Annual Report 2001

The National Committee for Pig Production

Research and Development

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Preface 2001

Much needed after a number of lean years, this year was characterized by a strong economy for the pig producers. Comprehensive investments and renovations were made with conversion to loose sows, controlled environment sections, multisite, etc. This emphasizes that pig producers are dynamic people for whom stagnation equals recession.

Environment

The pig producers have maintained faith in the future despite the extensive focus on environmental nuisances from pig production.

Odour, ammonia evaporation, distance requirements, and spreading of slurry became everyday language in the media, and politicians followed with governmental orders on environmental regulations. In the pig industry, we acknowledge that there are a number of environmental problems that need solving, and the National Committee for Pig Production has decided to expand research activities substantially within the environmental area in the coming financial years not least in terms of odour problems and ammonia evaporation.

Foot-and-Mouth disease

Another issue to occupy and affect the pig producers was the outbreak of Foot-and-Mouth disease in Great Britain, which spread to Holland and France. The Danish-German border was temporarily closed and a number of precautions were made concerning domestic sales. For instance, slaughter trucks were not allowed to drive to more than one herd on each route.

Experience from this situation will be positively used in future recommendations and regulations on virus protection and sales. We must minimize the risk of introducing viruses, and trade patterns must be built so that should disaster occur, virus is only spread to a few herds. The task now is to strike the right balance between the extra costs inflicted on the herd and the value of the virus protection measures. Sale of pigs is and will always be an essential part of Danish pig production.

Good competitiveness

Denmark is leading on the soft parameters: removal of growth promoters, low consumption of medication, animal welfare, environment, and eradication of Salmonella.

Yet, pig producers have succeeded in maintaining their competitiveness in relation to foreign competitors, and we occupy a solid position in relation to our neighbours.

Many people search for the secret behind the success of Danish pig production, but the answer is not simple. Besides the will and ability of pig producers to conversion and to employ new knowledge, part of the explanation must be found in Danish traditions and structure, e.g. joint strategy for slaughterhouse and pig producer, efficient breeding, speedy testing of new ideas within housing, nutrition and health, and close co-operation between governmental research institutes.

Breeding alone has in the past years provided many extra weaners. The sow's maternal properties are given more attention, and many of the new projects of the National Committee focus on the pig's survival ability and well-being in the farrowing section and on weaning.

Biotechnology provides new possibilities for selecting and breeding the right animals. A co-operation comprising the Chinese Beijing Genome Research Institute, the Royal Veterinary and Agricultural University, the Danish Institute of Agricultural Sciences and the National Committee for Pig Production has founded a company that during the next three years will map the pig's genome. This is an exceptional project that has resounded throughout the international research world. It should be stressed that the aim is not to create genetically modified pigs, but to use the technique to improve selection, e.g. for disease resistance, tail biting, aggressive behaviour, meat quality and other parameters that cannot be recorded in traditional breeding.

Removal of growth promoters and usage of medication

It is by now a couple of years since antibiotic growth promoters were removed from feed in Danish pig production. Unfortunately, many herds are still struggling with problems on that account.

In the National Committee we feel that problems at weaning must be solved through changes in management and nutrition instead of opting for antibiotics, which may be a necessary temporary solution.

To further strengthen the scientific knowledge in that area, the National Committee has initiated a number of comprehensive tests of application of feed at weaning. The National Committee also co-operates with the Danish Veterinary Association on appropriate usage of antibiotics.

Development of resistance and usage of medication in livestock production is closely observed by the authorities, and the herds placed high will be in further focus when VETSTAT, the public register for application of medication, is taken into use next year.

Thank you

Finally, the National Committee would like to thank all of our co-operative partners in the pig industry, governmental research institutes, authorities, vets, advisers, companies, etc. for yet another positive, active and prosperous year in Danish pig production.

This report provides the opportunity to get a systematic and focused update of the latest scientific knowledge. We wish a you joyful reading and thank you for this year.

Yours sincerely

Lindhart Nielsen / Orla Grøn Pedersen

The National Committee for Pig Production

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Lindhart Bryder Nielsen,
Løgstør.
Elected at the annual meeting

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

Director Orla Grøn Pedersen,
The National Committee for Pig Production

Contents of the annual report 2001

Budget and strategy

The National Committee for Pig Production is founded by four basic organisations: the Danish Bacon & Meat Council, the Danish Farmers' Union, the Danish Family Farmers' Association, 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 local pig production committees.

The National Committee safeguards strategy, development and information tasks concerning the live pig, and has a net budget of DKK 93.2 million for the year 2000/2001.

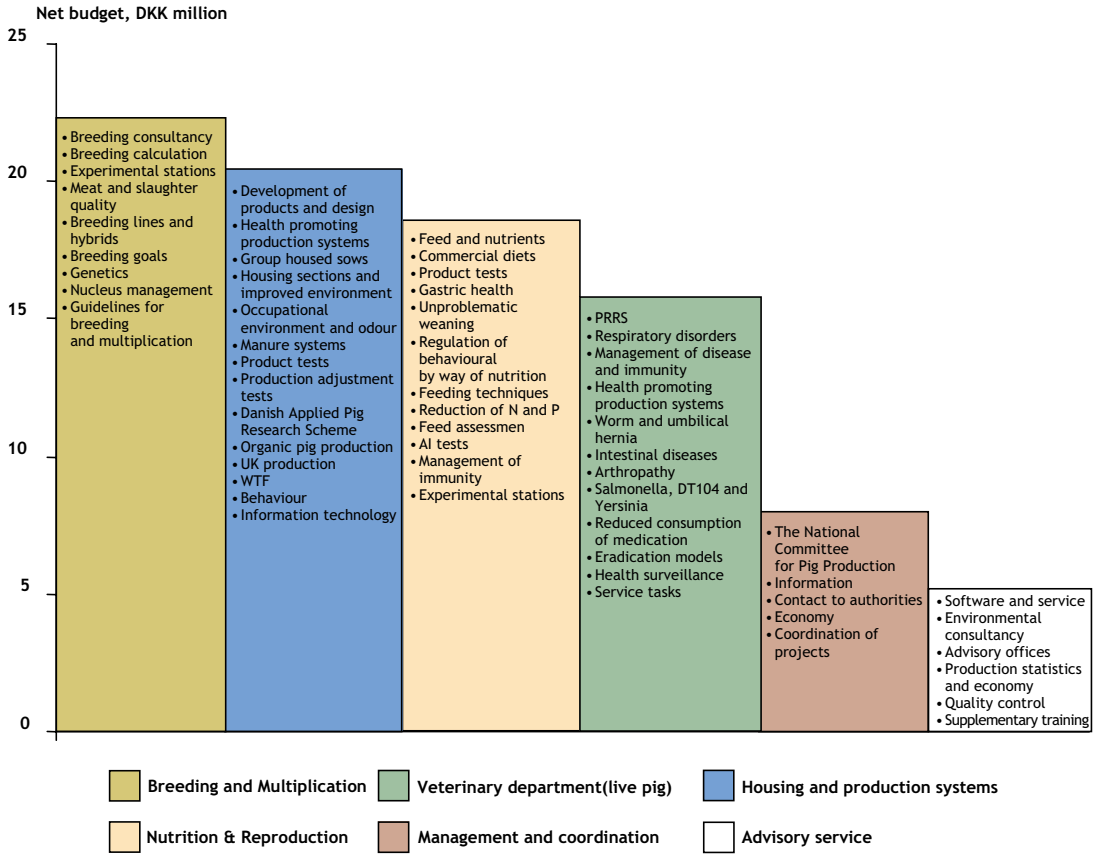
Strategy and new projects of the National Committee

After a couple of years with a largely unchanged budget, the National Committee has now increased the budget for additional efforts in three areas.

There is a substantial need for more research in reduction of odour and ammonia evaporation. The co-operation agreement on mapping the pig's genome requires strengthening of the genetic effort under the National Committee. Finally, after removing growth promoters, there is a need for precise recommendations for feeding of weaned pigs.

On adoption of the budget for the coming year, the National Committee decided to initiate the following new projects:

- Campylobacter
- Intestinal parasites and Salmonella
- Mapping of genes (health, aggression, meat quality)
- Organic feed
- Reduction of odour and ammonia emission
- Optimum work procedures
- Longevity of sows
- Flooring in sections for group housing
- Management in the farrowing section
- Immunity before and after weaning
- Application of feed at weaning
- Coli infections
- Acid binding capacity in weaner diets
- Combinations of breeds for boars
- New feed assessment system
- Segregation in feed systems
- Tryptophan and tail biting
- Effect of linoleic acid
- Networking
- Service and gestation sections
- Manure systems and rooting material
- Farrowing pens for sows housed in groups
- Outdoor farrowing sections
- Earth rays
- Diagnostics – strategic use
- Analgesics
- Spreading of disease (Geographic Information System)
- Eperytrozoon Suis



Sale of live pigs

Sale of weaners

Annually, ten to eleven million weaners are sold. The majority of these are sold in pig circles that follow the calculated weaner price or a combination of this and the pool price.

During the year, these two prices differ greatly; typically, the pool price is higher until the end of May, while the opposite is the case in the autumn. On average for 2000, the pool price was DKK3.70 lower than the calculated price, and in the first three quarters of 2001 it was DKK0.30 higher.

Sale of breeding stock

Every year the number of boars sold decreases slightly, which corresponds with the increase in the sale of semen. The sale of female animals varies depending on the economic cycles, but seen over a number of years the sale of female animals corresponds to half of the sow herds buying their young sows while the other half produce them themselves.

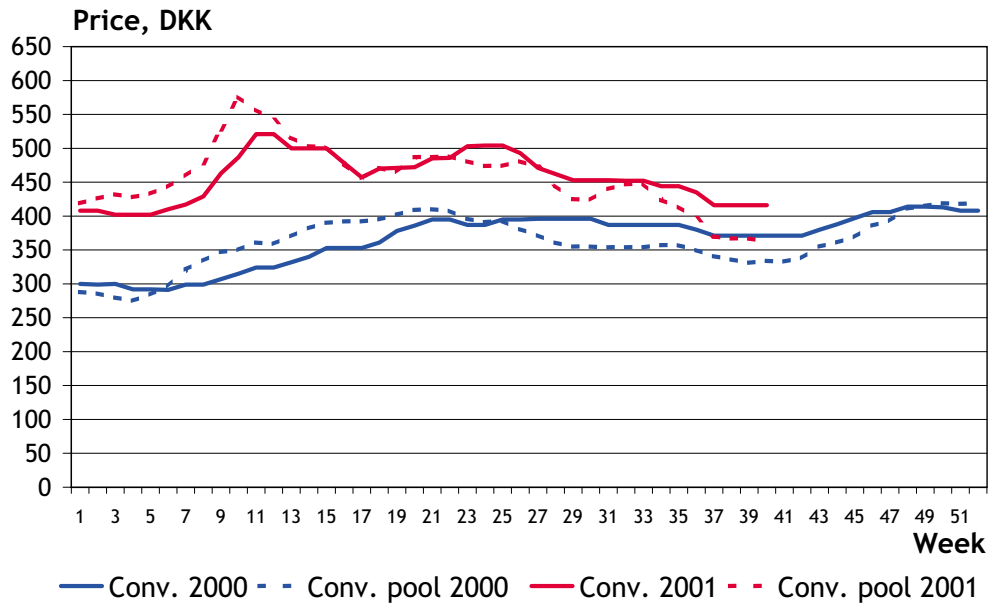
Export

In 2000, we exported 1,139,000 weaners, 181,448 finishers, 19,663 breeding stock, and 125,326 sows. Despite the export ban inflicted by the outbreaks of foot-and-mouth disease in Europe, 2001 seems to reach the levels of 2000.

Table 1. Sale of animals from breeding and multiplication herds

Breed	Health status	Female animals			Boars		
		98/99	99/00	00/01	98/99	99/00	00/01
Landrace	SPF etc.	8,538	7,833	4,202	429	460	511
	Conv.	632	258	733	76	64	31
Large White	SPF, etc.	3,617	3,256	2,138	1,030	649	569
	Conv.	228	572	306	104	109	118
Duroc	SPF, etc.	462	210	623	2,047	2,030	2,002
	Conv.	0	3	7	50	78	92
Hampshire	SPF, etc.	20	82	16	47	17	41
	Conv.	0	0	1	3	23	26
Purebred animals, total	SPF, etc.	12,637	11,381	6,950	3,533	3,156	3,123
	Conv.	860	833	1,047	233	274	267
Crossbred animals, total	SPF, etc.	190,493	156,264	180,931	4,946	3,840	3,911
	Conv.	20,122	30,251	34,414	627	443	228

SPF, etc. consists of sales from herds with SPF, MS, SKD/SKM status and sales through S.E.A., and animals born from caesarean incision.



Productivity

Development

The population of sows is expected to increase in 2001 resulting in a total population of 1,120,000 sows. This is an increase of 50,000 compared to 2000.

In 2000, 22.4 million finishers were produced, and this figure is expected to increase to 23.5 million finishers in 2001.

Results in herds with the Production Report

Sows

Efficiency is increasing in the sow units. In 2000, the number of live born pigs increased by 0.2, while the sows weaned 0.1 piglets more. The result thus became 0.2 pigs more per year sow.

The best sow keepers achieve 6.1 pigs more per year sow than the 25% poorest. This is an increase in difference. The best achieve more live born pigs, wean more pigs and have a significantly better reproduction, expressed as 12 non-productive days and 2.34 litters per year sow, compared to 23 non-productive days and only 2.14 litters per year sow for the 25% poorest.

Average daily gain increases again after a significant decrease after removal of growth promoters, but only the best 25% of the herds have reached the level of 1998.

Finishers

Gain is increasing annually, whereas the consumption of feed remains unchanged of 2.89 FUp/kg gain on average.

The differences between the 25% best and the 25% poorest of the herds are seen in both daily gain and consumption of feed. The best herds use 0.44 FUp less/kg gain and the pigs grow 86 g more/day. Furthermore there is a difference of 1.5 percentage points in dead and rejected finishers.

Table 1. Development in pig production

Year	1996	1997	1998***	1999	2000	2001*
Sows 1,000	980	1040	1070	1080	1070	1120
Prod. million**	20.1	21.1	23.0	22.5	22.4	23.5
Slaughter weight, kg	75.2	76.0	77.2	76.6	77.1	77.2
Lean meat %	59.8	59.9	60.0	60.0	60.0	60.0

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

Table 2. Average production results for sows and weaners

Year	1998 All	1999 All	2000 All	2000 Poorest 25%	2000 Best 25%
Weight/sold pig	30.0	29.4	29.5	30.3	28.9
Feed/prod. pig, FUp*	99.4	99.2	99.3	99.3	100.8
Prod. pigs/year sow	22.2	22.3	22.5	19.2	25.3
Litters/year sow	2.26	2.25	2.25	2.14	2.34
Year sows	215	223	230	186	270
First parity litters, %	20.9	21.6	27.8	25.7	30.2
Liveborn/litter	11.5	11.7	11.9	11.4	12.4
Stillborn/litter	1.0	1.1	1.1	1.1	1.1
Weaned/litter	10.2	10.3	10.4	9.6	11.1
Age on weaning, days	29	29	30	32	28
Weaning weight, kg	7.2	7.2	7.3	7.6	7.0
Dead post-weaning, %	2.9	3.6	3.4	5.2	2.2
ADG post-weaning, g	427	407	410	404	425
Age on 30 kg, days	82.9	85.3	85.5	88.9	82.3
Non-productive days/litter	17	17	17	23	12

* Not including feed for young sows

Table 3. Average production results for finishers

Period	1998 All	1999 All	2000 All	2000 Poorest 25%	2000 Best 25%
Produced pigs	3,005	2,991	3,180	2,699	3,488
Daily gain, g	786	798	817	771	857
Feed/kg gain, FUp	2.91	2.89	2.89	3.12	2.67
Weight on transfer, kg	31.7	31.0	31.3	32.2	30.6
Av. slaughter weight, kg	77.1	76.6	77.2	77.5	76.7
Av. lean meat %	59.9	60.0	60.0	59.9	60.2
Dead and rejected, %	3.4	3.6	3.4	4.3	2.8
Incidence of pleurisy rec. at slaughter	15.4	15.6	19.7	21.7	17.1
Total, incl. deductions	6.6	7.3	7.4	8.2	6.8

Economy

Development

After a couple of years with great losses per pig both for new establishments and for existing housing sections, this development was reversed in 2000 when the price incl. bonus payment increased by an average of almost DKK2 to DKK10, and this development is expected to continue in 2001 with DKK11.75 in average price. Thus, the result was DKK28/pig and is expected to reach DKK117 this year.

