enrichment and rooting materials. Rope can be used if it is placed completely or partly on the floor and if it is a type of rope that the pigs can bite into pieces and chew in.

The material must not pose a risk to the health of the animal or to the environment. Straw, hay, wood, sawdust, mushroom compost, peat or a mix of these, are mentioned in the EU directive on which the Danish legislation is built. When evaluating other materials, the authorities put emphasis on the fact that the texture and the character is similar to that of the abovementioned materials. On this basis, rope made of natural materials such as sisal rope could be used.

Table 1. Consequences of the new legislation based on the new EU directives

Sows and boars	
Tethering and loose operation	No changes
Space requirement	Is changed
Minimum measurements – the 3 m rule	No changes
Flooring	Is changed
Relief pens	Is changed
Enrichment and rooting materials	Is changed
Feeling of satiety and need for chewing	Is changed
Sprinkling	No changes
Boars	Is changed
Nesting material	Is changed
Piglets	
Weaning age	Is changed
Grinding of canine teeth, tail docking and castration	Is changed
Weaners, breeding stock and finishers	
Space and flooring	No changes
Enrichment and rooting materials	Is changed
Mixing and hiding	Is changed
Sprinkling	No changes
All pigs	
Dimensions of fully slatted floor	Is changed
Alarm system	No changes

Enrichment

Location within the pens

Regardless of the type of material used or the supply method, it is important that all pigs within a pen are able to gain access to the material as this reduces the risk of aggression. The material should be accessible within the activity area of the pens to reduce the risk of contamination with manure.

Straw

Straw and similar products, such as hay of grass or lucerne, can be used in pens where the slurry system is adequately dimensioned.

In pens with solid, drained, or partially slatted floors, straw can be supplied directly on the floor, in a feed tray, or in a trough. In all other types of pens, dispensers can be used. Dispensers have the added advantage of reducing wastage. The drawback is that dispensers can be expensive and need to be designed so that it is easy for the pigs to gain access to the straw.

Sphagnum

Sphagnum is compost from the production of mushrooms and vegetable refuse. Prior to use, it must be heat-treated to kill pathogenic bacteria.

Sphagnum passes easily through the slots. This has the added advantage that the slots do not block in the same way that straw does. Sphagnum can only be supplied directly on the floor in pens with solid floors.

Straw dispensers with extra grating can be used to dispense sphagnum. However, sphagnum is slightly moist and has a tendency to clot and get stuck. A viable alternative for pens with solid, drained, and partially or fully slatted floors is feed trays or troughs. Pectin waste in loose or pelleted form can also be supplied directly on the floor or in dispensers.

Rope

Rope can be used as rooting and enrichment material if it is placed on the floor of the pens and can be bitten and chewed into pieces by the pigs. It is recommended to use untreated. Ropes made of a natural material, such as sisal, provide good rooting materials. Nylon rope and strings from bales of straw should not be used, as they can cause problems with slurry systems, and the remnants damage the environment.

Pigs show more interest in rope if it is movable (e.g., suspended from a metal cross or a ball as opposed to a bunch of rope ends). Knots on the rope reduce consumption and prevent bitten off pieces from passing through slatted floors.

Wood

Wood is also a suitable rooting material, and pigs probably show greatest interest in soft woods. Like rope, wood needs to be placed on the floor of the pens. The pigs will quickly lose interest in a loose log on the floor as it quickly becomes contaminated with manure. Therefore, it is recommended to fasten the wood to the floor in the centre of the pen.

Combination of materials

A combination of rooting materials can prolong the durability of each material and makes it possible to use materials that are not expected to comply with the law. For example, the Perfect which is a combination of a suspended rope, coshes, and chains, and the Bite-Rite that consists of four chewing bars suspended on a "funnel" can be combined with rope or perhaps wood.

Current trial

The Danish Applied Pig Research Scheme is testing several materials to see whether they comply with the new legislation. The trial considers the practical implications, economics, and the behaviour of the pigs. The trial is expected to be completed by mid-2004.

A pen with a partially slatted floor and bedding meets the requirements of enrichment and rooting materials.

A straw dispenser can reduce the consumption of straw in pens with fully slatted floor.

Rope placed completely or partially on the floor can meet the legislative requirements in existing housing units.

A piece of wood fastened to the floor or the equipment in the centre of the pen.

Ecology and outdoor production

One of the primary problems of outdoor and organic pig production is the high level of labour. Furthermore, there is a low production level in organic pig production. However, there is at the same time a number of examples from practice where the producers fully or partly fulfil their success criteria in terms of limited labour and good production results. This can to a large extent be achieved by using the knowledge developed within the traditional pig production.

Sows on grass

The Danish Applied Pig Research Scheme has summarised experiences from three herds with sows on pasture.

To ensure well-established, stable and hard-wearing grass fields for the sows during the winter, the paddocks could be moved twice a year. Alternatively, the area available for the sows in the spring and summer seasons could be reduced. It is thereby possible to harvest crops on the remaining area to be used for the paddocks in the autumn and winter. Two, possibly three, cuts can be harvested in the farrowing paddocks for silage before the sows gain access to the entire paddock area. This roughage can be used for the gestating sows in the winter.

A dense grass field is a prerequisite for grass constituting a significant feed source for the sows and for the majority of the deposited nutrients to be absorbed in the grass or retained in the root zone. A dense grass field also has a reducing effect on the piglet mortality by ensuring a dry lying area.

Increased land requirement

Many outdoor and organic pig producers nevertheless choose to move the sows indoor now. This is partly caused by a change in the legislation requiring 30% more land per animal unit.

Reduced productivity

Furthermore, more and more producers experience problems with reduced productivity and inexplicable deaths among the sows, particularly during the summer. There are many symptoms, and they are not unequivocal including mastitis and farrowing problems.

The consequence may be a reduction in the production of up to ten pigs per sow/year. The Danish Applied Pig Research Scheme is currently studying experiences from practice in order to create a basis for an applied effort against the disease complex.

Housing of finishers

Production of outdoor and organic finishers requires that the pigs have access to both an indoor covered area and an outdoor area. Furthermore, the animals must have access to a well-defined, dry, no-draught lying area, cf. the EU regulation of 1999.

Types of pen and housing

There is great variation among the existing housing units. Some housing units are very open, which requires a lot of straw to keep the pigs warm. A large consumption of straw, which may become deep litter due to manure in the bedded area, requires pens of considerable sizes to be able to handle the manure mechanically. It can furthermore be difficult to control the feed supply when the pigs are kept in large groups of up to 60 animals as the pigs are often fed ad lib.

This makes it difficult to ensure a high lean meat percentage at slaughter. At the same time, large groups and large pens can make it difficult to weigh the pigs before slaughter.

Even though open housing units are often cheap to build, they involve high operational costs due to a large consumption of straw and labour.

There is a limited need for straw in insulated housing units, and part of the manure can be handled as slurry. This provides an opportunity of establishing smaller pens for groups of max. 25 animals, which makes it possible to feed restrictively and weigh the pigs more easily before slaughter, and it is also easier to dimension the cover.

Furthermore, closed pen partitions and lowered lying areas help reduce the risk of draught in insulated housing units with small pens compared to large, open housing units.

In insulated housing units, small pens are often built with room for max. 25 animals. This improves the chances of achieving good production results, as it is easier to manage the climate and the feed supply than in open housing units.

The production report - economic follow-up

The production reports in the programme Integrated Farm Management System – Pigs now also include financial ratios, which makes it possible to monitor the development in e.g. the gross margin, various costs and feed prices.

The production-technical indicators now include a calculation of animal units and a reference value for daily gain. The indicators for feed consumption are now calculated on the basis of the new feed units: FUgp and FUgs.

Financial ratios

The gross margin is expressed in relation to the production: sows per year, produced pigs/pig, per kg gain, and per animal unit.

The gross margin is expressed before and after the various costs, as there are no requirements of recording of various costs. The following various costs can be reported:

- Vet
- Medication
- Breeding costs
- Bedding
- DAKA
- Vaccination
- Production advice

The feed consumption is an important parameter in the pig production. To make this cost visible, we have chosen to express the feed costs in relation to the extent of the production and to calculate an average price per feed unit.

The following ratios are calculated:

The sow unit:
- Feed costs per sow/year
- Feed costs per young female, DKK/sow/year
- Feed costs, weaned pigs
- DKK/FUgs
- DKK/FUgp

Weaners and finishers:
- Feed costs per kg gain
- DKK/FUgp, start feed
- DKK/FUgp, weaners
- DKK/FUgp, finishers

In order to be able to compare the financial ratios across periods and herds, we have selected sows/year and kg gain as the parameters in the calculations, as they are not affected by production fluctuations.

To ensure that the gross margin is correctly calculated, the scientific definition of GM is used. With this as our point of departure, we have incorporated the requirement of reporting prices for all sales and recordings of consumption. Status values must be found for the individual animal groups for calculation of the herd changes. If these requirements are not met, the gross margin is not calculated.

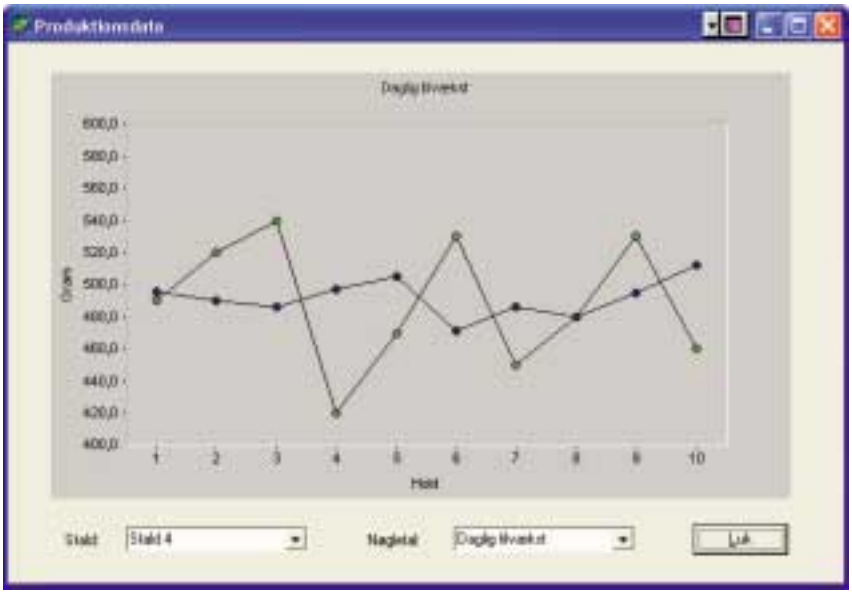
Production-technical indicators

Animal units

This calculation takes into consideration the potential fluctuations in the weight per pig upon transfer from the production. The total gain of that period is not calculated, which makes the calculation an actual expression of the animal units.

Reference daily gain

The indicator daily gain, kg, does not take into consideration the potential fluctuations in the production in terms of start and finish weights of the pigs, and therefore this indicator cannot be used for monitoring the development in the production in between periods. On this basis, we have incorporated a reference figure for daily gain. The results achieved over a period of time are converted via the Qompertz growth function into the herd's daily gain in the weight interval 7-30 kg or 30-100 kg. This calculation makes it possible to monitor the development in between periods and across herds.



The curve shows the actual calculated gain (green) and the standardised 7-30 kg gain (blue). The large fluctuations in the actual calculated gain are caused by the varying start and finish weights.

Surveillance and planning of production

Automatic weighing of pigs

A weighing system based on cameras is being developed. The preliminary results show that by way of this system it is probably possible to calculate individual growth curves even though one does not know the identity of the individual animal.

This means that besides being able to monitor the gain at pen level, one also gets an overview of the development in the weight spread. It is expected that the image weighing system will applicable for:

- Monitoring the development in the pigs' daily gain
- Formulating the nutrition as changes in diets must take place at the right weight at pen level
- Projecting the number of pigs ready for slaughter at given times and thereby reach an optimum delivery strategy

The system will be completed during 2004 and the equipment for weighing will then be put into production.

Surveillance through sound recognition (coughs)

In co-operation with the Danish Technical University, the National Committee for Pig Production is developing a method for automatic recording of coughs among pigs. The preliminary results have shown that it is possible to detect changes in the level of coughing with the equipment and programmes used.

The degree of agreement between the coughing recorded automatically (mechanically) and manually by the herd vet is now being studied. If it turns out that the technical measurements are really recording conditions concerning the health of pigs, the system will be developed fully to be used in the production.

The perspectives are great: if pneumonia can be detected at an early stage, the costs of treatment could be reduced and the pigs will thrive.

Farm*Watch*® in two versions

Farm*Watch*® has been expanded with an independent programme for management and computation of batch production alone (Management). The programme is included together with the water surveillance section and the alarm section in the complete Farm*Watch*® programme (surveillance).

Farm*Watch*® Management computes important technical indicators and financial ratios for batch production, e.g.:

- Average daily gain, feed conversion per kg gain, mortality in per cent, water consumption per batch and per kg gain
- Gross margin per batch, per produced pig, and per kg gain
- Feed costs and other production-related costs per kg gain

The indicators can all be printed on paper as text or as curves.

The results can be computed on an ongoing basis for the individual batches. This is practical in connection with e.g. double WTF where the results can be computed for part of the period or for the entire growth period.

It is also possible to compare batches with different weight intervals, such as 6-31 kg with 8-27 kg.

Farm*Watch*® Management automatically converts the current figures of average daily gain to reference values based on the standard weight intervals 7-30 kg, 30-100 kg, and 7-100 kg. This way, the performances of the individual batches can be directly compared with each other.

More networks

Farm*Watch*® Surveillance now supports four networks:

- P-Net, which is a common European standard of network communication used by e.g. SKIOLD-ECHBERG A/S
- InfoMatic used by SKOV A/S
- Professor Partyline developed by Klima Design A/S
- Opticon developed by M.H. Jensen, Maskinfabrik ApS

Planning of work and logistics

In co-operation with regional advisors, the National Committee for Pig Production has developed a programme that can help the pig producers obtain an overview of transfer dates for the sow and weaner batches and of who is receiving the pigs.

The programme can make a transfer calendar for e.g. a 12-month period. This calendar provides an overview for all the participants in the network of when they are scheduled to receive pigs.

The programme can also make a work calendar containing the main activities such as service, farrowing, weaning, and transfer of pigs. The calendar also gives a good overview of the amount of labour from week to week, and can be used for planning holidays, days off, and need for extra labour.