Analysis of accounts

A large number of herds prepares production accounts. These accounts allocate all income, costs and labour to the sow unit and to the finisher unit, respectively. Unfortunately, still fewer herds prepare these accounts.

Sow units

The accounts figures of 2000 reveal a decent increase in efficiency of 0.4 produced pigs/year sow compared to 1999. Related to unchanged prices per feed unit and not least an increase in the price of approx. DKK100/weaner, this increase results in a gross margin of DKK4,612, which is almost twice as high as in 1999.

Finishers

Gross margin for finishers also increased significantly from DKK85 in 1999 to DKK115 in 2000. This result is also due to in-crease in prices and to insignificant increases in feed costs in that period.

Capacity costs

The capacity costs originate in pure sow premises or finisher premises, respectively. This explains the different gross margins in the two tables. Maintenance costs in the sow unit decreased in 2000 compared to 1999 despite improvement in the economy. Overall, the herds achieve a positive yield when all costs relating to the pigs have been paid.

Table 1. Barometer for Danish pig production for new building

	1997	1998	1999	2000	2001*
Price, incl. bonus payment, DKK/kg	11.70	8.32	8.02	10.0	11.75
Av. feed price, DKK/FUp	1.37	1.32	1.21	1.18	1.29
GM/pig from farrow to slaughter, DKK	383	152	159	315	407
Capacity costs, DKK	118	123	127	125	123
Financing costs, DKK	187	180	180	162	167
Result/pig, DKK	78	-151	-148	28	117

** projection*

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

	Sow units		Finishers	
	1999	2000	1999	2000
No. premises	153	104	151	106
Year sows	214	240		
Prod. pigs/year sow	22.4	22.8		
Produced finishers			2,801	3,430
Weight, kg/prod. weaner	30	30		
Gain, kg/finisher			71	71
FUp/produced weaner	107	110		
FUp/kg gain			2.9	2.9
Price, DKK/prod. pig	272	370	601	775
Price, DKK/FUp	1.33	1.33	1.08	1.11
Gross gain, DKK	6,133	8,589	313	395
Feed costs, DKK	3,182	3,375	222	232
Vet & medication, DKK.	278	334	3	5
Other costs, DKK	250	268	3	3
Gross margin, DKK	2,429	4,612	85	155

Table 3. Capacity costs

	Year sow		Finisher	
	1999	2000	1999	2000
Gross margin, DKK.	2,747	4,734	85	159
Maintenance, DKK	232	210	13	15
Energy, DKK	226	233	8	8
Labour, DKK*	1,670	1,735	63	51
Depreciation, buildings/inventory, DKK**	940	827	33	33
Profit, buildings/inventory, DKK***	1,138	916	41	39
Profit, herd, DKK***	228	291	9	10
Result/year sow/finisher, DKK	-1,687	522	-82	3

** Labour: DKK120/h in 1999 and DKK123/h in 2000*
*** Calculated on the basis of invested capital*
**** 7% in return on invested capital*
Source: Department of Farm Accounting and Management, Danish Farmers' Union

Genetic improvement

Table 1 shows the annual genetic improvement for the period 1997-2000 for each breed and the average of that period for all four breeds.

The development in killing-out percentage as an average of the four breeds over the last four years has been slightly poor, but the last two years have witnessed a positive development as the killing-out percentage for all four breeds has increased. Daily gain from 0-30 kg and pH are both fairly new index traits and their development is on the right track, as can be seen in table 1, though the development varies slightly between the breeds.

The genetic improvement is of great financial importance. As an average of all four breeds, the gross margin per finisher is improved by DKK9.88 a year, and of this approx. DKK9.25 are expected to be realized in the production herds.

Table 1. Genetic improvement over the last four years, stated annually per breed. Average genetic improvement per year is calculated for each breed and as an average of all four breeds.

Breed	Year	Daily gain (30-100 kg), g/day	Feed - conversion, FUp/kg of daily gain	Lean meat content, %	Litter size, no. piglets born/litter	Conformation, point	Daily gain (0-30 kg), g/day	pH, units	Killing-out percentage, %
Duroc	97/98	20.7	-0.04	0.04	-0.09	0.01	1.2	-0.001	-0.01
	98/99	23.8	-0.04	0.13	-0.03	0.04	2.0	0.002	-0.16
	99/00	16.5	-0.04	0.26	-0.08	0.02	2.5	0.013	0.00
	00/01	20.0	-0.03	0.12	0.03	0.04	3.2	0.008	0.06
Average	4 years	20.3	-0.038	0.14	-0.04	0.03	2.2	0.006	-0.03
Hampshire	97/98	19.1	-0.04	0.10	-	0.02	1.2	0.000	-0.11
	98/99	17.8	-0.03	0.10	-	0.04	3.7	0.001	0.06
	99/00	18.0	-0.02	0.06	-	0.02	3.1	0.000	0.08
	00/01	11.8	-0.03	0.07	-	-0.01	2.5	0.003	0.12
Average	4 years	16.7	-0.03	0.08	-	0.02	2.6	0.001	0.04
Landrace	97/98	18.3	-0.02	-0.16	0.55	0.04	-0.2	0.000	-0.07
	98/99	17.0	-0.02	-0.02	0.52	0.09	-4.1	0.001	-0.18
	99/00	14.3	-0.03	0.07	0.46	0.09	-3.0	0.001	-0.10
	00/01	12.3	-0.04	0.05	0.31	0.10	-0.6	0.001	0.04
Average	4 years	15.5	-0.03	-0.02	0.46	0.08	-2.0	0.001	-0.08
Large White	97/98	9.5	-0.01	-0.03	0.18	0.07	-1.2	0.001	-0.04
	98/99	13.0	-0.01	0.00	0.22	0.10	-0.2	-0.001	-0.02
	99/00	9.6	-0.02	0.00	0.29	0.09	1.2	-0.001	0.00
	00/01	11.7	-0.02	0.09	0.30	0.09	-0.6	-0.001	-0.01
Average	4 years	11.0	-0.02	0.02	0.25	0.09	-0.2	-0.001	-0.02
Average four breeds	4 years	15.9	-0.03	0.06	0.36*	0.03** 0.09***	0.7	0.002	-0.02

* Average of Landrace and Large White
** Average of Duroc and Hampshire
*** Average of Landrace and Large White

Production level

Tables 1-4 show the production results achieved at Bøgildgård test station and in the nucleus herds in 2000-2001.

In the past year, the number of animals tested at Bøgildgård returned to the normal level. Compared to last year, we see reductions in daily gain and feed conversion due to among others the fact that Bøgildgård is now operated with PRRS-positive status. The extent of performance tests in the nucleus herds peaked this year due to e.g. the expanded population of Landrace. The uneven distribution by sex of Landrace and Large White reveals that some of the boars are not included in the test.

When comparing the production levels between breeds, one must take into account the fact that only few animals of different breed were tested in the same environment (same herd), and on comparison of levels of daily gain between breeds, one must also take into account differences in killing-out percentage (table 1). In the performance tests in the herds, daily gain is measured on live animals while the figures from the test station are based on slaughter weight or adjusted to this.

Table 1. Average production results achieved by boars at Bøgildgård test station in 2000-2001

Breed	Number	Daily gain (30-100 kg), g/day	Feed conversion, FUp/kg gain	Lean meat content, %	pH (Loin/ham), units	Killing-out percentage, %
Duroc	1,712	925	2.40	59.9	5.67	74.5%
Hampshire	530	853	2.46	62.5	5.55	76.3%
Landrace	1,245	915	2.48	60.0	5.55	74.9%
Large White	1,245	905	2.40	61.6	5.60	75.8%
Total	4,934	-	-	-	-	-

Table 2. Nucleus herds – average production results for boars in 2000-2001

Breed	Number	Daily gain (0-30 kg), g/day	Daily gain (30-100 kg), g/day	Lean meat content, %	Conformation, points
Duroc	9,110	377	1005	59.3	3.05
Hampshire	1,193	361	855	61.8	2.99
Landrace	18,260	383	968	61.6	3.00
Large White	13,559	370	965	61.1	3.22
Total	42,122	-	-	-	-

Table 3. Nucleus herds – average production results for female pigs/gilts in 2000-2001

Breed	Number	Daily gain (0-30 kg), g/day	Daily gain (30-100 kg), g/day	Lean meat content, %	Conformation, points
Duroc	10,345	375	955	59.3	3.15
Hampshire	1,774	362	820	61.7	3.11
Landrace	24,438	385	932	61.6	3.20
Large White	16,220	369	932	61.0	3.36
Total	52,777	-	-	-	-

Table 4. Litter size of purebred litters in nucleus herds in 2000-2001

Maternal breed	Litter size (purebred litters in nucleus herds)	Percentage of gilts
Duroc	10.0	74
Hampshire	8.3	74
Landrace	13.5	62
Large White	12.0	59

Research and development

Mapping the genome of the pig

The research institute in Beijing, China, was one of the main forces behind mapping of the human genome. Having finished this project, it was decided to start mapping the genome of the pig, and Denmark was selected as partner in this project.

Together with the Danish Institute of Agricultural Sciences and the Royal Veterinary and Agricultural University, the National Committee for Pig Production has formed the company that will head the Danish delegation in this highly interesting project.

The agreements were signed in April 2000, and work is already well under way. Research work involves three main tasks.

The first task is to map as much as possible of the total genome. It is expected that more than 75% of the genome will be mapped.

The second part of the project is mapping of almost all the genes that are active in the pig. A total of 10,000 genetic products will be collected from each of the 100 different tissues that will be examined. It is estimated that we will gain knowledge of more than 95% of the active genes in pigs.

The final part of the project is processing the data. Large amounts of data will be created in this project.

The project will run for three years, and a prolongation will subsequently be considered.

Breeding for disease resistance

This project aims at discovering individual genes with substantial influence on disease resistance, production traits and meat quality.

The project was initiated in 1999 and consists of two phases. The first phase consists of data collection and analyses. The second phase will be carried out if the results from the first phase show any differences in frequency of diseases, daily gain or meat quality in litters by different boars. In the second phase, an examination is made of the genome of approx. 10,000 pigs and their parents.

The test pigs originated from specially selected Duroc AI boars that were mated with LY/YL sows. Data is collected from three commercial herds with a certain prevalence of pneumonia.

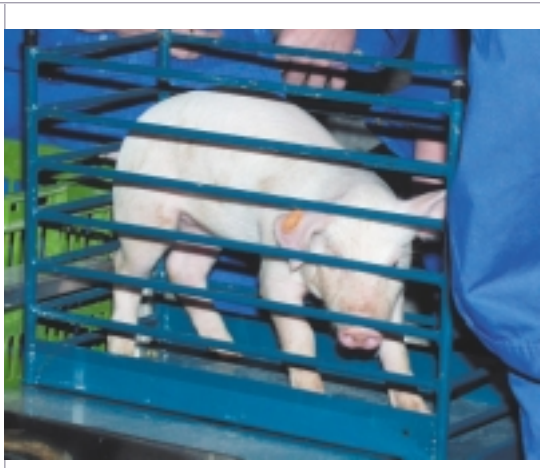
The last test pigs were slaughtered in September 2001, and the data material is subsequently analysed with the aim of discovering differences between the boars used.

The project is carried out in co-operation with the Department of Animal Breeding and Genetics of the Danish Institute of Agricultural Sciences, the Clinical Institute of the Royal Veterinary and Agricultural University, and the Veterinary Department of the National Committee for Pig Production.

Pietrain free from the halothane gene

In 1999-2001 tests were made with the aim of examining if it would be beneficial to use Pietrain that does not house the halothane gene as terminal sires in Danish pig production.

Offspring of Pietrain boars from the German breeding company ZNVG were compared to offspring of randomly selected Duroc boars and HD hybrid boars from Danish AI stations. The entire offspring were bred in a Danish commercial herd with LY/YL sows that were free from the halothane gene. The test comprised 11 Pietrain boars, 13 Duroc boars, and 11 HD boars. None HD boars housed the RN^-- gene. Each boar line produced a total of approx. 60 litters. Two castrates and two



In the project "Breeding for disease resistance", the test pigs were weighed individually at birth, weaning and on transfer to the finisher section.

female pigs from each litter were performance tested at Experimental station Jylland and slaughtered at a high slaughter weight, while the rest of the pigs were performance tested in the commercial herd and slaughtered when they reached normal slaughter weight.

The overall conclusion of the test is that the use of Pietrain boars as terminal sires does not result in any financial advan-tages in terms of production. However, the use of Pietrain may be an alternative for producers with excess space in the housing section and with problems with low meat percentage.

Compared to Duroc and HD hybrids, the Pietrain hybrid had a significantly lower daily gain that could not be compensated for by a slightly significantly higher content of meat.

There were no differences in feed conversion despite the reduced daily gain in the Pietrain pigs. Slaughter loss was low (20.2%) in the Pietrain offspring and high in the Duroc offspring (21.4%), while the HD offspring had a slaughter loss of 20.8%.

Among the pigs tested at Experimental station Jylland, the Pietrain hybrids had low pH in both loin and top round. A corre-

Table 1. Production and meat quality results for pigs tested at Experimental station Jylland and at a commercial herd

	Exp. Station Jylland (high slaughter weight)			Commercial herd (normal slaughter weight)		
	Pietrain	Duroc	HD	Pietrain	Duroc	HD
Daily gain (30-100 kg), g/day	889	987	955	783	869	856
Daily gain (30-115 kg), g/day	948	1,034	1,006	-	-	-
Feed conversion (30-100 kg), FUp/day	2.68	2.68	2.64	-	-	-
Feed conversion (30-115 kg), FUp/day	2.71	2.70	2.67	-	-	-
Age on slaughter, days	175	165	168	164	155	157
Lean meat content, %	59.5	58.1	58.7	61.8	60.6	60.7

sponding difference was only found in pH in the loin of pigs from the herd. Drip loss was almost 1% higher in the Pietrain hybrids. Table 1 shows the production results.

Breeding for longevity

A project has been initiated to examine the genetic variation in sows' longevity and the relation between assessment of conformation at 90 kg live weight and longevity, and the relation between production traits and longevity.

The test is performed in commercial herds that either buy replacement females or produce them themselves by way of KerneStyring (nucleus management in closed herds = known origin). Conformation is assessed on all the female animals when they weigh approx. 90 kg live weight, and the life production of the animals is recorded. Besides the newly transferred female animals, the sows already in the herd at the beginning of the test will also be monitored.