Finally, a monthly calendar can be made where the work operations within the individual housing units are shown with indications of who is responsible for what.

The programmes for batch production can be found at http://www.landsudvalget.dk under the section "videnscenter".

Consumption of time

Increasingly large herds increase the requirements of overview and competent management to avoid irrational work routines and as a consequence of this a large consumption of time in housing units that do not necessarily require a great work effort. A good example is the gestation unit where different types of design and production result in different work routines and varying time consumption.

Time consumption can be used for identifying the difference in labour of different technical designs in housing units and for optimising and changing the work routines. The system can be used in the future management of large pig herds.

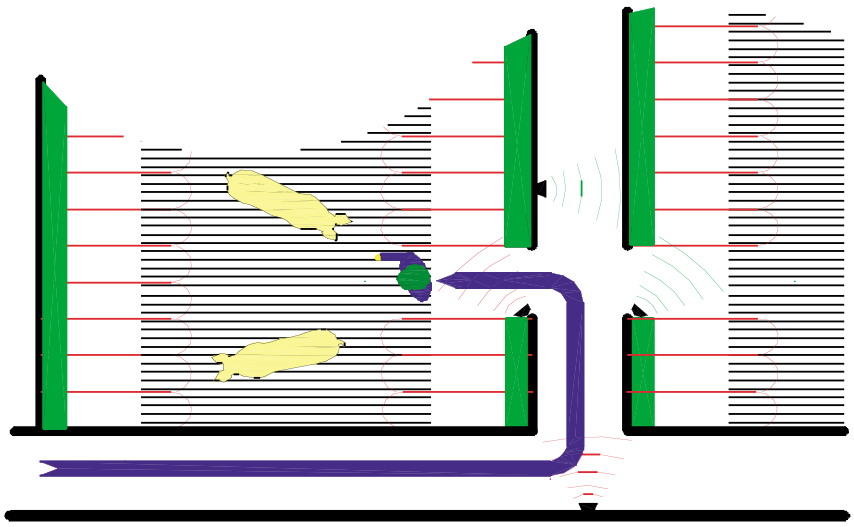
Method of recording

To optimise the time spent in Danish housing units, the Danish Applied Pig Research Scheme has developed/converted alarm equipment from the health sector for electronic recording of time in different sections of the housing unit.

The staff in the herds is handed a chip that shows their presence in the housing unit through recordings from installed sensors. When the staff moves around in the different sections, the chip detects signals from the sensors that transmit the time, date and position to a computer. Based on a combination of these data, the average consumption of time is calculated.

Time study in three different gestation units

There were great differences in the consumption of time between the three studied gestation units. The herds were characterised by the sows being tethered in stalls in herd 1; the sows being group-housed in pens with electronic sow feeding in herd 2; and the sows being housed in pens with access to individual feeding stalls in herd 3.



This principle sketch shows how the activities of the staff in a housing unit are recorded.

The housing unit with the most time spent per place unit was as a point of departure the herd with electronic sow feeding.

However, if the total consumption of time was adjusted for the difference in methods of supplying straw, the variation was significantly smaller, and the herd with electronic sow feeding was then the system that spent the smallest amount of time. A partial conclusion was furthermore that group-housed sows require more time during the weekends compared with the tethered sows.

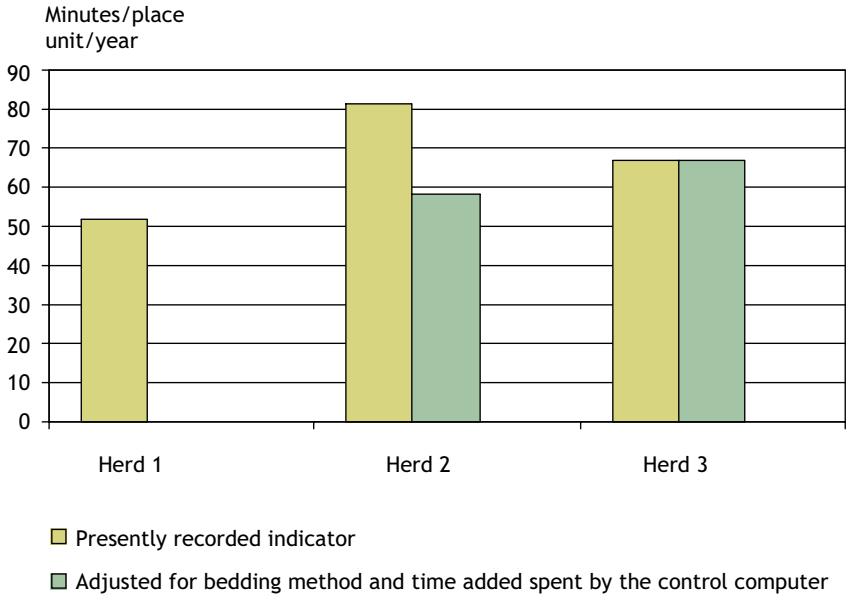


Figure 1. The figure shows the currently measured consumption of time expressed in minutes/place unit/year and the indicators adjusted for bedding technique. The numbers show the consumption of time if the same amount of time was spent on bedding in herd 2 as in herd 3.

Human Resources management

New figures show that of those employed in primary agriculture on pig herds, 2,752 are farmers and 4,205 are employees. This means that the majority of all pig producers have at least one employee and are thereby HR managers.

HR management is a professional craft. Like tending to pigs, management is a discipline that can be learned, but it requires care, common sense, practice and attention.

Are you flying in the same direction on your herd?

It is essential that the employees are aware of the goals of the herd. They need to know what is going on at the herd and to be continuously consulted in an open dialogue. Their areas of responsibility must be clearly defined, and there must be follow-up procedures so that the manager knows what is going on in the herd and can be attentive.

HR management focuses on:

- Recruitment. Employment of the right employees?
- Keeping the employees. Is the work environment sound and do the employees enjoy their work?
- Planning of the work. Are the hours spent optimally?
- Further development of the employees. Are the employees faced with challenges and responsibility, are they included in the decisions, and do you together have the knowledge required?
- Leaving. Are the relevant experiences and knowledge summarised when an employee leaves?

Help and inspiration

The website "LandbrugsInfo" has a theme site with information on management. Here you can find links to courses in management and various professional materials that can be downloaded and adjusted according to your need. There is for instance an staff manual, a management manual, and a specific description of the work procedures in a pig herd called "This is how we do it".

Staff manual

The staff manual is a template for how to describe to the staff your kind of herd. For instance, the goals of the herd can be described as can the rules for overtime work, holiday, pay, confidentiality, residence, areas of responsibility, and finally there is room for describing life at the herd, employee meetings, performance reviews, social events, etc.

A complete staff manual provides a good picture of employment at the herd.

Management manual

The management manual is a help to the manager. The manual consists of checklists and questions that can be used for:

- Recruitment – interviews and introduction course
- Keeping the employees – performance reviews and agendas for staff meetings
- Leaving – resignation talks. The questions are aimed at the different staff groups.

"This is how we do it"

"This is how we do it" contains suggestions for descriptions of the daily work routines in the herd's individual sections.

Adjust it to your herd. There are many ways of describing things, and it is essential that you draw up the material in a way that fits your herd and the people employed. The written materials are therefore available as Word documents that can be downloaded onto your own computer and rewritten according to your own needs.

Network of advisors

HR management is a relatively new discipline among the advisors in the agricultural industry. However, a new network of professional advisors is now ready to help providing advice on this area.

The theme site on management can be found at:
www.landscenret.dk/personaleledelse.

Pneumonia

Pneumonia

Infection with mycoplasmas is the basic cause of pneumonia – a pulmonary disease that in itself is fairly mild. However, many studies have shown that the mycoplasmas often precede more virulent infections, such as PRRS and the Ap bacterium. Studies made by the National Committee have shown that finishers that suffer from pneumonia grow an average of 60 g less a day than healthy finishers in the same herd. Controlling pneumonia is therefore an important prerequisite for a healthy and profitable pig production. For a number of years, the National Committee has worked on finding solutions to perform the best control of pneumonia. The following is an outline of the central parts of these studies.

Depopulation

The most efficient way of preventing problems with pneumonia is to depopulate the herd that is infected with Mycoplasma. Complete depopulation with the SPF method is well-known and has been tested successfully over a number of years. So-called partial depopulation has also proved to be a good method. Here, all the young animals in the herd (all animals less than 10 months old) are culled, and the sow unit is medicated for a period of 14 days. Over the last ten years, the National Committee has monitored many herds that have been partially depopulated, and it seems that nine out of ten attempts succeed. There is obviously a risk that the herd becomes reinfected, for instance through the air from neighbouring herds. The probability that this happens in the individual herd can be assessed in a GIS report, which can be ordered from the National Committee.

Vaccination

Vaccination is another good way of preventing pneumonia and some of its complications. At the beginning of the 90s, the first vaccinations against pneumonia were introduced on the Danish market. From the beginning, the National Committee has tested many of the vaccines under Danish conditions. Generally, they all seem to be able to reduce the prevalence of pneumonia in pigs by approx. 50% and to reduce the impact of pneumonia in the pigs that are still suffering from the disease. The prevalence of chronic adhesive pleurisy can also be reduced by vaccinating against pneumonia. The vaccines thus improve the health and also the daily gain in the fattening period by 10-40 g.

Management and housing systems

In order to reduce the prevalence of respiratory disorders, there has been a lot of focus over the past years on establishing sectioned housing units with batch production according to the all-in all-out principle. The pig producer can thereby obtain a good disruption of infection between each finisher batch, but nevertheless most batches are still infected with pneumonia. A more pronounced sectioning can be obtained with multisite production – a production type that is gaining foothold in Denmark. Studies show that approx. half of the batches are free from pneumonia at the time of slaughter. However, it is typical of these types of production that the pigs are moved and mixed several times, which is stressful to the pigs and can reduce their resistance to the infections present in the herd. Therefore, the National Committee has carried out a study with the aim of evaluating the health and the production aspects of housing the pigs either from farrow to finish (FTF) at the same premises, or in the same pen from weaning to finish (WTF) combined with transfer at weaning to another property than the sow unit.

The study showed that the pigs in the FTF and in the WTF systems were largely free from pneumonia at slaughter. This must be compared with the pigs produced in the sow herd in a traditionally sectioned process with weaner and finisher units (control) where 39% of the pigs suffered from pneumonia (cf. table 1). The productivity was significantly better among both the FTF and the WTF pigs than in the control pigs. Compared with these, the FTF pigs and the WTF pigs had an additional growth of 71 g and 181 g a day, respectively. The study primarily shows the very large growth potential of the pigs – a potential that is seen when the pigs are offered conditions in which a good health and a low stress level are considered.

Table 1. The importance of the production system to the development of pneumonia and to the productivity

	Control	FTF	WTF
Pneumonia, % of the pigs	39	4	2
Gain, g/day, 30-100 kg	791	862	972
Dead and rejected, %	3.5	3.2	1.2

The future

In the future, the National Committee will also work on the conditions concerning pneumonia, such as an optimisation of vaccination strategies. Thus, studies have been initiated to evaluate the effect on the finisher production by vaccinating against mycoplasmas and PRRS simultaneously, and by vaccinating the sows against mycoplasmas in multisite systems.

Reasons for culling of sows

Since January 2001, the Danish Applied Pig Research Scheme has recorded reasons for culling among 14,526 sows from 37 herds. The main purpose was to get an insight into the normal culling strategy in the Danish sow units. In each of the 37 herds, the reasons for culling were recorded on the basis of an evaluation by the herd manager. Thus, each sow was accompanied by a background description when leaving the herd, regardless of whether it was slaughtered, destroyed or sold. It was thereby possible to consider the motive of the herd manager for culling a sow.

An average of 78% of the culled sows were slaughtered, 11% were found dead from accident or disease, 10% were destroyed, and 1% were recorded as sold in the 37 herds.

Conditions relating to reproduction were the predominant factor (approx. 60%) when a sow was selected for slaughter, while 20% were due to age and 14% due to disease and injuries.

Of the culled sows, 10% were destroyed in the herds due to the conditions shown in table 1.

Table 1. Reasons for destruction of 1,372 sows in 37 herds

Cause of destruction	Number	%
Injuries - fractures, leg problems	811	59
Disease	389	29
Other - age	101	7
Reproductive problems	42	3
Not recorded	29	2

1,575 sows died from accident or disease: the herd managers estimated that 67% were caused by disease, while the cause of death in the remaining 33% was unknown.

To elucidate this, 10 of the 37 herds were selected for further analyses. Autopsies of the destroyed and dead sows at the Laboratory of Pig Diseases and an extended health control at the sow slaughterhouse in Skærbæk gave a slightly more detailed picture of the pathological state of the sows (figures 1 and 2).

A good leg health requires an effort in several areas: one must ensure that the young females are fed restrictively from 50 kg, have an area of 1.2-1.5 m2 per young female, are approx. 8 months old when they are first served, and that they are selected on the basis of a good leg position and healthy, uniform hooves. Gilts must furthermore be housed separately from older, larger sows. Routine control and possibly trimming of the hooves and dewclaws of all the female animals are most conveniently done in the farrowing unit. There ought to be approx. 5% relief pens and a consistent strategy for handling of animals with a need for special care.

In figure 2 it can be seen that the actual cause of death among 23% of the sows was related to reproduction in the form of e.g. retained embryos, metritis, inappropriate assistance at birth and other factors related to farrowing. An almost corresponding number of sows died because of torsion of the organs whereby the sow dies of internal bleedings or of circulatory disturbance. The reason for torsion of the organs has not been established, but the problem may be related to the gastric health among the sows. Therefore, an extended health control was also made on the slaughter sows from the ten herds, and it was found that almost 44% of the slaughter sows had gastric changes - a very large part suffered from ulcers (figure 3).

Obviously, the problems with ulcers are not equally large in all herds, and in this study there was a tendency to a higher prevalence of ulcers in housing systems completely without or with very limited amounts of bedding (red columns in figure 3). There are no studies of the importance of the feed to the gastric health of the sows, but several studies among finishers show that coarsely ground feed clearly has a beneficial effect on the gastric health. It is extremely important that a healthy gut function is maintained in the sows under all conditions to ensure a sufficient feed intake and avoid a negative energy balance. Ad lib access to straw in the gestation unit and in the farrowing unit in the week before farrowing is good for the gastric health. This study forms a good basis for further studies and measures that can contribute to a reduction in the number of dead and destroyed sows in the herds.