In three to four years, it will be possible to calculate heritability of longevity and correlation to production traits on the basis of the data recorded, and it will subsequently be possible to determine the value of assessing conformation in relation to longevity.

Sow experiment at Grønhøj

The two main purposes with the test are to establish if there are any significant differences in litter size and longevity for (YD)L, YL and zigzag sows. Young females for the three "herds" at Grønhøj originate from a purchased nucleus herd. "The herds", each with one type of sows, are constructed and renewed according to the normal renewal procedure at Grønhøj, which means that the test will run for a number of years.

Preliminary results show no differences in litter sizes between YD(L) females and YL females.

The "supersow" project

In autumn 2001, two to three herds initiate a pilot project where a number of factors related to the maternal traits of the sow are recorded in connection with farrowing and nursing. The project, which will later include all Landrace and Large White herds, is an offshoot of the latest revision of breeding objectives where focus was on the continued development of litter size. To gain full advantage of fertile sows it is obviously necessary that the sows not only give birth to, but also wean as many live pigs per litter as possible.

In this light, the project mainly focuses on vitality, birth weight and milk producing capacity.

The project is expected to comprise approx. 10,000 purebred sows from each of the two sow breeds: Landrace and Large White.

Within two to three years, the project is expected to deliver one or more new traits of breeding objectives that may balance the high increase in litter size.

Leg conformation/ osteochondrosis

As an extension of the sow experiment at Grønhøj, a project on leg conformation is carried out where Landrace, (YD)L and YL sows and young females are x-rayed and their conformation is assessed. Furthermore, in connection with the x-ray, the animals' hooves are assessed. After slaughter, leg joints from all animals that have been x-rayed and assessed are removed and subsequently examined.

The "supersow" project focuses on new possible breeding objectives that may improve the general performance of the LY/YL sow.

Research and development

This project offers the opportunity of studying the correlation between assessment of conformation and the degree of osteochondrosis in the examined animals when they are six to eight months old, and the animals' longevity. Furthermore, it provides an opportunity for studying how articular changes develop over time.

Assessment of the hooves will provide knowledge of the influence of the hooves on the sows' longevity and reasons for removal.

In the past year, 4,000 young Landrace and Large White animals have been examined according to a comprehensive conformation assessment method. The aim was to see if the conformation assessment might be made more accurate, more explanatory and more precise. Unfortunately, preliminary analyses indicate that it is not possible to improve heritability by way of this examination.

Elimination of the RN^- allele

For several years, it has been known that the Hampshire breed has a gene that is found in two versions (alleles); rn^+ and RN^-. Pigs with the genotypes RN^-rn^+ and RN^-RN^- have a relatively low pH after slaughter resulting in increased drip loss and less yield after processing. In particular the French market requests hams with a high pH, and the French settle according to pH. Thus removal of the unwanted RN^- allele is of both financial interest and of interest in terms of meat quality.
By mid-1999, the National Committee decided to remove the allele by way of selection within the Hampshire breed using DNA tests based on blood samples. At that time it was estimated that only approx. 2% of the animals in that breed were rn^+rn^+; ie. completely free from the unwanted gene. In the efforts of eliminating the gene without causing too big a loss in genetic improvement, a long-term strategy was drawn up in co-operation with the breeders that initially involved use of heterozygotes, RN^-rn^+ , and with a subsequent, gradual tightening of the demands to AI boars and breeding stock. Today, two years on, we have come a long way. The allele frequency of the desired gene has increased from 15% to 85% for the coming purebred Hampshire litters. The unwanted gene will be completely eliminated in all breeding stock born after April 2003, and boars on AI stations and sales boars are by now free from the unwanted gene.

Hernia

For the last year, in co-operation with Norwegian NorSvin, the National Committee has participated in a project aimed at establishing whether a single gene is responsible for the occurrence of hernia in pigs. The project focuses on three defects: umbilical hernia, scrotal hernia and cryptorchidism.

Norwegians believe that one single gene or a few genes code for these defects. Analyses are therefore made of DNA from family members with or without defects with the aim of discovering a useful gene marker/test. Danish breeders contribute with registrations and submission of blood from families with individuals carrying the defect. The analyses are carried out in Norway and we will subsequently gain access to use the results in Danish populations.

Revised breeding objectives

On December 11, 2000, the National Committee decided to revise the breeding objectives slightly with effect as of December 20, 2000.

The revision had very small consequences for the index and ranking of the breeding stock. Compared to previous breeding objectives, more emphasis is put on lean meat percentage and pH, less on feed conversion and daily gain, while the emphasis on the other traits is largely unchanged including also litter size.

The basis for the decision was a recalculation of the economic weightings based on updated prerequisites, including changed demands to housing sections, feed prices, etc.

Heritability of drip loss

Drip loss, the ability of the meat to retain in the meat juice, is an important meat quality trait regardless of whether the meat is used for processing or as fresh meat. Drip loss was therefore recorded in the loins of 2,686 slaughtered male pigs from Bøgildgård with the aim of determining the heritability of drip loss.

The discovered drip loss was low in Duroc (2.04 + 1.21%) and high in Hampshire (3.67 + 1.44%), while drip loss in Landrace and Large White was 3.35 + 1.68% and 2.55 + 1.30%, respectively. The high drip loss in Hampshire is not surprising as basically all Hampshire pigs contained the RN^- gene in single or double doses; this gene results in a low ultimate pH and high drip loss. However, it was surprising that drip loss in Landrace was that high – it was not significantly different from drip loss in Hampshire. It is likewise remarkable that there is such a large standard deviation in drip loss in Landrace.

Landrace:	0.063	± 0.059
Large White:	0.317	± 0.077
Duroc:	0.188	± 0.067

Due to the differences among breeds in drip loss, it was decided to calculate the heritability for each breed individually. The heritability was determined to be:
A study showed that neither the halothane gene nor the RN^- gene is found in Landrace, and this gene is therefore not the explanation of the high drip loss. Research is continued to discover the reason for the high drip loss in Landrace.

KerneStyring© (nucleus management in closed commercial herds)

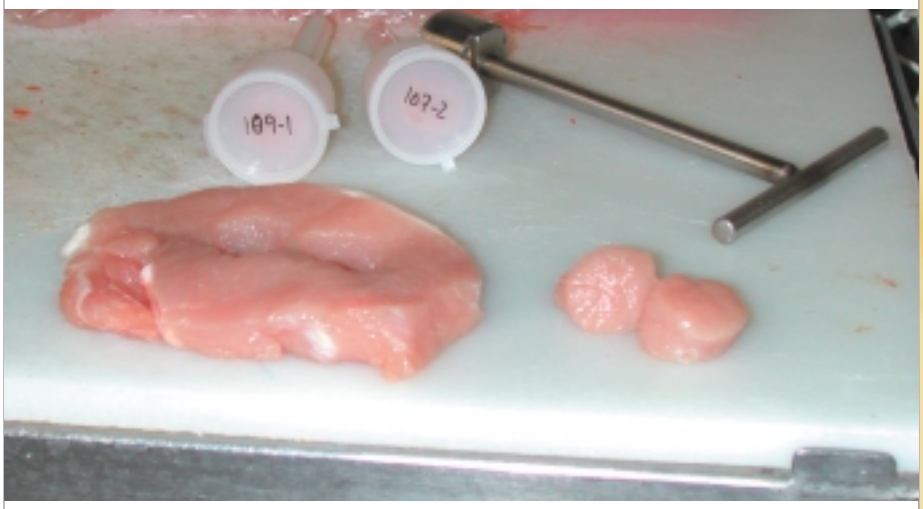
More than 250 herds with a total of approx. 100,000 commercial sows participate in the "closed herd nucleus management programme", and they constitute approx. 20% of the commercial sows in herds with in-house production of breeding stock.

In the past year, 20 herds have opted out of KerneStyring – typically after having participated for a brief period of time. The reasons for opting out are often lack of time and lack of interest in the detailed work required by KerneStyring. The herds that opt out mainly choose to switch to purchase of replacement females from multiplier herds.

Table 2 shows the index level of breeding stock in the herds producing their own replacements with the use of KerneStyring.

It can be seen in table 2 that the best of the participating herds are able to produce LY/YL- and zigzag litters with an average index level of more than 100 corresponding to the average of the multiplier herds.

Furthermore, it can be seen that the herds as such succeed in exploiting the nucleus management tool as the female animals with the highest index are used as mothers to the next generation of breeding stock.



Heritability of drip loss in loin is examined in 2,686 boars from Bøgildgård.

Table 1. The prevalence of KerneStyring©, August 2001

	Nucleus strategy	Alternating crossing strategy (zigzag)	Total
Herds, no.	110	153	263
Sows, no.	44,500	55,500	100,000
Average no. of sows	405	363	380

Table 2. Average index of breeding stock in closed commercial herds using the nucleus management programme, August 2001

	Nucleus nating		Alter-crossing strategy (zigzag)
	LL	YY	
Female animals	80	85	78
YL/LY litters: all	94	X	-
YL/LY litters: top 20	100	X	-
Zigzag litters: all	-	-	96
Zigzag litters: top 20	-	-	104
Sows used for:			
Purebred mating	96	100	-
Crossbred mating	89	92	-
Boars used for:			
Purebred mating	125	124	-
Crossbred mating	120	123	-
Sows: zigzag mating	-	-	91
Boars: zigzag mating	-	-	122

Artificial insemination (AI)

Semen sale

Overall, approx. 47% of all sows are bred by purchased semen. This figure is computed on the basis of a population of 1,200,000 sows. In 2000/2001, DanBred's AI stations sold 2,977,125 doses of semen, which is an increase of approx. 11% compared with the year before.

Dilution of semen

The durable semen diluent Androhep was tested in a recently finished study (Rep. 508). Semen collected Friday and diluted with Androhep or EDTA was compared with mixed semen from the same boars collected Monday and diluted with EDTA (control). The semen was dispatched at the same time Monday for use that same day and the day after. The reproduction results, which comprised approx. 850 litters/group, revealed no significant differences in the farrowing rate and total born piglets per litter. However, in terms of total born piglets per litter, the Androhep group tended to be lower than the control group (0.32 pigs, $p = 0.07$). On the basis of this test, it can therefore not be recommended to switch from the EDTA diluent to the Androhep diluent.

A test has been initiated in which the EDTA diluent is further developed with the aim of improving the durability of boar semen. As the sperm cells are stored in the epididymis, it is obvious to include conditions in the epididymis in this test. It is desired that the sperm cells are inactive in the diluent until use and therefore focus is on factors important to the activity of the sperm cells: pH, substrate content, ion balance and oxidation.

Antibiotics added to semen

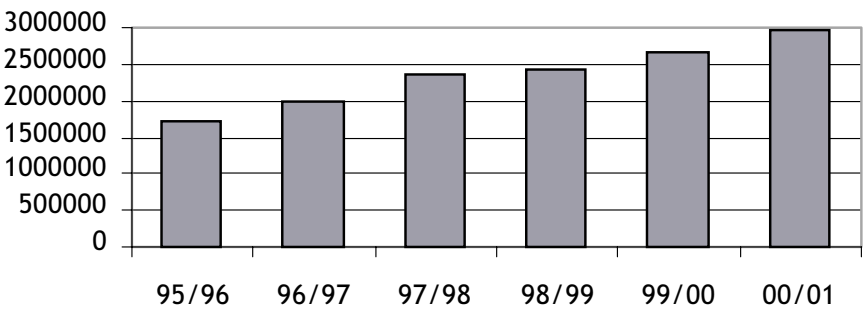
Antibiotics are added to the semen in order to reduce the risk of transfer of bacteria on sale of semen. A herd test of a combination of Amoxicillin and Gentamycin added to the semen showed no differences in the reproduction results compared with the previously used antibiotics (Rep. 496). The new antibiotics combination is also effective against Salmonella Typhimurium, DT104. The Danish Veterinary and Food Administration has authorized application of the new antibiotics combination, and it is currently employed by Danbred's AI stations. The first part of a stability test of the combination of Amoxicillin and Gentamycin is also finished (note 120). The final part of the stability test is based on aqueous solutions of the two antibiotics.

Process and storage temperatures of semen from Large White

A current test observes the temperature of semen from Large White from the time of collection at the AI station, during the dilution process, during transport to the herd and until use in the service section. The aim of the test is to establish if semen from Large White is more sensitive to temperature changes than semen from other breeds.

Hygienic control programme

The development of a hygienic control programme using the HACCP method (Hazard Analysis of Critical Control Points) is finished (Rep. 509). A total of 1,330 ejaculates were examined at DanBred's AI stations of which 2.5% contained a bacterial count of more than 300 colony formed units per ml semen. The upper contamination limit was set to be 300 colony formed units per ml semen. At the same time, an increase in the bacterial count was seen over time indicating the development of resistance



Semen sale the last six years from DanBred's AI stations (no. of doses)

in one of 100 samples. The introduction of a new antibiotics combination as addition to the semen is expected to reduce these counts significantly.

Age and concentration of semen

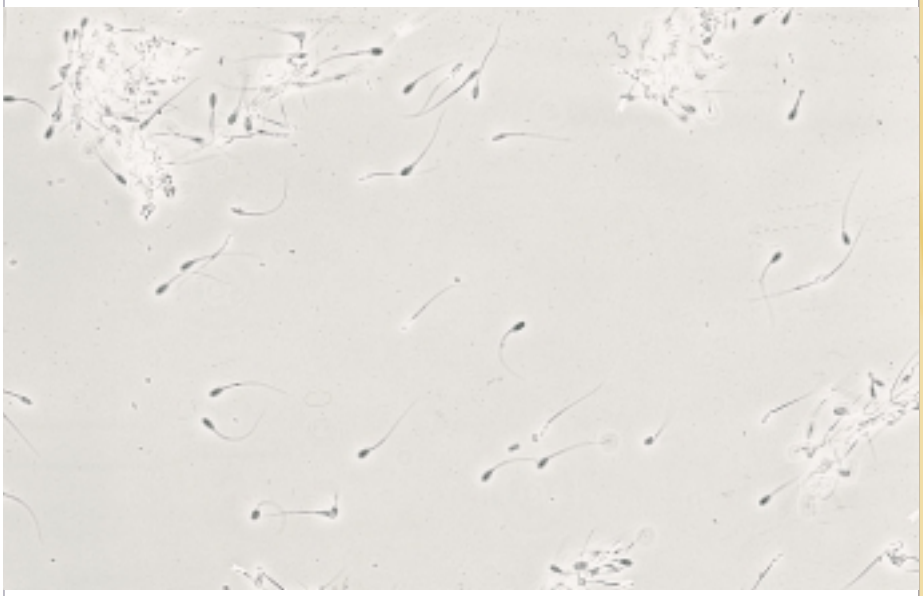
A test (Rep. 515) showed that semen doses with 1.8 billion progressive motile sperm cells that were stored for two days yielded the same reproduction results as fresh semen with 2.2 billion or doses with 3.6 billion progressive motile sperm cells. Doses with 3.6 billion progressive motile sperm cells yielded a smaller litter size. This indicates that the EDTA diluent might not be able to nourish a high number of sperm cells. This is relevant information when using on-farm AI where high concentrations of sperm cells are often used, and emphasizes that semen collected in the herd should be used that same day.

On-farm AI versus purchased semen

A current test examines if the reproduction results, expressed as total born piglets per litter and the farrowing rate, are affected by using semen produced in the herd compared with semen produced at an AI station. The test will be finished in 2002.