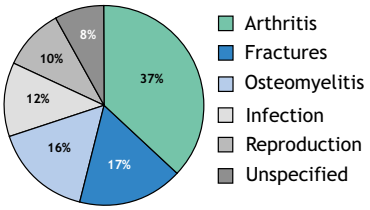


Figure 1. Distribution in per cent of post-mortem findings of 169 sows.

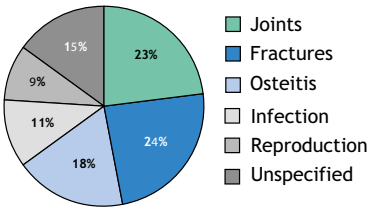


Figure 2. Distribution in per cent of post-mortem findings and actual causes of death among 93 sows.

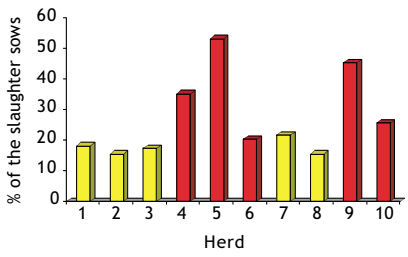


Figure 3. Proportion of ulcers in the white part of the stomach among 749 slaughter sows from ten selected herds.

Leg problems and hoof trimming

The National Committee for Pig Production has just finished a study of hoof trimming in one herd. The aim of the study was to show whether regular hoof care of group-housed sows had benefited the production in the form of an increased litter weight at weaning and improved longevity of sows.

Hoof care can be used both as an acute treatment method and as part of a long-term strategy for prevention of hoof diseases. With hoof care, one usually recreates or maintains the normal shape and health of the hoof and thereby increases the sow's productivity, well-being and longevity.

A thorough examination of the hooves requires that the sow be tethered in a hoof trimming stall where the hoof can be trimmed (picture 1). Some hoof injuries are superficial, while others run deeper. Trimming provides a good opportunity for evaluating the importance of a given hoof injury for the movement and well-being of the sow and the subsequent treatment.

A sow tethered in a hoof trimming stall.

Overgrown hooves are a significant reason for lameness in sows. This is due to claw injuries and changes in the strain on the hooves, joints and tendons. Besides soreness, these claw injuries result in an increased blood supply to the affected area and thereby an increased growth. The condition is thus self-enhancing.

Hoof problems in sows involve a number of different changes in and around the hoof, and they have varying effects on the sow's productivity, longevity and well-being. Particularly lesions in the heel, the junction between the heel and the toe, the white line and the side wall of the hoof are of importance as they increase the risk of infection in the hooves.

In normal, well-shaped hooves (picture 2) the body weight is evenly distributed across the entire sole of the hoof and the risk of developing hoof injuries is reduced.

A normal hoof

However, in many cases pigs are predisposed to developing hoof injuries partly due to a sharp transition between the soft and the hard horns, and partly due to an uneven weight distribution on the sole of the hoof and between the inner and the outer hooves. A deviating toe angle and too small inner hooves are hereditary disorders that change the weight distribution and thereby increase the strain on certain parts of the hoof.

Anatomi and injuries. a = toe, b = heel, c = dewclaw, d = junction of heel and toe, e = overgrown heel, f = cracks in the white line of the hoof

In a recent trial, the sows with even ear numbers had their hooves trimmed twice a year. The sows with odd numbers were included in the normal strategy of the herd: no hoof trimming. In both groups, hoof injuries were mainly seen at the lateral hoof. The prevalence was higher on the lateral hoof of the hind leg.

Table 1 shows the four most frequent hoof disorders of 1,532 sows. It can be seen that 61% of the sows had uneven hooves (small inner hooves) on their hind legs – a factor that strongly contributes to injuries occurring to the outer hooves.

Table 1. Hoof recordings in sows

Recording	Foreleg	Hind leg
Long hooves	13%	24%
Uneven hooves	9%	61%
Cracks in the white line	17%	28%
Overgrown heel	26%	44%

The study ran for three years and was carried out in a herd with group-housed sows and electronic sow feeding. The pens had small nesting boxes and narrow inspection alleys with slatted floor.

The study showed no significant differences in production results or culling causes between the two groups.

A housing system that causes extensive hoof problems combined with a high prevalence of uneven hooves among the sows made it impossible to maintain let alone recreate the hoof health by way of two annual trimmings. It is therefore recommended that herds with this type of housing unit be particularly focused on avoiding uneven hooves in their selection of young females. As the long hooves and/or uneven hooves dispose to lameness in the individual sow, the importance in terms of welfare of hoof trimming should be included in the health and welfare strategy of the herd.

Post-weaning diarrhoea

The National Committee for Pig Production has studied the ability of a Swedish diet to prevent post-weaning diarrhoea and compared various strategies for restrictive feeding and their importance to the pigs' health and behaviour.

Swedish weaning feed

Laboratory tests and practical trials in Sweden indicate that weaning feed that stimulates the excretion of a certain protein (protein AF) in the intestines of pigs can reduce the prevalence of post-weaning diarrhoea and improve the gain and feed conversion.

In the trial of the National Committee, the trial and control pigs were given Swedish diets the last 14 days in the farrowing unit and the first 14 days post-weaning. The two diets were identical except for the fact that the trial feed included 6% specially treated wheat that should stimulate the excretion of protein AF.

The pigs in the trial group were given electrolyte that should also stimulate the development of protein AF. The trial was finished 4-5 weeks post-weaning. It was carried out in three herds with varying degrees of diarrhoea caused by pathogenic E. coli bacteria.

The results of this trial showed that there was no significant effect of this feed on the mortality, treatments for diarrhoea or productivity in the three Danish herds with E. coli diarrhoea post-weaning. Therefore, the trial could not confirm the results of the Swedish trials.

Restrictive feeding

Manual feeding of pigs post-weaning often requires a lot of time. Restrictive feeding on the floor from suspended feed boxes was studied in two herds. The effect on the pigs' health, gain and behaviour was compared during:

- Feeding ad lib
- Restrictive feeding twice a day
- Restrictive feeding twice a day and ground barley ad lib
- Restrictive feeding four times a day

The restrictive feeding was initiated four days post-weaning.

The number of treatments for diarrhoea was identical in all four groups. The group fed four times a day had lower total mortality than the other three groups. The mortality was approx. halved compared with the mortality of approx. 3% in the other groups.

Numerically, there was a reduction in the mortality, but this reduction was not significant. The gain of the pigs fed restrictively was 13-23 g lower than the gain in the group fed ad lib.

The results are shown in figures 1 and 2.

The behavioural studies showed that the levels of aggression varied between the herds.

The pigs in the herd with fully slatted floor had a higher level of aggression than the pigs in the herd with solid floor and straw.

The pigs displayed the most aggressive behaviour immediately after feeding.

The pigs that were fed twice a day had a higher level of aggression than the pigs fed four times a day and the ones fed ad lib.

On the basis of this trial, it must be recommended to still feed restrictively and split the feed into four feedings a day.