Determination of concentration and vitality of sperm cells

A new method for determination of the concentration of sperm cells has been developed in co-operation with the Royal Veterinary and Agricultural University and the Federation of Danish A.I. Societies supported by the Directorate for Food, Fisheries and Agro Business (Rep.514). The method is based on dying the sperm cells and on a flow cytometric determination. This method also enables a determination of the number of "live" sperm cells. Preliminary results show a correlation to total born pigs per litter of 0.04 pigs per percent vitality. However, this difference is too small to be of any practical and economic importance.



Sperm cells seen through a microscope.
The sperm cells have located around gel particles in the ejaculate.

New techniques

A technique for congelation of boar semen is being further developed. The aim is to be able to store semen doses for a long period of time and achieve reproduction results equal to those achieved when using fresh semen. However, it should be expected that the concentration of sperm cells in frozen semen per dose must be significantly higher than the present two billion for fresh semen.

In the long term, a technique in which the semen is led to the uterus will change the current use of AI. So far, this technique involves leading a catheter through the traditional catheter and on through the cervix. Apparently, this will halve the need for sperm cells in a semen dose. A plastic tube that can be led further up through the uterus horn is being developed, and will further reduce the need for semen. These methods will only be of limited interest to traditional AI, but to those using frozen semen or after sorting the sperm cells according to gender, the new methods are of great potential. It cannot be recommended to use the catheters currently on the market as the risk of injuring the sows is too high.

The experiences with the new insemination catheters will be used in the transfer of embryos so that in future this can be done on sows that are not anaesthetised. A useful technique has yet to be developed.

Stress as a consequence of housing and its effect on reproduction

A test has been initiated in co-operation with the Swedish University of Agricultural Sciences in Uppsala, supported by Norma & Frode Jacobsen's Fund. The primary aim is to study stress-related influences on the sows' reproduction results when they are housed individually in pens as opposed to stalls.

Feeding group-housed, gestant sows

Feeding principles or diets that increase the feeling of satiety for a long period of time influence the sows' welfare and perhaps also the productivity. Different types of ad libitum feeding are currently being studied in two tests.

Restrictive feeding and free access to roughage

In this test, the sows in the test group are given a basic ration of sow feed, approx. 1.6 FUp by way of an electronic feed station. Furthermore, the sows have free access to roughage in the form of pectin feed. The sows also have free access to straw as the lying area is bedded with straw. The sows in the control group are fed restrictively according to body condition by way of electronic feed stations. The sows in both groups are housed in a pen with approx. 120 pen places and three feed stations.

Preliminary results show no differences between the two groups in the sows' reproduction ability or longevity. The sows that have free access to feed are calmer and the consumption of straw is halved.

Free access to dry feed

In another test the effect is being studied of feeding gestant sows ad libitum with a high-fibre diet (dry feed). The sows in the test group are given the feed by way of dispensers. There is a maximum of ten sows per dispenser. The sows in the control group are fed restrictively with a normal gestation diet.

Preliminary results show no significant differences between the two feeding principles in terms of reproduction results or the sows' longevity. The sows that are fed ad libitum are calmer and less aggressive than the sows fed restrictively.

Even though the diets used for ad libitum feeding are composed from feedstuffs that increase the feeling of satiety over a long period of time, this has not reduced the sows' feed intake and thereby their gain.

Table 1. Digested and excreted macro nutrients (g/day) when using control feed (normal gestation feed) or test feed (gestation feed with 60% dried beet pulp (Pulpetter), among other things)

	Digested			Excreted through manure		
	Control	Test	P value	Control	Test	P value
Organic matter	1532	1489	0.0001	288	368	0.0001
Protein	227	220	0.09	58	108	0.0001
Fat	91	39	0.0001	36	43	0.003
Starch	939	335	0.0001	s	s	-
NSP	163	615	0.0001	99	102	0.08

Digestibility of a high-fibre diet

Together with the Danish Institute of Agricultural Sciences a digestibility test has been carried out with high-fibre, satiety enhancing diets that contain 60% dried beet pulp (Rep. 525), among other things.

The test showed that the digestibility of soluble fibres in the form of pectin-rich components was very high.

The composition of the feed greatly influenced the excretion of undigested nutrients. Both the total amount of organic matter and the excretion of protein were significantly higher when feeding with the test feed compared with the control feed. This resulted in an excretion of protein that was twice as high for the test diet as for the control diet.

The restrictions on the excretion of nitrogen may make it difficult to use behaviourally regulating diets that contain large amounts of dried beet pulp. In herds where normal gestation feed is used, the sows are sometimes given more feed than they need as that may reduce the activity and aggression levels. However, the additional feed will also increase the excretion of nitrogen. On selection of the composition of the ingredients and of feeding strategy, it is important to take into consideration the welfare of the sows.

Pectin feed is given to the pigs by way of dispensers. The sows have free access to the dispensers and thereby to the pectin feed.

Managing the body condition of sows

Feeding in the gestation period must ensure that the sows have the right body condition. As the sows' appetite and feed conversion vary, feeding according to body condition can only be practised in systems with individual feeding. Feeding appropriately and thereby managing the body condition is important for the feed consumption, the farrowing rate, the number of piglets born and to the birth weight of the litter.

During ovulation, 16-18 eggs are shed in gilts, and 20-28 eggs in sows, but considerably fewer piglets are actually born. The difference in the number of eggs shed and piglets born may be due to absent fertilization, but is in particular due to a high embryo mortality in the early gestation period. Embryo mortality within the first three to four weeks of the gestation period averages approx. 40% of the fertilized eggs.

The high mortality is caused by the fact that the uterus houses embryos at different stages of development, and the uterus mucosa excretes hormones, proteins and minerals that kill the least developed embryos. If one uses a feed dose that ensures that the sow has a slightly positive energy balance during the first three to four weeks of the gestation period, a smaller difference is expected in the development of the embryos, which reduces the embryo mortality. Thus, a test showed that sows may be given up to 3.0 FUp a day the first four weeks after service without affecting the litter size.

From four weeks after service and until two to three days before farrowing, the sow is fed according to body condition. However, the feed dose must be increased slightly the last four weeks before farrowing in order to meet the need for energy required for embryo growth. The last two to three days before farrowing, the feed dose is decreased to approx. 2.5 FUp daily to encounter as few problems as possible during farrowing.

Feeding according to body condition is normally managed by a visual assessment of the body condition. However, a study showed a poor relation between the scanning of the sows' back fat and the visual assessment of their body condition. Scanning is a fairly objective way of assessing the body condition. A future test will decide if it is practically relevant to manage feeding of the individual sow on the basis of a scanning. Problems with visual assessment of the body condition are partly the differences in physique in young and old sows and partly differences in breeds. Furthermore, the visual assessment is easily affected by the body condition of the other animals in the herd.

A transverse computation showed a positive relation between total born piglets per litter and gain in the gestation period, as shown in figure 1. This means that gestant sows must achieve the gain stipulated by the very gestation and the age in order to be able to produce as much as possible, as shown in figure 2. Thus, there is no effect on total born piglets per litter by increasing the gain in full-grown sows. On the basis of this computation, it is not possible to point out certain periods of the gestation period when the gain is more critical, but this will be established in future tests.

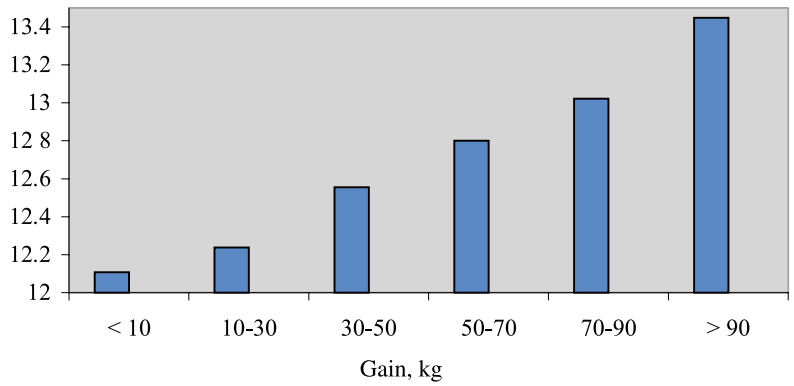


Figure 1. Total born piglets/litter

Figure 2. Total born piglets/litter

The farrowing section

Weaning uniform, large and healthy pigs require a good organisation of the work in the farrowing section. A number of routines are already incorporated, but increased demands for efficiency require still more knowledge.

Adjusting the litter size

In one herd, gilt litters were divided into two groups. In one group, the smallest piglets were moved from the gilt to a sow that had farrowed at the same time and were replaced by medium-sized piglets from the sow. In the other group, piglets were only moved if there were more than 11 piglets in the gilt litter, and in that case, the large piglets were moved from the gilt. In both groups, medium-sized piglets were moved to the gilts if necessary to achieve 11 piglets per litter. These two strategies yielded the same results and overall there were no differences between the groups in mortality or gain. There was a slightly higher mortality among the small piglets that were moved to sows compared with the small piglets that stayed with the gilts. In that same group there was also a slightly poorer gain in the piglets that remained with the sows as they were forced towards the poorest teats by the transferred, medium-sized piglets. The conclusion of this test is that the piglets should be moved as little as possible and that variations in size in the individual litters are of no importance.

Number of piglets with the sow

Traditionally, each sow has ten to eleven pigs. The national average is 12 live born pigs per year sow and it is therefore relevant to know if the sows are able to handle more piglets. The sufficient number of teats is available, but is the milk producing capacity sufficient and is there enough room around by the equipment?

In two herds with a high litter size, the effect of 11 or 13 piglets per litter after litter equalization is being tested. When the equalization is complete, the piglets in both groups are tended alike and runts are moved to nursing sows in both groups. Preliminary results from one herd indicate that many sows are able to handle 13 piglets, that the weight at weaning and the mortality appear to be identical in the groups, and that the need for room for nursing sows was reduced by having 13 piglets in each litter.

Sow feed

The effect of changing the acid/base balance in feed for nursing sows was studied in two herds. The feed had become more "acid" as the amount of chlorine and sulphur was increased resulting in a reduction of pH in the urine. Apparently, this change did not affect the sows' feed intake in the nursing period nor did it have any positive effect on the sows' production results in the farrowing section. Therefore, there does not seem to be any gain in terms of production by affecting the acid/base balance in the nursing feed.

Table 1: 11 or 13 piglets nursing with the sow

Pigs with the sow after farrowing	11	13
Piglets dead by day 4	10.9	12.1
Piglets dead before weaning	1.1	1.3
Weaned/litter	11.3	11.7
Weaning weight	8.1	8.1
Nursing sows, %	16	9

Data from one herd with a total of 14.1 piglets born per litter

Segregation of dry feed

When the content of nutrients such as minerals, in the feed is reduced to a level close to the pigs' requirement it is even more important that those nutrients are homogeneously distributed in the feed. If the nutrients are not homogeneously distributed in the feed due to lack of accuracy when mixing or due to segregation in the transport system, there is a risk of poor utilization of the nutrients (over-supply) or of reduced productivity due to under-supply.

Segregation of dry feed in pipelines

The risk of segregation of dry feed was tested in 42 herds that used home-mixed meal feed, purchased pelleted feed or feed that may reduce Salmonella consisting of approx. 25% coarsely ground grain and approx. 75% pelleted feed (Experience no. 0011).

There was a significantly higher risk of segregation in meal feed and feed that may reduce Salmonella compared with pel-leted feed. For meal feed, the greatest risk of segregation of minerals and protein was in pipeline systems with a pipe di-ameter of 38 and 48 mm.

There were no significant problems with segregation in pelleted feed; however, there were great differences in the content of dust (crushed pellets) in the dispensers. The first dispenser on the pipeline contained 34% dust, while there was 13% and 21% dust in the silo and the last dispenser, respectively. There were no differences between the pipe diameters in terms of the amount of dust. Large amounts of dust did not affect the risk of segregation of minerals and protein when using pelleted feed.

Mixing of dry feed

The homogeneity during the mixing of the dry feed was tested in eight herds (Report no. 512). Liquid mineral premixes (AquaBlend, Svin and CalciNa) were compared with dry mineral diets. In four herds, the feed was mixed in horizontal mixers, and the remaining herds used diagonal mixers.

In the herds, two to three charts were made of the dry feed or the liquid mineral diet/pre-mix, respectively. From each chart, 12 feed samples were collected, and a total of 196 feed samples were analysed.

The analysis results revealed that with both types of mineral diets/pre-mixes it is possible to achieve a satisfactory homogeneity and thereby accuracy when mixing. However, the best homogeneity was achieved with liquid mineral diets. The homogeneity for crude ashes, calcium and copper was significantly higher ($p<0.001$) in feed to which liquid mineral premixes were added than in feed to which dry mineral diets were added. In all herds, a higher homogeneity was found for phosphorus when using liquid mineral premixes, but the difference was not significant. There were no significant differences in zinc between the different types of mineral diets.

The content of water in the feed was increased by an average of 2.7 percentage units when using liquid mineral premixes and liquid vitamins and amino acids. This is of no practical importance if feed is produced for a maximum of three days at a time.

The use of liquid premixes with e.g. minerals requires authorisation from the Danish Plant Directorate even if you are already authorized to use home-mixed feed.

A future test will determine whether the use of liquid mineral premixes can reduce the risk of segregation of minerals and added amino acids.

Further tests will determine how small amounts of any given additive may be added and mixed into a homogeneous diet in a dry mixer.

The liquid mineral premixes were sprayed onto the feed while in the dry mixer.

The mix time was identical whether feed was mixed with dry mineral diets or liquid mineral premixes.

Feeding weaners

Glutamic acid and threonine

The effect of additional glutamic acid (+50%) and additional threonine (+20%) for weaners was studied.

Glutamic acid is a non-essential amino acid and one of the primary energy sources in the intestines. It constitutes approx. 20% of the crude protein content in a typical weaner diet. In case of diarrhoea, the digestibility of the feed protein will be reduced (= less glutamic acid) and it is possible that the intestinal cells thereby do not receive enough energy and are consequently lost.

Weaners suffering from diarrhoea probably have a higher requirement for threonine (essential amino acid) than healthy pigs do. When a pig suffers from diarrhoea, the intestinal mucosa's excretion of mucins increases (with a high content of threonine) resulting in a higher consumption of threonine.

The test showed that allocation of additional glutamic acid and threonine yielded a significantly higher production value than in the control block. There were no differences in the frequency of diarrhoea treatments, the manure texture or the content of dry matter in the manure between the groups. In this test it was not possible to establish whether the increased productivity was caused by the glutamic acid, threonine or the combination of the two amino acids. Future tests will determine the effect of changing the dosing of threonine and glutamic acid.

One possible explanation of the increase in productivity could be that pigs given additional glutamic acid and threonine easily regenerate damaged intestinal tissue. A fast regeneration of the intestinal tissue enables the pig to exploit the feed better and it will start growing soon after e.g. outbreaks of diarrhoea.

Glutamic acid is expensive and it is therefore not realistic to add 50% extra to the feed.

Formi™

The product Formi™ was recently approved as a growth promoter. Addition of the acid product was tested in one herd with many outbreaks of diarrhoea and a low productivity. The effect of Formi™ was compared to using an antibiotic growth promoter (AGP) (Avilamycin).

The test revealed that the pigs given Formi™ had significantly fewer treatments for diarrhoea compared with the pigs given an AGP. However, the level of treatments was still higher among the pigs given Avilamycin. Furthermore, the pigs given Formi™ tended to have a lower production value.

Overall, the test showed that Formi™ did not result in the same levels of health and productivity as an AGP (Avilamycin). Thus in a herd with many problems, more measures are needed to eliminate the health problems.