Straw may help reduce the stress

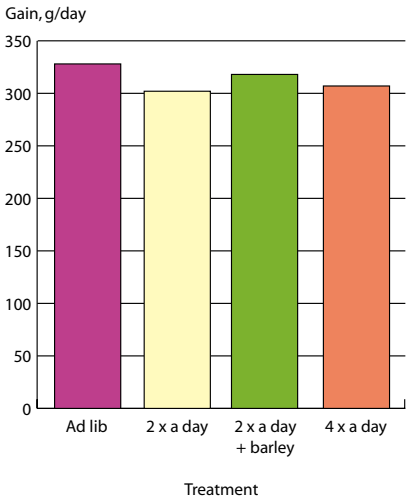


Figure 1. Effect of restrictive feeding on the daily gain

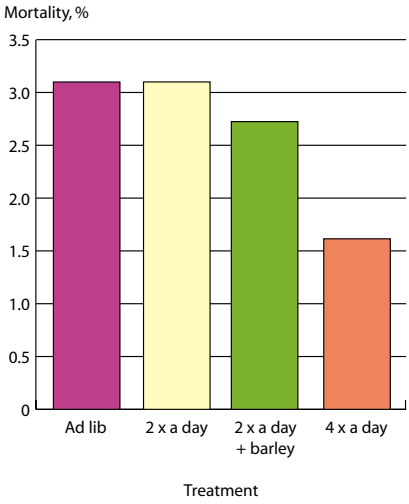


Figure 2. Effect of restrictive feeding on the mortality

Lawsonia

Together with the Danish Veterinary Institute, the National Committee for Pig Production has conducted a number of studies concerning Lawsonia.

Effect of meal feed

The effect of feeding with meal feed compared with pelleted feed was studied in a herd with pigs from 7 to 100 kg. The effect was measured in relation to the prevalence of Lawsonia, diarrhoea, and to the productivity. Dry feed was used in the herd (Report no. 596).

Meal feed during weaning tended to reduce the number of treatments for diarrhoea (from 1 day per pig to 0.83). There were no differences in the faecal score.

In the fattening period, meal feed reduced the number of treatments for diarrhoea compared with pelleted feed (from 0.57 day to 0.38) and the number of days with diarrhoea in the pen (from 12.0 days to 8.8). There was less excretion of Lawsonia in the fattening period when meal feed was used compared to pelleted feed (31% Lawsonia positive pens with meal feed vs. 43% with pelleted feed), and this reduction was identical with the results of previous studies. Furthermore, using meal feed seemed to reduce mortality during the fattening period (1.1% with meal feed and 2.1% with pelleted feed).

The best productivity was reached with the pigs given pelleted feed. This applied to both the weaning period and the fattening period, when the productivity was somewhat lower among the pigs given meal feed compared with the pigs given pelleted feed. The results are shown in table 1. The effect of meal feed will be further studied in two herds.

Eradication

Eradication of Lawsonia has been attempted after restocking of sow herds. The new sows were treated with antibiotics for two periods. After the first treatment period, the animals were washed and moved to a new housing unit. Lawsonia was detected in ten of the eleven herds that participated in the treatment programme. Lawsonia was typically detected 15-20 months after the treatment programme had been completed. The last herd has been free from Lawsonia for four years.

Eradication of Lawsonia was also attempted in existing herds. The method in these herds was the same as with eradication of pneumonia. All animals under the age of 10 months were removed from the herd, and the breeding stock was medicated for two periods as during eradication in new herds.

In one of two herds, Lawsonia was detected 12 months after medication. Two years after the medication strategy, the other herd, a producer of 7 kg pigs, has still not detected Lawsonia. All herds had a good health status and a good productivity until Lawsonia was detected.

So far it looks as if medical eradication is possible, but on the basis of these experiences, eradication will be studied in another 3-4 herds according to a tightened plan. These herds will be closely monitored in order to find the possible origin of Lawsonia if detected in the herds.

Protection against infections

The effect of optimised protection against infections is studied in 2-3 herds. The optimised protection includes e.g.: wash until no manure, weaning in litters, transport of pigs from the farrowing unit to the weaner unit in carts, consistent batch production, and use of separate boots in all pens.

Excretion

Studies in five herds showed that most pigs excreted Lawsonia in the age period 10-12 weeks. The excretion lasted 2-6 weeks, and none of the pigs excreted Lawsonia after the age of 18 weeks. Infected pigs had a tendency to reduced weight gain in the excretion period.

Table 1. Effect of meal feed on diarrhoea and faecal score

	Weaners		Finishers	
Diet	Pellets	Meal	Pellets	Meal
Days with treatment for diarrhoea before intermediate weighing	1.00	0.83	-	-
Days with treatment for diarrhoea, total	1.15	1.00	0.57a	0.38b
Days with abnormal manure/pen	25.3	26.7	12.0a	8.8b
Days with manure the colour of cement/pen	0.74	0.63	4.3a	2.1b
Pens with Lawsonia, %	-	-	43	31
Productivity index	100a	92b	100a	83b

a, b: figures with different subscripts denote significant differences between groups.

PMWS - experiences with the disease in Denmark

In co-operation with the Danish Veterinary Institute (DVI), the National Committee for Pig Production has completed many studies on PMWS in the past year.

Occurrence in Denmark

In the past six months, 20 herds a month have been diagnosed with PMWS. Thus, as of August 4, 2003, PMWS has been diagnosed in 225 herds.

Figure 1: PMWS in Denmark on August 4, 2003.

Characterisation

The first 45 herds with the diagnosis PMWS in Denmark were visited by the National Committee for Pig Production in the period summer 2001 to autumn 2002. The herds were characterised and the extent of the outbreaks studied.

The herds were primarily located in Jutland: 38 of the herds were sow herds with pigs until min. 30 kg; five herds purchased their pigs at weaning; the last two herds were finisher herds. Both herds with SPF, MS and conventional health status were represented. 70% of the herds were infected with PRRS, which correspond to the presumed distribution of PRRS among all Danish pig herds. Apparently, the mortality in these herds was higher than in herds without PRRS.

The mortality post-weaning until 30 kg varied from 2% to 30% with an average of 11%. The study showed that batch production in the weaner unit resulted in a lower average mortality after weaning until 30 kg compared with the herds with continuous production.

Transmission of PMWS

A study made by the National Committee for Pig Production showed that PMWS could be transmitted from pigs with PMWS to pigs without PMWS. Another study showed that the risk of a pig dying after weaning was increased if the sow had high antibody titre against PCV2 before farrowing. The risk of dying after weaning was in this study not related to the number of pigs at birth, the number of pigs at weaning, the weaning age or the parity number of the sow. The study was conducted in three herds, and the result was must prominent in one of the herds.

Time of infection

In four herds with PMWS and four herds without PMWS it was studied at which age the pigs develop antibodies against PCV2.

As can be seen from figures 3 and 4, the pigs in the herds with PMWS developed antibodies against PCV2 at the same time

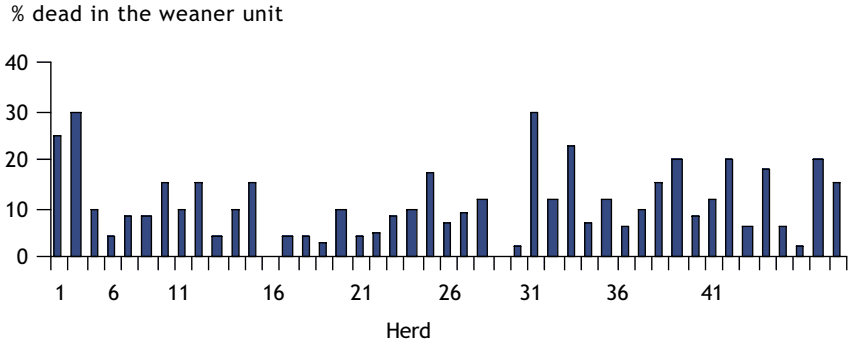


Figure 2: Mortality in herds with PMWS

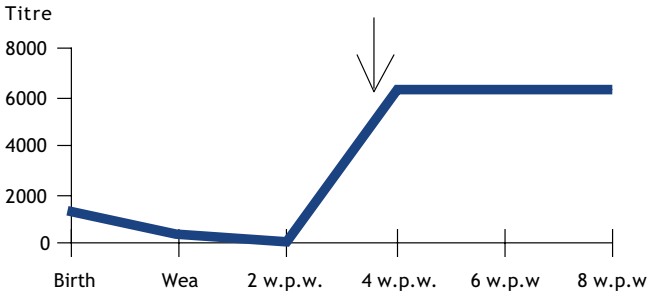


Figure 3. PCV2 titre in herds with PMWS. The arrow indicates the time of the outbreak of PMWS (w.p.w. = weeks post-weaning)

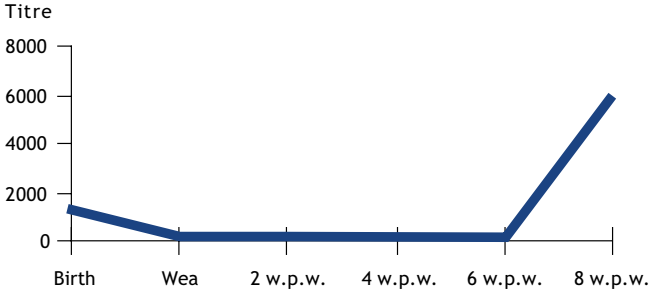


Figure 4: PCV2 titre in herds without PMWS (w.p.w. = weeks post-weaning)

as there was an outbreak of disease in the herd. However, PMWS cannot be diagnosed by a titre increase, and blood samples cannot be used to diagnose PMWS.

Control measures

Operational efforts against PMWS were monitored in five herds. Apparently consistent sectioning and batch production resulted in a decrease in the mortality rate in two of the herds (from 23.3% to 5.9% in one herd, and from 15.1% to 4.9% in another).

As we have still not found any connection between PMWS and factors other than PCV2, it is difficult to outline specific control measures against PMWS. However, it does look as if the following procedure can reduce the mortality:

- General improvement of the management conditions - batch production, cleaning and avoidance of mixing age groups
- Limited cross-fostering in the farrowing unit
- Litter-wise weaning of pigs
- No weaning earlier than four weeks of age
- Sectioning with batch production according to the all-in all-out principle
- Emptying and disinfection of the weaner units (partial depopulation)

The control measures will also have a good effect on the management of other infections in the herd, particularly respiratory diseases.

It is important to keep in mind that even though a herd is infected with PMWS, the pigs can also be infected with the other diseases of the herd, and often these infections cause the death of the pigs.

Respiratory disorders can be controlled by vaccination or medication. The programme must be arranged so that the pigs are stressed as little as possible around weaning.

In a study of the extent of vitamin E in the blood among weaners until four weeks post-weaning, no correlation was found between the risk of dying from weaning until 30 kg and the amount of vitamin E in the blood (cf. figure 5).

Studies

The National Committee for Pig Production is still using many resources on clarifying more conditions of PMWS. In co-operation with DVI, the National Committee for Pig Production will thus initiate two very important studies in 2003. A study will be initiated to - if possible - establish the cause of PMWS, which can either be conditional upon special herd conditions, another virus than PCV2, or another, more pathogenic PCV2 type. Furthermore, it is expected to initiate a serum study in 2003. This trial will establish whether PMWS can be controlled with serum in the herd, either a specific PCV2 antiserum or an auto serum extracted from the finishers of the herd. Besides these two projects, the National Committee is also studying other possible aspects: are some breeds more prone to PMWS than others; is there an effect of various feed additives; and does medication with a reducing effect on inflammations have a preventive or a directly curative effect. Specific measures in different herds are monitored, and the effects of complete depopulation and partial depopulation are studied.

Furthermore, it is studied whether transferring the pigs directly from the farrowing unit to other premises can reduce the losses caused by PMWS. Hopefully, the study will clarify whether an improvement is seen in the herd with a reduced stocking density in the weaner unit and whether the pigs that are transferred to other premises remain healthy.

Figure 5. Content of vitamin E in the blood of the pigs that died and the pigs that did not die post-weaning (w.p.w. = weeks post-weaning)

The future

During the next year, the National Committee for Pig Production will also work intensively on clarifying various aspects of PMWS. In this connection it is important that herds with problems that resemble PMWS establish whether PMWS really is the problem. This is important in order to clarify how widespread PMWS really is, but also in order to see whether there are new problems in the herd that the herd owner needs to deal with. Furthermore, the National Committee for Pig Production has set up an Internet-based discussion group where it is possible for owners of a PMWS herd to talk with other herd owners.

Salmonella

Feed

The effect of a new Salmonella reducing feed for finishers was studied in two finisher herds and compared with standard wheat-based, pelleted feed or meal feed. Both herds had problems with Salmonella, and Salmonella Typhimurium had been detected. The Salmonella reducing feed contained among others: coarsely ground barley and wheat, 10% sugar beet pellets and a mix of 1% lactic acid and 1% formic acid. The new feed was heat-treated and pelleted.

The prevalence of Salmonella was significantly reduced in the finishers given the Salmonella reducing feed (cf. table 1). However, there was generally a high prevalence of Salmonella in all groups, which was probably caused by the fact that both herds were in Salmonella level 3 for a period of time. The Salmonella reducing feed did not reduce the productivity significantly compared with the wheat-based, pelleted feed. The productivity was reduced when meal feed was used, and contrary to previous findings there was no reduction of Salmonella in the meal fed pigs.

The results showed that the prevalence of Salmonella could be reduced using pelleted feed composed especially to reduce Salmonella, without any significantly negative effect on the productivity. Such a diet is thus an alternative to the usually recommended meal feed in herds with Salmonella problems.

Changed bacteriological analysis

It was studied whether faecal samples collected in the herd and submitted for Salmonella analysis could be analysed at the laboratory as pooled samples. The aim was a reduction of the analysis costs for the herd owner without reducing the probability of detecting Salmonella when it was present in the herd.

Upon reception at the laboratory, submissions with 20 pen faecal samples were mixed two at a time, four at a time or into one large pooled sample so that 10, 5 or 1 pooled samples, respectively, were analysed. The study only included submissions where Salmonella had been detected. It was furthermore studied whether the Salmonella type should be determined on all Salmonella isolates or just on one isolate from a positive submission.

The study included 51 Salmonella positive submissions and of these 94% were still Salmonella positive when 10 pooled samples were analysed; 92% were positive when 5 pooled samples were analysed, and only 73% were positive when 20 faecal samples were analysed as one pooled sample. There were no differences between the typing of all the isolates or only one when Salmonella Typhimurium was found in a submission. The bacteriological follow-up procedure was subsequently changed, so that faecal samples received at the laboratory for Salmonella analysis (excluding DT 104) could be analysed as five pooled samples. It is, however, a requirement that the pooling takes place at the laboratory. In the future, the Salmonella type will be determined on the basis of one isolate per submission.