Commercial products

The National Committee for Pig Production has carried out many tests of commercial products for weaners in the past years. As the market teems with products, it is difficult to discover which products have a positive effect. In the past year, 24 tests were carried out of products and products in varying doses for weaners. The results are shown in table 1.

Four products for weaners tended to have a positive effect on the production value: formic acid showed the best effect on the productivity. NuPro, which is a yeast extract, and beet pectin also tended to improve the production value. None of the tested products had any effect on the frequency of diarrhoea. Addition of citrus pectin with a high degree of methylation affected the production value negatively.

Brewer's yeast in water

Addition of brewer's yeast to drinking water was tested. The dose was adjusted so that it corresponded to the pigs getting 10% brewer's yeast with a dry matter content of 15% in the water. There were no effects on the productivity or the frequency of diseases. Therefore, on the basis of this, it cannot be recommended to add brewer's yeast to drinking water to weaners.

Commercial diets

In the spring, two tests were made of commercial diets for weaners. In the first test, the diets were selected in Northern Jutland. The diet from PP Hedegaard yielded a significantly higher production value than the diets from control and DLG and KFK. Likewise, there was a tendency ($p = 0.07$) towards an improved production value for the diet from PP Hedegaard compared with the diet from ØAG (Rep. 524). The test resulted in the following index based on the production value (four to ten weeks):

Control: . . . . . .100 (b)
Minigris L3/Maxigris L6 from
PP Hedegaard: . . . . . .115 (a)
Hurtigstart/Prolet S from
KFK: . . . . . .99 (b)
Starline 6, 9 16 from
DLG: 98 (b)
Minette/Multigris from
ØAG: . . . . . .102 (b)

(Different letter = significantly different production value)

The Starline mixes from DLG were given to the pigs in the following weight intervals: Starline 6: 6-9.5 kg; Starline 9: 9.5-16.5 kg; and Starline 16: 16.5 kg to ten weeks.

In the second test, commercial diets were selected in Eastern Jutland. Here, the diet from DLG yielded a significantly better result than the other diets (Rep. 527). The test resulted in the following index based on the production value (four to ten weeks):

Control: . . . . . .100 (b)
Markant start/Acid start from
Hornshyld Købmandsgaard: . . .102 (b)
Organica Avanti/Organica Santi from
KFK: . . . . . .98 (b)
Minifiber/Aminostart from
Aarhusegnens Andel: . . . . . .106 (b)
Grisette Acid FI/Prima 9 Acid FI from
DLG: . . . . . .117 (a)

(Different letter = significantly different production value)

Table 1. Commercial product tested for weaners during the last year.

Company	Name of product	Type of product	Dosage 1)	Index based on 5 years' prices (95-00)	Report
Helm Skandinavien A/S	HSK 2000	Mixed acid	1.2/0.6%	102	492
			1.2/1.2%	102	
			1.8/1.2%	93	
APC	AP820	Blood plasma 2)	5.0/0%	98	497
Bidana Agro	Orega Rom	Plant extract	2.5/1.25%	108	497
Orffa Danmark	Vepro 75 PSCF og Makrogard/ Enteroguard	Blood plasma 2) Beta-glucan/Allicin and cinnamon oil	4% and 250 ppm/0.05%	102	497
	Vepro 75 BC og Makrogard/ Enteroguard	Blood plasma 2) Beta-glucan/Allicin and cinnamon oil	4% and 250 ppm/0.05%	107	497
Axiss France S.A.S.	XTRACT TM Pig Starter 6950	Aromatic	200/200 g/tonne	98	519
		Aromatic	400/400g/tonne	102	
	XTRACT TM Pig Starter 6950 og Formic acid	Aromatic and Aromatic and acid (85%)	200 g/tonne and 0.35%/200 g/tonne and 0.35%	105	519
	Formic acid	acic (85%)	0.70%/0.70%	109*	519
Hamlet Protein	HP300	Soy protein 3)	10/0%	90	520
	HP730	Soy protein and pectin 3)	10/0%	98	520
NLM Combineering	Brewer's yeast from Novo Nordisk	Brewer's yeast in drinking water	10% with 15% DM	105	523
CP Kelco Aps	Pektin DM 80	Citrus pectin High	3.2/1.6%	88***neg.	501
	Pektin DM 60	methylation	3.2/1.6%	93	501
	Pektin DM 80		0.8/0.8%	91***neg.	501
	Pektin DM 45	Citrus pectin	3.2/1.6%	104	501
		Medium	3.2/1.6%	105	
		methylation	1.6/1.6%	104	
	Pektin Ca+	Citrus pectin High methylation Not-Ca sensitive	3.2/1.6%	98	501
	Pektin Ca-	Citrus pectin High methylation Not-Ca sensitive	3.2/1.6%	102	501
	Roepektin	Beet pectin	3.2/1.6%	110*	501
Alltech	Nupro 2000 4)	Yeast extract	2.5/2.5%	105*	526

1) When stating two doses, the first figure states the dose in Diet 1 (4-6 weeks of age) and the second one states the dose in Diet 2 (6-10 weeks of age).
2) Blood plasma used as a replacement for fish meal and soybean. In accordance with the EU, as of January 1, 2001 it is no longer allowed to use blood plasma in feed due to BSE.
3) HP300 and HP730 replaced soybean.
4) NuPro replaced fish meal and whey powder, primarily.

The effect on the production value is compared with control in the list.

** = Tendency*

*** = Significant difference*

Index values can only be compared within the same test.

Feeding finishers

Fermented liquid feed

A previous test of fermented liquid feed for weaners showed that synthetic amino acids are decomposed during the fermentation process (Rep. 510). When fermenting liquid feed, it is therefore important that the synthetic amino acids are added after fermentation. This requires two liquid feed tanks as one tank is used for fermentation of e.g. grain and the other for adding e.g. a mineral diet containing synthetic amino acids.

Fermented grain

A test was made of fermented grain in liquid feed for heavy pigs. The grain consisting of a barley/wheat ratio of 1:5 was mixed with water that was heated to approx. 25-30°C, and fermented in a fermentation tank. Grain and water were added to the fermentation tank once daily, and there was a residue in the tank of approx. 50% of the daily consumption. pH in the fermented grain was approx. 3.6. The fermented grain was mixed with the other feed components in a separate mix tank immediately before each feeding.

Table 1 shows the production results. Both gain and feed conversion were improved when fermented grain was used, but the lean meat percentage was reduced. The production value calculated on the basis of the production results was significantly improved when fermented liquid grain was used. Thus, the results of this test show that in terms of cost-effectiveness it may be beneficial to ferment the grain in a liquid feeding system.

Lawsonia

Fermented grain has a positive effect on the microbial ecosystem in the gastrointestinal tract. It is therefore being studied if liquid feed with fermented grain can reduce the prevalence of Lawsonia the first six weeks after transfer to the finisher section. The results are shown in figure 1. Two weeks after transfer to the finisher section there was a high prevalence of Lawsonia, but there was no difference between the groups. Six weeks after transfer, there was a tendency that the pigs given fermented grain in liquid feed had a lower prevalence of Lawsonia than pigs given not-fermented grain in the liquid feed.

Reducing ammonia evaporation and odour by way of feed

It is important to establish that problems with ammonia and odour are not necessarily related. Put simply, the ammonia primarily originates from N in urine, while the most important odour components are said to be short-chained fatty acids, phenol combinations and indole combinations that are in or liberated from faeces. According to our knowledge today, the reduction of nitrogen content in slurry is connected to the reduction of odour from slurry.

Improved feed conversion

All other factors being equal, an improvement in feed conversion from the present, national average of 2.9 FUp/kg gain to 2.5 FUp/kg gain will reduce the ammonia evaporation by 22%. For instance, the use of pelleted feed versus meal feed re-duces the ammonia evaporation by approx. 3-9% (the most with dry feed) as the feed conversion is better in pelleted feed.

Reduced surplus of nitrogen in feed

Foreign studies show that 1 gram less of digestible crude protein in the feed per FUp reduces the ammonia evaporation by 1 percentage unit for the feed in the interval 135 to 105 g digestible crude protein per FUp. A large reduction in the crude protein content requires a high addition of free amino acids, which greatly increases the price of feed. Report no. 467 shows that it costs 0.4 meat percentage units/10 g reduction in digestible crude protein in the interval 130 g to 110 g/FUp, but we still need more knowledge of standards for all essential amino acids and of the effect on the production results when reducing the crude protein level.

Table 1. Production results when fermented grain is used for heavy pigs (25-120 kg)

	Not-fermented grain in liquid feed	Fermented grain in liquid feed
Daily gain, g	921	958
FUp/kg gain	2.60	2.46
Lean meat %	58.5	58.0
Production value, index	100a	111b

A; b: significant difference

Reducing pH in slurry

A cheap alternative is to reduce pH in the slurry and thereby the liberation of ammonia from this. This can, for example, be done by using other sources of calcium than calcium carbonate (chalk). Tests have been made of calcium formate and calcium chloride as replacements for chalk in finisher feed. Calcium formate did not have a measurable effect on the pH of the slurry (figure 2), but did result in an improved feed conversion in finishers given pelleted feed. Calcium chloride reduced pH in urine and slurry (figure 3) to a level, which according to Dutch studies corresponds to a 30% reduction of the ammonia evaporation. However, calcium chloride also reduced daily gain by 34 g due to a reduced feed intake. According to the same Dutch studies, calcium benzoate will reduce ammonia evaporation by 50%, but this substance is not allowed in pig feed. It is used as a preservative in human nutrition.

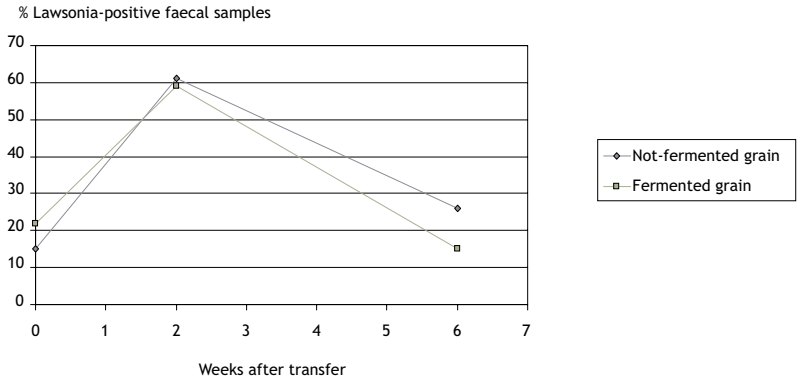


Figure 1. There was a tendency to reduced prevalence of Lawsonia six weeks after transfer to the finisher section in pigs fed fermented grain.

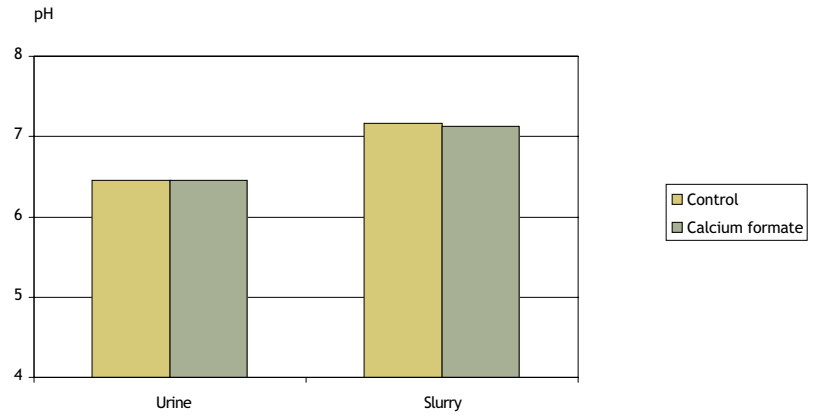


Figure 2. Calcium formate in feed did not have a measurable effect on pH in urine and slurry.

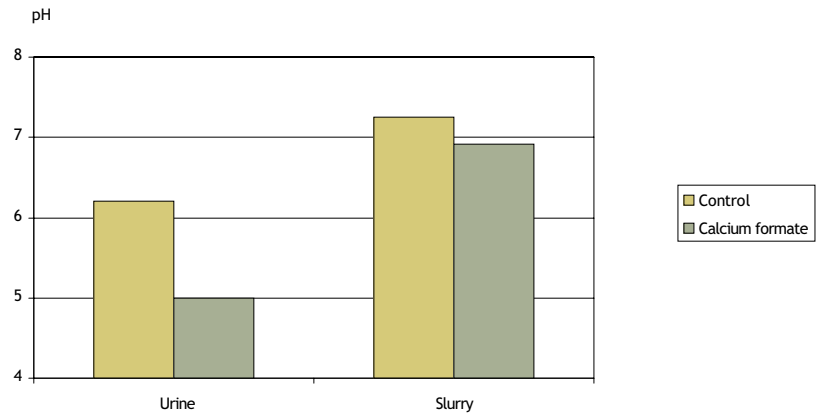


Figure 3. Calcium chloride in feed reduced pH in both urine and slurry.

New feed assessment system

The present feed assessment system for pigs is more than 25 years old and does not take into consideration the newest knowledge on the digestibility of amino acids nor is it suitable for formulating environmentally correct diets with a low pro-tein content. The Danish Institute of Agricultural Sciences and the National Committee for Pig Production have toget-her developed a new feed assessment system that will be introduced in the summer 2002.

Essence of the new system

1. A new analysis is introduced that together with the analysis of enzyme-digestible organic matter facilitates a division of the feed into what is dige sted in the small intestine and what is fermented in the large intestine where the last faction is of lower value to the pigs.
2. The energy factor for the individual nutrients is changed so that they cor respond to "the physiological energy value" of the nutrients. This is the amount of energy available to the pigs for growing when adjustment has been made for the losses in metabolism in the body. This results in a drastic devaluation of high-protein feedstuffs and a revaluation of fat and feedstuffs rich on starch.
3. In future, amino acids digested in the small intestine are each assigned their own digestibility. In the present system, the digestibility of the indivi dual amino acids is alone defined by a table value of the protein digestibility.
4. New standards for amino acids adjus ted to the new system will be introdu ced.
5. There will be a division into two energy values for each feedstuff; one value for growing pigs and lactating sows (FUgr) and one value for gestant sows (FUso). The practical consequen ce of this is that feedstuffs that are difficult to digest are assigned a hig her value for gestant sows than for growing pigs.
6. A conversion factor is used so that average feed contains the same num ber of new feed units as it did of old FUp. It is thereby possible to use the same feed graphs as today.

New calculation of animal units

Pursuant to environmental regulations applying since December 18, 1998, the regulations for calculating the number of animal units in a pig production will be changed as of August 1, 2002.

A work group managed by the Danish Institute of Agricultural Sciences has reassessed the standards for the content of nutrients in livestock manure, which may be used for revising the calculation regulations.

This reassessment has updated the standards for the amount of nitrogen (N), phosphorus (P) and potassium (K) in manure from the most common productions and housing systems. Table 1, p. 25, shows the new standards for housing systems with partially slatted floors. The standards formed the basis of the proposal from the Danish National Forest and Nature Agency for revision of the conversion factors when calculating the number of animal units.

Table 2 shows the proposal for conversion factors expected to be included in the current revision of the environmental regulations.

Increased harmony area for sow herds
The proposed conversion factors result in a requirement of an increase of 30% of the agricultural area available for utilization of the nutrients in livestock manure from sow herds as of August 1, 2002. This results in a 5% reduction in space requirement for manure from weaners and largely the same space requirements for manure from finishers.

Table 3 shows productions that constitute 250 animal units with the presently applying factors and the proposed, new con-version factors. Here is also shown the amount of N and P in livestock manure ex slurry tank/hectare harmony area together with the standards applying so far for nutrients in livestock manure and with the revised standards expected to be included in the manure accounts for the manure year 2001-2002.
The results of the new standards and conversion factors for a housing section

Table 1. Examples of feedstuffs' energy value/kg dry matter in the new and the old feed assessment systems.

	New energy values		Old value
Feedstuff	FUgr	FUso	FUp
Barley	1.24	1.24	1.15
Wheat	1.38	1.35	1.28
Soybean meal	1.01	1.04	1.30
Wheat bran	0.76	0.82	0.71
Beet pellets	0.63	0.78	1.05
Pig fat	3.87	3.10	2.8-3.4**

** Depends on the organic enzyme-digestible organic matter value of the diet.

Animal units and harmony area

with partially slatted floor is an amount of nitrogen of approx. 140 kg N per ha and a phosphorus amount of 37-44 kg P per ha for 1.4 animal units per ha.

Reduction of phosphorus

The amount of phosphorus is problematic during complete fertilization with livestock manure over a number of years. It is estimated that regular crops on pig herds take in 20-25 kg phosphorus per ha annually.

The content of phosphorus in manure from pig production may be reduced by way of one of the following methods:

- Addition of phytase to the feed so that the animals' digestion of the feed's natural content of phosphorus is increased. This method requires installation of additional equipment and additional use of phytase in the feedstuff plants. It is estimated that the costs for installation and addition of phytase break even with the savings on an improved utilisation of the content of phosphorus in the feedstuffs.
- Replacement of phosphorus in mineral supplements that is difficult to digest by highly digestible phosphorus. It is estimated that this method involves limited additional costs for highly digestible phosphorus sources.
- Introduction of phase feeding where the diet for the individual groups of animals in the herd is adjusted to the present requirement for phosphorus. The method requires increased costs for establishment and management of feed systems for handling e.g. twice the usual amount of diets in the individual herds.

The proposed conversion factors etc. were subject to a public hearing in July and August 2001. The new regulations are expected to take effect as of August 1, 2002.

Table 1. Standards for nutrients in manure ex slurry tank and ex animal in pig herds with partially slatted floors.

Animal	Housing	Unit	Amount, kg Ex animal			Ex slurry tank		
			N	P	K	N	P	K
Gestant sows	Part. slatted floor	1 year sow*	26.6	7.31	8.89	16.43	5.11	6.22
Farrowing section	Part. slatted floor	1 year sow*				7.04	2.19	2.67
Weaners (7.2 -30 kg)	Controlled environment unit, part. slatted floor	1 weaner	0.64	0.18	0.28	0.57	0.18	0.29
Finishers (30-100 kg)	Part. slatted floor	1 finisher	3.15	0.72	1.26	2.73	0.73	1.29

* Manure from one year sow is the sum of the contribution from gestant sows and from the farrowing section.

Included in the calculation is 1,340 FUp per sow annually, 2.06 FUp/kg gain for weaners, and 2.88 FUp/kg gain for finishers. Included is also 23.2 weaners/sow annually weaned at 4 weeks, 7.2 kg.

Table 2. Conversion factors for calculation of animal units

Animal	Unit	Animals for one animal unit
Sows with weaners for weaning (4 weeks, 7.2 kg)	1 year sow	4.3
Weaners, weaning until 30 kg	1 produced animal	175
Finishers, 30-100 kg	1 produced animal	36

Proposal from the National Forest and Nature Agency, July 2001

Table 3. 250 animal units (AU) for sows, weaners, finishers and integrated production. Harmony area, ha and N and P stated in kg.

	Animals for 250 AU		Harmony area, ha		Kg N/ha		Kg P/ha	
	Today	1/8-2002	Today	1/8-2002	Today*	1/8-2002	Today*	2002
Year sows with weaners for weaning	1,150	1,075	147	179	169	141	55	44
Weaners 7.2-30 kg	34,000	43,750	147	179	132	139	44	44
Finishers 30-100 kg	7,500	9,000	147	179	139	137	35	37
Year sows with pigs up to 30 kg	660	687	147	179	153	140	50	44
Year sows with finishers up to 100 kg	225	249	147	179	144	138	40	39

** Standards from report no. 736, 1997 from the Danish Institute of Agricultural Sciences (22 pigs per sow per year, slaughter weight 98 kg). As of August 2002: standards from Revision of standards for livestock manure. The Danish Institute of Agricultural Sciences May 2001 (23 pigs per sow annually, slaughter weight 100 kg).*

External environment

The National Committee for Pig Production endeavours to develop methods for reducing odour and ammonia emissions from housing sections. Reduction of manure surfaces is one the most important effort areas in reducing ammonia and odour emissions. Furthermore, research is being done in the development methods for purifying the outlet air from housing sections.

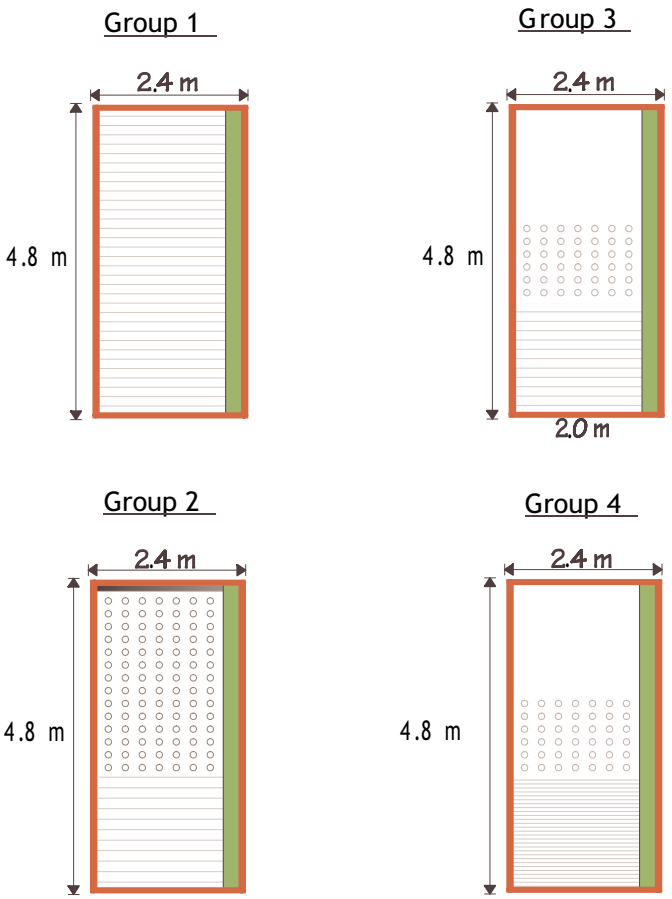
Slurry system with v-shaped containers

V-shaped slurry channels from the company Oranje Beton were compared with traditionally designed slurry channels in a finisher herd with pens with partially slatted floor. In the test period, the slurry channels were emptied on Fridays and the concentration of ammonia in the housing section was measured the following Tuesday.

The pilot test concluded that

- The slurry surface was reduced from 1.4 m to 0.6 m across.
- The ammonia concentration was 16% lower in the sections with v-shaped slurry containers.
- There was no accumulation of manu re on the sloping edges in the v-sha ped slurry containers.

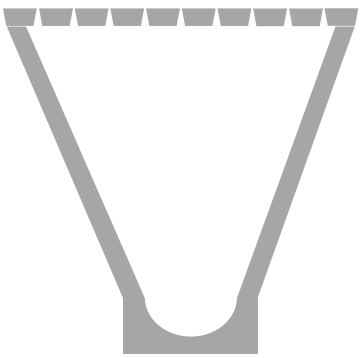
In order to fully utilise the potential in v-shaped slurry channels, frequent emptying of slurry is required in order to reduce the slurry surface as much as possible. Thus, the pilot test is followed by a new test with automatic daily emptying. Hereby the slurry surface is further reduced, which reduce ammonia and odour emissions substantially.



Floor profiles in finisher sections

In a finisher herd that employ restrictive liquid feeding, four different floor profiles, all in which the entire space beneath functioned as slurry channel, were compared in order to assess the ammonia emission from the housing section.

Contrary to expectation, no differences were found between the four floor profiles. This was probably due to the fact that the entire area beneath all floor profiles functioned as slurry channel, which explains why the slurry surface was not reduced.



V-shaped slurry channel reduces the slurry's surface and thereby the ammonia emission.

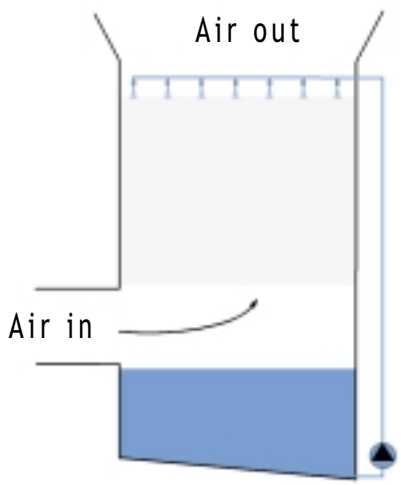
Purification of outlet air

One way to reduce odour from housing sections and thereby also reduce odour immission at nearby dwellings is to purify the outlet air from the housing sections.

Several methods may be used for purifying the air depending on the amount and composition of pollution. However, most of these methods are not appropriate for purifying the air from housing sections as they are associated with unrealistically high costs. The methods that seem realistic today are different types of air scrubbers, bio filters, and ozone treatment.

Biological air scrubber

Together with two companies, the Danish Applied Pig Research Scheme works on developing a biological air scrubber for removal of ammonia and odour from the outlet air of housing sections. The essence of the system is that the outlet air is led through a filter that is sprinkled with water. During this process the water absorbs ammonia and odorants passing through the filter. The ammonia and the odour are subsequently decomposed by bacteria living in the water and on the surface of the filter.



Draft of an air scrubber.

Treatment of outlet air with ozone

Together with two companies, the Danish Applied Pig Research Scheme is studying if the outlet air from housing sections may be purified efficiently if we add ozone to it. Ozone is a highly oxidizing gas that decomposes the odour substances. Ozone is dangerous to animals and humans and is therefore not added to the outlet air until the air has left the housing section. The ozone is decomposed when it encounters the odour substances. It is also studied how large an effect we can achieve by adding varying amounts of ozone and also the influence of time of action is studied.

Assessment of the air around housing sections

Complaints about odour from housing sections and site approvals have led the authorities to increase their demands to get information on the scope of odour in the area around the housing section. The level of odour around a housing section varies greatly depending on e.g. the design of the buildings, temperature, wind and the stability of the atmosphere.

On the basis of information on building dimensions, ventilation systems and the size of the odour emission, it is possible by way of the so-called OMA model (Operative Atmospheric Air quality model) or similar models to theoretically calculate how high odour levels it is possible to record in different distances from the housing section. It is possible to compare such calculation with the demands put forward by the authorities of maximum odour concentration.

By changing the parameters for ventilation systems or odour emission, it is possible e.g. to examine how large a reduction in the odour emission is necessary in order to the meet the authorities' demands or how high the exhaust pipe must be to achieve the same effect.

Atmospheric thinning of the air from housing sections

In co-operation with the National Environmental Research Institute and Risø National Laboratory, the Danish Applied Pig Research Scheme conducted a number of dispersion tests with their point of departure in an isolated housing section approx. six metres high for finishers.

Dispersion tests were made with three different heights of exhaust pipes: four existing exhaust pipes that were approx. 70 cm higher than the roof ridge, four exhaust pipes that were three meters higher than the roof ridge, and one overall solution with one pipe that was six meters higher than the roof ridge. During the tests that were all conducted in the summer, smoke and trace gas were added to the exhaust pipes. A number of observing stations were placed in three circles around the housing section in distances of 50, 100 and 150 meters, respectively. Each test lasted 30 minutes, and then we switched to another test design.

Measurements in a distance of 100 meters from the housing sections revealed that the calculated intensity of odour was lower when using a pipe that was raised six meters above the roof ridge. At a distance of 100 meters, there was apparently no effect of raising the individual exhaust pipes by three meters.

Work environment

Being a farmer is healthy as they generally live long. However, farmers experience increased risks of contracting

- Chronic bronchitis and asthma
- Hearing disability
- Inguinal hernia
- Varicose veins
- Osteoarthritis

Respirator project

The best way to avoid respiratory problems is to wear breathing masks with mechanical ventilation. If you wear a ventilated breathing mask you are 100 per cent protected against dust in the housing section.

In co-operation with the University of Aarhus, Vejle Hospital and Aalborg Hospital, a project has been initiated to establish if people suffering from respiratory disorders caused by their job receive sufficient protection from wearing a breathing mask with mechanical ventilation in situations involving high amounts of dust or if the mask should be worn during the entire workday.

This year, 26 persons participated in the project and next year a further 30 persons will participate. These persons have themselves selected their breathing mask between five different types.

Preliminary results show that

- 18 of 26 participants selected the product Proflow II
- Many participants inhaled an average of more than three milligrams of dust/m3 air during a workday (limit value of the the National Working Environment Authority) even though they wore breathing masks in dusty situations. During winter, one should thus as a minimum wear breathing masks in the dusty work situations.
- Many participants experienced fewer respiratory problems when they wore breathing masks.

Feed in the farrowing section

Meal feed and pelleted feed in farrowing sections were compared in terms of dust. The respirable and the total concentration of dust were measured in 12 blocks, and in each block the concentration of dust was measured twice weekly.

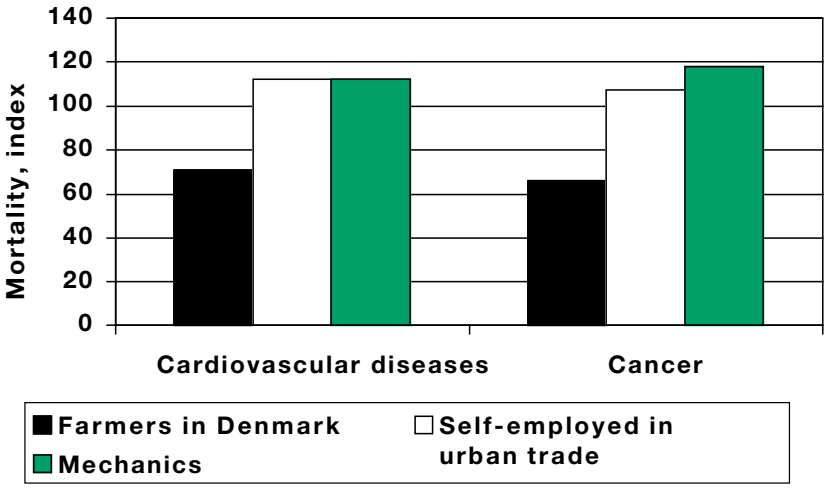
When 3.2% fat were added to the nursing diet there were no significant differences between the diets in the average concentration of dust in the air in the housing section.

However, during outdoor temperatures below three degrees Celsius a dust concentration of more than three mg/m3 was measured.