Optimised surveillance

An investigation was carried out with the aim of reducing the costs of the current serological surveillance of Salmonella. On the basis of existing Salmonella data it was studied whether the number of meat juice samples could be reduced in herds with a low prevalence of Salmonella without reducing the sensitivity of the surveillance.

The preliminary results show that the number of meat juice samples to be collected in herds with a low prevalence can be reduced to 1-2 a month without having to assign significantly more or fewer herds to levels 2 or 3. Such an optimisation of the Salmonella surveillance, which will lead to a reduction in the costs while maintaining high food safety standards, is currently being negotiated with the Danish authorities.

The Salmonella surveillance programme

The Salmonella surveillance programme for pigs is working very satisfactorily. The number of herds in Salmonella levels 2 and 3 is at its lowest point since the introduction of the surveillance programme. The prevalence of Salmonella in fresh pork has decreased further to 1.5% in 2002. The surveillance programme has reduced the number of Danes hit by Salmonella from pigs from 1,100 in 1993 to only 77 in 2002.

Table 1. Effect of different types of feed on the prevalence of Salmonella and on the productivity of finishers

	Pelleted feed	Meal feed	Salmonella reducing feed
Groups	43	43	43
Prevalence of Salmonella, % *	55	55	34
Daily gain, g	900	834	895
FUp/kg gain **	2.69	2.93	2.80
Production value **	100a	82b	95a

** Per cent blood samples that were Salmonella positive*

*** Feed conversion and production value are based on one herd only*

a, b Figures with different subscripts denote significant differences

Streptococcal meningitis

Disease occurrence

Streptococci are one of the bacteria found in all Danish herds. The sows carry the bacteria in the pharynx. When the piglets are only a few days old, they have already received one or more types of Streptococcus suis (S.suis) from the sow. However, most disease outbreaks are not seen until post-weaning in the weaner unit.

Meningitis often occurs in periods, and the mortality can reach 10% in the weaner period. Some herds also experience problems with meningitis among finishers. Four types of the bacterium – types 2, 4, 7 and 8 – are all common in Denmark.

PMWS, PRRS and arthritis

Streptococcal meningitis often flares up in connection with other disease outbreaks in the herd, for instance in connection with virus diseases such as PMWS and PRRS. In herds with PMWS problems, streptococcal meningitis is one of the infectious diseases that take advantage of the pigs being weakened.

In some herds, streptococcal meningitis causes arthritis that is seen in both piglets and weaners. Weaners with arthritis must be moved to a relief pen and treated with antibiotics administered via injection.

Serum

Together with the Danish Veterinary Institute, the National Committee for Pig Production has tested serum prevention of S. suis type 2 in two herds with weaners. Only in one herd did the mortality drop significantly when the pigs were treated preventively with antiserum. In the other herd, the mortality was actually significantly higher among the pigs treated with serum compared with the control group. In this herd, the disease was caused by type 7, which the serum treatment did not cover for. Due to the ambiguous results, we were unable to document that serum treatment in general could prevent meningitis. However, in an experimental test, the Danish Veterinary Institute did prove that serum prevented 50% of the cases of meningitis.

Prevention

Serum is not produced for use in the herds. Nor are there planned further trials of serum. In cases of disease outbreaks, one should act with due care (report no. 599) and the prevention must be aimed at the general resistance of the pig and on fighting other diseases in that age group.

There must be focus on giving the pigs the optimum feed and on avoiding errors when adjusting the ventilation.

Herds with S. suis type 2 disease will be able to use the streptococcal vaccine on exemption, but the efficacy of the vaccine has not yet been tested under Danish conditions.

Due care

Careful and frequent monitoring of the pigs in the critical periods is often necessary. A serious case of meningitis can develop within just a few hours. As soon as meningitis is detected, the pig must be moved to a relief pen with plenty of bedding. It is crucial that fluid is offered to the pig. Very sick pigs can be given water from a soft drink bottle via a tube. Antibiotics must of course be administered as soon as possible -always as injection – preferably two times a day for the first two days. Pigs that are not cured after five days should be destroyed.

Multisite

Sectioned operation, all-in all-out batch production, multisite, WTF – the many measures for breaking the infection chain by separating age groups are sadly not that efficient when it comes to streptococcal meningitis. The reason is that the piglets become carriers already a few days after birth. It is not possible to clear a pig of the streptococcal bacteria through treatment with antibiotics. Therefore, streptococcal meningitis is a disease that needs attention also in the different types of sectioned operation.

A pig is treated with antiserum

Published results, 2002-2003

Reports

No. 23: Nursing sows
Manual: PMWS manual, 2nd version, July 2003

Practice reports

No. 0212: Daily gain and feed conversion in different weight intervals
No. 0213: Housing of organic finishers of different sizes in the same pen. Preliminary study
No. 0301: Experiences with time consumption in gestation units
No. 0302: Fit-Mix, a feeding system for group-housed gestating sows
No. 0303: Renovated buildings for group-housed gestating sows
No. 0304: Technical performance test of detectable hypodermic needles
No. 0305: Renovated service units for loose sows in existing buildings
No. 0306: Effect of process and storage temperatures of semen from Large White and Landrace boars on the reproduction results
No. 0307: Experiences with methods for supply of straw in housing units for group-housed gestating sows

Trial reports

No. 573: Predisposing factors to lameness in finishers
No. 574: Interaction between Salmonella and worms
No. 575: Commercial products for weaners – Biacton
No. 576: Salmonella infection dynamics
No. 577: Commercial products for weaners – Pioner Feed ADD-S, benzoic acid and Ropadiar alone and combined with Greenacid LBF
No. 578: EAW in drinking water for weaners
No. 579: Effect of a plant extract on Salmonella, the gastro-intestinal health and productivity of finishers
No. 580: Particle distribution in meal feed for finishers
No. 581: Consumption of antibiotics in Danish finisher herds in 2000
No. 582: Affecting the acid-base balance of lactating sows though feeding
No. 583: Importance of birth weight on the gain
No. 584: Effect of Salmonella reducing feeding principles for sows in Salmonella infected sow units with production of weaners
No. 585: 11 or 13 piglets per litter
No. 586: Importance of rest after insemination
No. 587: Influence of the sow on mortality in pigs from 7 to 30 kg in a PMWS herd
No. 588: Bedding materials in farrowing huts
No. 589: Removal of the growth promoter tylosine from finisher feed: effect on Lawsonia, Salmonella and texture of manure
No. 590: Lawsonia Intracellularis: infection dynamics in integrated sow/finisher herds
No. 591: Predisposing factors to ear necroses in finishers
No. 592: Predisposing factors to tail biting in finishers
No. 593: Service units with individual pens or group-housing – altered service strategy
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Information material

At www.lu.dk various information can be downloaded as PDF files. Signs etc. can also be ordered on this address.

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Merete Klingert, tel. +45 3373 2556,
e-mail: mkl@danskeslagterier.dk

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The National Committee for Pig Production • Axeltorv 3 • DK-1609 Copenhagen V
Tel.: +45 3311 6050 • Fax: +45 3311 2545 • E-mail:lu@danskeslagterier.dk • Internet: www.lu.dk
THE DANISH BACON & MEAT COUNCIL • DANISH AGRICULTURE • THE DANISH PIG PRODUCERS' ASSOCIATION