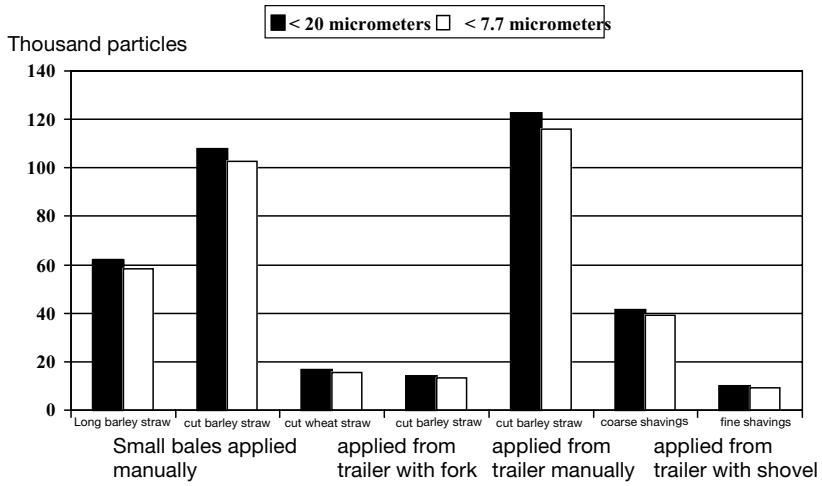
Bedding material

In co-operation with Research Centre Bygholm a test was carried out of release of dust from different types of bedding and under different methods of application.

The number of dust particles in inhaled air was registered every 20 seconds. The results revealed that the participants inhaled five to six times more particles during manual application of cut bedding than with a fork. There were no differences between application of cut wheat straw and cut barley straw. There was a great difference in the amount of dust from shavings even though the label said that the shavings were fairly dustless.



Farmers are less exposed to contracting cancer and cardiovascular diseases.



Inhaled dust during application of 12 kg of bedding

Ventilation

The climate in the pigs' activity area must be correct, but having the right ventilation system is not sufficient – climate management systems are not yet able to "look at" the pigs.

Adjustment of temperature

Assessed on how the pigs lie in the pen, insufficient management of the climate in the housing section is a common reason for the climate problems established by the climate consultants of the Danish Applied Pig Research Scheme.

In housing sections with solid and drained floors the temperature must be adjusted so that the pigs lie in partial lateral position in the lying area in the pen. The pigs must be clean and dry. If they spread over the entire pen and lie in lateral position it is a sign that it is too hot. Before the pigs start dunging in the lying area they become dirty. At that stage it is still possible to lower the temperature or increase the sprinkling and thereby avoid mess.
The temperature must not be so low that the pigs are not able to huddle together lying on their stomach. If the pigs conglomerate, possibly on top of each other, it is too cold.

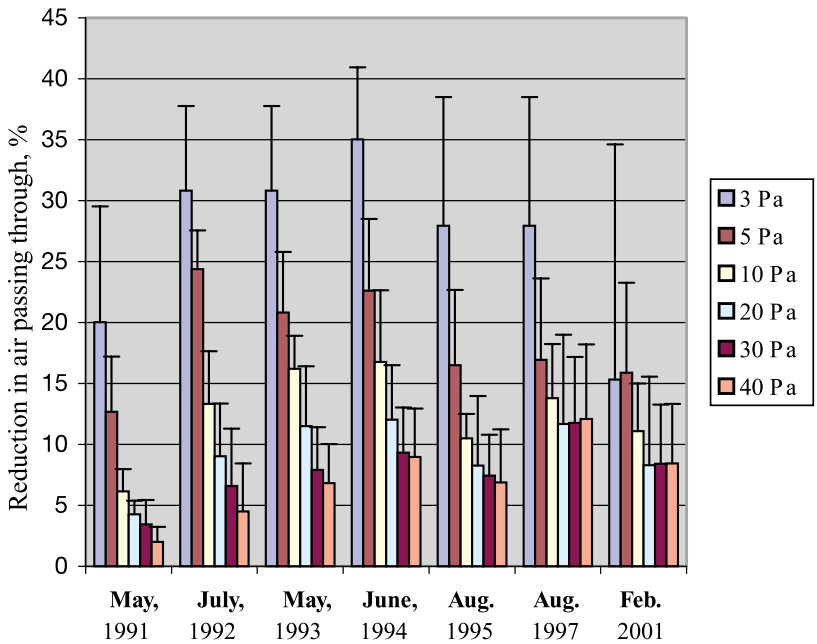
Wind shielding

In particular in housing sections with wall inlets, the distribution of air is very sensitive to wind impact. Low pressure typi-cally varies between 5 and 30 Pa, which is relatively little considering the fact that a wind of 10 m/s stopped by a building causes a pressure of 60 Pa.

We have had positive experiences with a fairly new, simple type of wind shielding where the inlet area varies as the need for ventilation varies during the year. The reduced inlet area makes it possible to achieve a significantly higher reduction of wind impact in the winter compared to wind shielding with a fixed inlet area.

The wind shielding with adjustable inlet area typically has two or three options for adjustment. With three options, adjustment during the summer must have a light area corresponding to the inlet area of the valve, spring/autumn adjustment must reduce the light area to 50%, and winter adjustment must reduce the light area to 25% of the inlet area of the valve.

Continuous adjustment of the temperature according to the behaviour of the pigs is crucial to the correct function of the pen.



Over a ten-year period the air passing through was measured in four elements from a diffuse air intake with 100 mm glass wool 42 and Fibertex as lagging. After ten years, only a limited reduction was seen. A reduction of 8% only results in a reduction of 1-1.5% in the total performance of the ventilation system.

Sprinkling systems

Besides complying with the act on cooling of weaners, finishers and gestant sows, sprinkling of the dung area with water may contribute to ensuring a good pen function. Experiences have shown that a large part of the sprinkling systems does not work satisfactorily. A number of requirements and recommendations may be listed to ensure more reliable sprinkling systems. It is recommended to meet these requirements regardless of whether you buy pre-assembled system or choose to design, buy and assemble it yourself.

Selecting a ventilation system

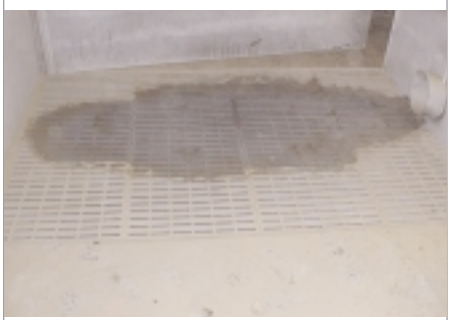
In housing sections with diffuse air intake, a nozzle with a water performance of 0.5-1 litres/minute should be selected. In housing sections with jet ventilation and natural ventilation it may be beneficial to select nozzles with a water performance of 1-2 litres/minute, depending on the atomisation of the nozzle. The working pressure should be 2-3 bars.

When the area to be sprinkled is defined, it is possible to calculate which nozzle is better and which height to place it in.

The individual nozzles must be equipped with anti-drip to ensure simultaneous initiation of all nozzles when sprinkling is activated. It is then possible to reduce the sprinkling period and thereby reduce the consumption of water. The duration of the sprinkling and the length of the intervals between the sprinklings should be adjustable. It must be possible to have respites for parts of the day, and you should be able to manage the systems section by section. In housing systems with many sections, it is beneficial to centralize the management of the sprinkling. It is hereby ensured that only one section is sprinkled at a time, which requires less of the water performance and water pressure in the housing section.

Assembling

The nozzles are placed so that they can be changed without using a step ladder etc., i.e. in a height of 2.0-2.2 m above the slatted floor. The nozzles and the pipes are assembled independently of feed pipes etc. By placing the nozzle pipes 60-70 cm in the pen above the slatted floor and select a nozzle that can direct the jet vertically towards the area to be sprinkled, the risk is reduced of sprinkling the wrong areas. The aim should be a dry area of 30-50 cm between the lying area and the sprinkled area so that the pigs do not drag manure and humidity into the lying area. Nozzles are placed at least one meter from exhaust units to avoid the water being exhausted. A uniform water pressure on the entire pipeline is ensured by using a pressure equalization valve and by using a pipe with the correct diameter.



The sprinkling area must be limited to a part of the dung area to avoid sprinkling of the equipment, the dispenser, the lying area and the inspection alley.

In consideration of pen hygiene, work environment, and air quality it is unacceptable that equipment and inspection alleys are soiled in water.

Operation

Choked up nozzles are cleaned in acetic acid or another decalcifier. It is recommended to have two sets of nozzles of which one is always decalcified and ready for use.

Adjustment of the amount and pressure of water to avoid wind impact is known from e.g. the field sprayer.

Before transferring the pigs to clean pens, it is recommended to sprinkle the dung area to make the pigs use the pen as intended. It may be advantageous to sprinkle frequently the first couple of days after transfer. Later, sprinkling and respites are adjusted to the behaviour of the pigs. Optimum sprinkling and respites vary from herd to herd.

Service and gestation sections

It is possible to achieve very positive production results in systems for group-housed sows, but many factors still need elucidation. Present and future tests will therefore focus on production safety and on reduction of resources.

Service sections

Group-housing in the service section

A current test will elucidate the production safety in service sections where the sows are housed in groups with free access to feeding/insemination stalls.

Preliminary results indicate that in this system it is possible to achieve production results equal to those achieved with individual housing.

This is probably due to the non-competitive feeding system and to the fact that

The best way to establish a non-skid floor in the service section is to use deep litter. The non-skid property of the floor is important when the sows are housed in groups to avoid injuries in connection with the establishment of hierarchy and during mounting.

the sows are able to seek shelter in the stalls in connection with the establishment of hierarchy and during mounting. If the sows are housed in groups in the service section, the floor must have good non-skid properties. A recent test showed that sows housed in groups in pens with partially slatted floors have a high risk of injuring legs and feet. The leg problems were primarily caused by poor non-skid properties.

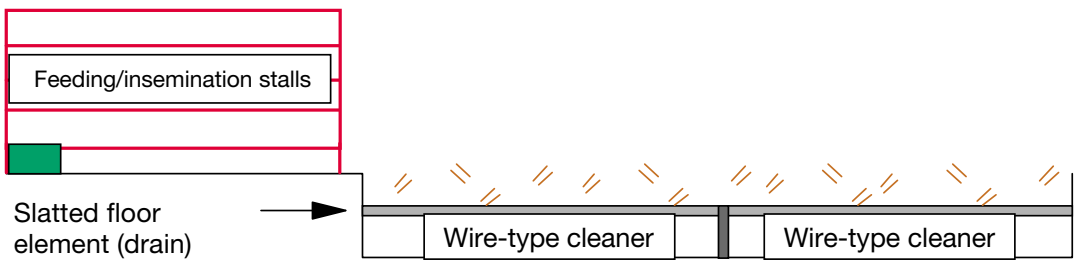
The disadvantage of deep litter is that it is often connected with a large amount of work and it requires a high consumption of deep litter to maintain a sufficiently dry mat. The aim of future tests is therefore to discover designs that reduce labour and the consumption of litter without jeopardizing the production safety.

The influence of different types of litter, litter technique and bowl depth on labour and amount of litter and on

Table 1. Preliminary reproduction results from a test in which the sows in the period from weaning until after service were housed individually or in groups with free access to feeding/insemination stalls.

	Herd 1		Herd 2		Herd 3	
Housed in service section	Individual	Group	Individual	Group	Individual	Group
Prod. litters, no.	203	199	548	453	325	348
Total born* per litter	13.5	14.1	13.3	13.3	13.3	13.5
Farrowings, %	81	81	71	76	82	84

* liveborn + stillborn



A future test will examine if establishment of drains beneath the deep litter can create a dry and non-skid mat that never needs cleaning.

Service and gestation sections

reproduction results is currently being studied in two herds.
During the next years, it will be established if there is anything to be gained in terms of production by

1. Sorting the sows according to size on transfer to the service section
2. Housing the sows in stalls in connection with the initiation of heat

Housing the sows in stalls for up to four weeks after service is legal if pigs are not produced for the British market.

Feeding/insemination stalls of different brands are tested in relation to e.g. work conditions, durability and adjustability.

In pens with one feeding stall per sow it is recommended that

- Two-rowed pens are only established in housing sections that use deep litter
- There is slatted floor both underneath and immediately behind the stalls and in one end of the pen
- The temperature in the housing section is low, in particular in housing sections that use deep litter
- All sows are transferred at once
- Sub-divided pens are used for uneven blocks in the beginning until batch operation, the number of services sows etc. corresponds to what is planned.

Experiences are gathered from five herds that have established service sections for group-housed sows in existing buildings. Preliminary experience shows that when renovating one must take into account the low stocking rate. Often, additional heat is required in the housing section to achieve a satisfactory air quality and thereby a good environment in the housing section.

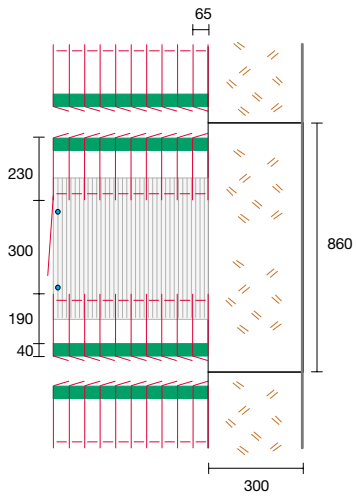
Gestation sections

One eating stall per sow

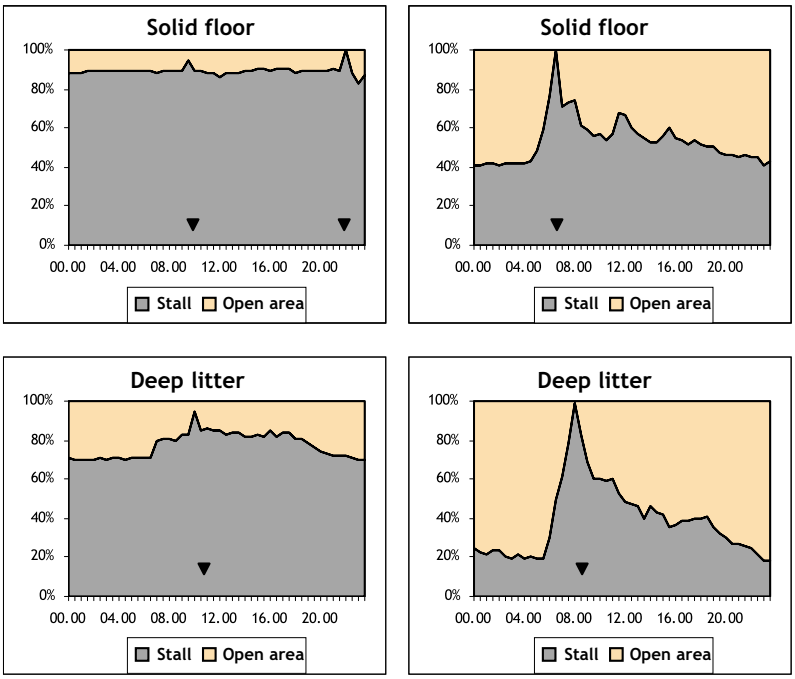
In a system where the sow has permanent access to a feeding stall, the sow is ensured an individual feed dose and she can go into the stall if she feels threatened by higher-ranking sows. Furthermore, the floor in the stall may seem cooling in periods of the year when the sow needs this. This type of system is estimated to be one the most production-safe systems for housing gestant sows in groups.

However, the behaviour of the sows in this pen system differs from herd to herd. Behavioural studies made by the Danish Applied Pig Research Scheme in four herds revealed great differences in terms of how many of the sows spend time in the open area and in the stalls. The sows can freely choose where to be in the pen, but the design of the pen and the management greatly influence how attractive the area behind the stalls is to the sows.

Pen with one feeding stall per sow. If the deep litter is dry is it possible to make sows stay outside the stalls for the better part of the day.



An example of the future pen with one feeding stall per sow. Tests will show if its function is satisfactory.



Distribution of sows during the day in and outside the stall in pens with one feeding stall per sow. The results are from two herds with solid floor and limited bedding, and two herds with deep litter. The amount of bedding does not determine the extent to which the sows stay outside the feeding stalls.

▼ = ***Time of feeding***

Slatted floors

A test showed that there is no simple answer to the recommendations of dimensions of slat widths and slots for slatted floors in gestation sections. The test focused on the influence of slatted floors on the health of the sows' legs and on the hygiene in the pen.

Three different types of slatted floors were tested. The results revealed that slats and slots wider than what is so far used – which is approx. 90/20 mm – did not influence negatively the health of the sows' legs or the hygiene in the pen. In two out of three herds there was a larger puttying of the slots in the floor with the narrowest slat width/slot compared to the other two types. It is therefore estimated that a slat width of approx. 145 mm and a slot of approx. 22 mm may replace the narrower slats and slots. It cannot be recommended to use very wide slats, approx. 300 mm, due to the risk of accumulation of manure on the slats. This very wide slat did not benefit the health of the sows' legs as had been expected.

Regular sprinkling may help keep the slatted floor clean regardless of its dimensions.

If the pen is equipped with several long, narrow dung areas, it is generally recommended to use slatted floor with the dimensions approx. 145/22 mm.

Electronic sow feeding

In ten herds employing electronic sow feeding (ESF), with large slatted floor areas and small nesting areas with a cover, experiences were collected in relation to nutrition, management and pen design.

The pen system offered poor facilities for applying straw. The long, narrow passages with slatted floors offered the sows with poor possibilities for escape and establishment of hierarchy. Furthermore, the sows had to walk long distances on slatted floors to get from the farthest lying areas to the feeding stations. These factors are likely to have contributed to the fact that 20-30% of the sows seemed to have sore legs and that in several of the herds, 30-40% of the removed sows had either died or had had to be put down.

Idle chewing was seen in all ten herds with small nest areas and large areas with slatted floors. This behaviour signals lack of stimuli in the pen environment.

Service and gestation sections

Management

When establishing systems for group-housing, it is crucial to be aware of and acknowledge the fact that compared to traditional systems, production is much more based on the animals' premisses.

Yet in even the most well-known group-housing systems, problems may occur of a high return rate, small litter size, large variations in body condition, injuries caused by vulva bites, scratches and mess in the lying areas. Thorough supervision and an accurate analysis of the problems will usually help solve the problems.

Mess in the pen

Mess primarily occurs in situations where there is no harmony between lying areas and activity areas or where draught from gates makes the sows dung in inconvenient places in the pen. These problems are often caused by incorrect design or construction. For instance, incorrectly designed steps/platforms, ventilation systems and slippery floors are often seen.

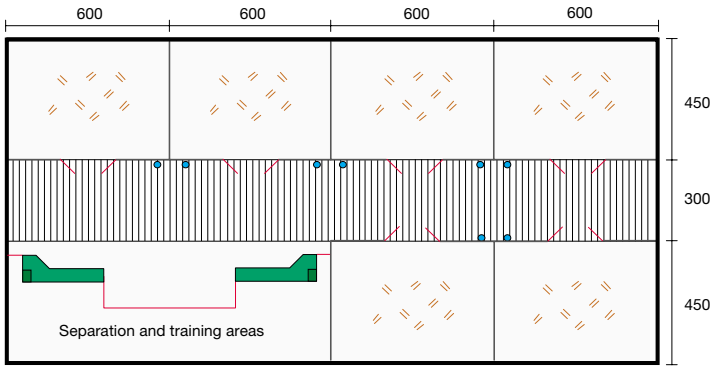
These types of errors are fairly easy to identify, but are not always cheap to correct. Therefore it is important to avoid or discover this during the planning stage.

Supervision

Unfortunately, it varies greatly when the herd owner/staff discovers a problem in a group-housing system.

Leg problems are quickly discovered in systems with individual feeding stalls when the sows walk/run to and from the feeding stalls. However, it is more difficult to discover sows that have sore legs or walk poorly in housing sections with ESF and ad lib feeding. In these systems, it is necessary to walk among the sows and look at them during periods of activity.

Systems with ESF, large areas with slatted floors and nest areas are attractive because of a minimum of labour for handling straw and manure and because the design is fairly easy to adjust to existing buildings. However, the system is hard on the sows and it is estimated that 10-20% relief pens are required.



Alternatives to small nest areas are either a design with a large lying area with deep litter or a design where "the nests"/lying areas are enlarged e.g. 4.5 x 6.0 m. It is estimated that it is easier to apply bedding material in the large nest areas and that escape possibilities in the pen are significantly better.

Circadian rhythm

Group-housing systems reveal many types of behaviour that are not seen in traditional systems. Some of these types of behaviour can be used as an indicator of the sows' welfare and may therefore also be used as a symptom of problems long before a reduction in production results is seen. Furthermore, behaviour points directly towards solutions to the problems.

There must be periods of rest in the housing section. The circadian rhythm typically consists of a brief period of activity in the morning, a period of rest at noon, a long period of activity in the afternoon, and a long period of rest at night. In most herds, the period of rest at noon is seen between 10 and 13 o'clock. In a well-functioning group-housing section, only few sows react to visitors in the housing section during that period. However, if the housing section is visited during a period of activity, many and consistently active sows are a positive sign.

Loose housed, lactating sows

Piglet mortality

Danish housing systems for loose housed, lactating sows are often combined with a high mortality among the piglets. A co-operation between the Danish Institute of Agricultural Sciences, the Royal Veterinary and Agricultural University, and the Danish Applied Pig Research Scheme will provide knowledge on what factors in the lactating period influence the mortality among piglets in different loose housing systems.

Preliminary results show that the majority of the pigs that die, die within the first 24 hours after farrow and that the majority of the pigs die because of injuries inflicted by crushing. Half of the crushed pigs have not eaten any raw milk. Data also show that every fourth sow has a piglet mortality of more than five pigs per litter. The average mortality in the litters of the remaining sows corresponds to the mortality rate in traditional pens. The results indicate that the design of the pen in systems for loose housed sows must be optimised in terms of sow's movement patterns and needs, so that crushing of piglets can be avoided. Furthermore, it must be ensured that the piglets are able to find the udder and that they have free access to it during and after farrowing.

Mushroom pen

The Danish Applied Pig Research Scheme compared the Mushroom pen with traditional pens. The Mushroom pen is equipped with fully slatted floor made of plastic. It is possible for the sow to move around in the pen, and plastic rails mounted on springs protect the piglets from being crushed. The piglets have access to a screened corner with a heating plate.

Preliminary results show that piglet mortality is high in the Mushroom pen (14.4%). The high mortality seen in comparison with the traditional pen (8.1%) is probably caused by the piglets mainly staying in the area around the sow thus risking being crushed.

Despite the high mortality compared with the traditional pen, the Mushroom pen is a good alternative compared with other loose housing systems where mortality often exceeds 20%. It is therefore estimated that by further development, the Mushroom pen can become a very functional pen.

The Mushroom pen. Plastic rails on springs only provide limited protection of the piglets.

Outdoor farrowings

Haulm, barley straw or wheat straw in farrowing huts

Mortality among piglets in outdoor sow units are high in the first couple of days after birth as the piglets in this period are very sensitive towards cold and humidity. If one chooses to equip the huts with a non-absorbing litter material (haulm or wheat straw) before the sows are penned, it is expected that the litter absorbs less humidity from the ground. Thereby the surface is drier and improves the immediate environment for the piglets. At the same time, the need for litter after farrowing is reduced.

A current test examines the effects of littering with three different kinds of litter in farrowing huts on piglet mortality and consumption of straw. Before the sows are placed in the farrowing paddocks, haulm, wheat straw or barley straw, respectively, is used. Subsequently, all huts are supplemented with barley straw.

Preliminary results (winter 2000-spring 2001) indicate a lower overall mortality (stillborn and dead during the lactating pe-riod) in the litters where haulm was used (17.8%) compared with 20.4% and 22.3% in the litters where barley straw or wheat straw, respectively, is used.

The group given haulm is given a large amount before the sows are penned, but less afterwards. This could mean that the sows are disturbed less after farrowing affecting piglet mortality positively. Litter is applied mechanically before the sows are penned, but subsequently it is applied manually. Thereby, there is least manual labour in the group with haulm.

Pens for weaners and finishers

Newly weaned pigs

Restrictive feeding on the floor of weaners

After removing antibiotic growth promoters from feed for weaners, many herds have encountered problems with diarrhoea that requires treatment. Previous tests have shown that it is possible to reduce the prevalence of diarrhoea by feeding restrictively four times daily post-weaning.

This method has a positive effect on intestinal infections. At the same time, new research shows that weaners that start eating within the first 24 hours post-weaning have a higher daily gain than pigs that start eating later.

We only have limited knowledge on weaners' eating behaviour immediately post-weaning. The Danish Applied Pig Research Scheme has therefore initiated a study in which the behaviour, health and production results of weaners are studied under different feeding strategies.

Immediately post-weaning, weaners are highly motivated for eating at the same time. With restrictive feeding, relatively small amounts of feed are fed on the floor on a limited area. If the amount of feed per feeding is reduced too much, the level of aggression will increase in the pen as the animals will fight to get to the feed.

Furthermore, the number of pigs that start eating within the first 24 hours post-weaning is recorded. These recordings will provide greater knowledge on optimum feeding of weaners and will be used to improve the effort to make more pigs start eating within the first 24 hours.

Feeding techniques for weaners

Restrictive feeding with several feedings a day is very time consuming, and this has created a need for development of technical solutions for reducing the amount of time spent.

Therefore a study based on experiences has been initiated with the aim of elucidating advantages and disadvantages in terms of labour and function, and investment costs of equipment for restrictive feeding the first weeks post-weaning.

The different types of equipment all share the feature that they can supply different variants of gruel feed. The equipment can be adjusted so that small or large amounts of feed may be supplied according to the pigs' appetite. However, most of the equipment does not accommodate the feeding of an entire meal where all the pigs can eat at the same time.

Examples of technical equipment on the market today are eg. Funkimat II from Funki, Spotmix from BoPil-Schauer, Baby-Feeder and Sprinter from W. DominoA/S, and Optimäst and Vacuummatic from Diplomat.

The equipment is adjusted to either meal feed (Funki matII, Sprinter, Baby-Feeder), pellets (Funki matII, Optimäst) or liquid feed (Vacuummatic). Part of the equipment supply the feed individually to a number of pens and phase-feed ungraduatedly to each pen.

Sprinter from W. Domino A/S

Baby-Feeder from W. Domino A/S is also included in a comparison between feeding with freshly mixed liquid feed and dry feeding ad libitum.

Baby-Feeder from W. Domino A/S can feed fresh liquid feed many times a day, in a long trough, for instance.

Rooting material

In order to comply with the Act on application of rooting material for pigs that commences on July 1, 2005, the Danish Applied Pig Research Scheme has studied the effect of different types of rooting material on the behaviour of finishers in the fist nine weeks of the finisher period. The following five materials were studied individually:

1. Straw
2. Alfalfa hay supplied by way of a straw dispenser
3. Wood beam
4. Rope
5. Cosh in an adjustable chain

Measured by the number of animals occupied with the material, the pigs preferred the materials in the below order:

1. Alfalfa hay
2. Rope, straw and cosh
3. Wood beam

Furthermore, the results showed that there was no difference on the activity level of the pigs between the groups. However, the way the pigs rooted/manipulated did differ. In the groups given the most attractive materials, activity was focused on the materials whereas several pigs rooted on floor and equipment in groups where the materials were less attractive.

There was no difference between the groups in the total number of confrontations between pigs. However, the groups in which the material was supplied by way of a dispenser experienced a significantly higher number of confrontations by the materials – the most at alfalfa hay – reflecting the attractiveness of the materials. The limited amount of space

Rope made of hemp/sisal. The height was adjusted as the pigs grew so that the ends of the rope were in the pigs' shoulder height.

The cosh is made from material that is harmless to the pigs. If a hose is used, it must not be armoured.

by the dis-penser also affected the number of confrontations negatively. The groups that were given rooting material that was not attractive had a significantly higher number of confrontations at the dispensers.

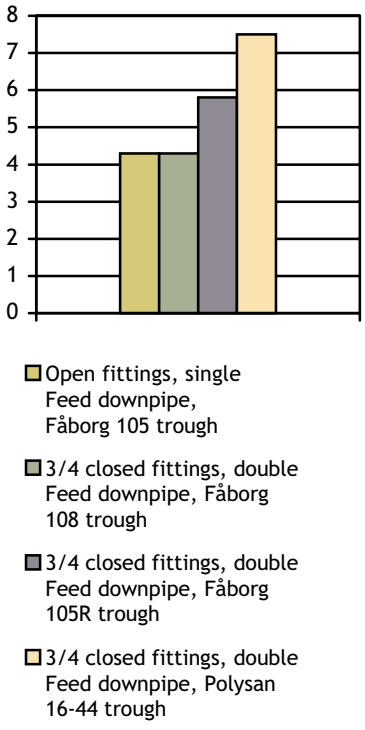
Restrictive liquid feeding of finishers

A test of different troughs and types of equipment was carried out in order to examine the influence of the design of the trough on the hygiene in finisher pens with partially slatted floors. The test revealed that restrictive feeding and partially slatted floors may be combined without encountering hygiene problems in the lying areas, if these were equipped with one third of solid floor and a cover. In the pens with two-thirds of solid floor, the pigs dunged in that half of the lying area that was closest to the slatted floor. The test did not reveal any differences between the groups in terms of production results or hygiene in the pens.

The test also showed that

- Less than 0.5% of the recordings showed a feed waste in a distance of more than 30 cm from the trough
- Platforms along the trough reduced the risk of filth in the trough
- Closed fittings above the trough reduced the risk of manure in the trough

Per cent of pens with messed lying area



Pens for weaners and finishers

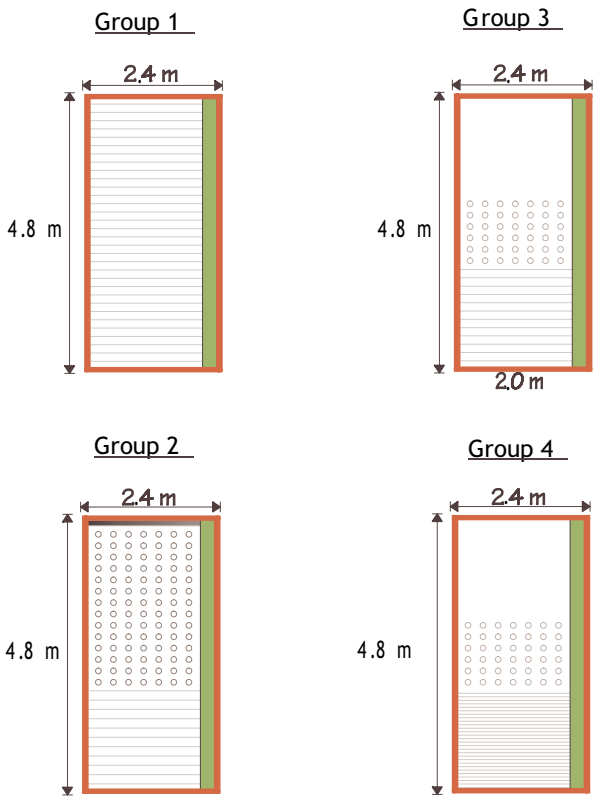
Types of flooring in finisher pens

As of July 1, 2000 it became compulsory to equip finisher pens with solid or drained floor in at least one third of the minimum space requirement applying at any time.

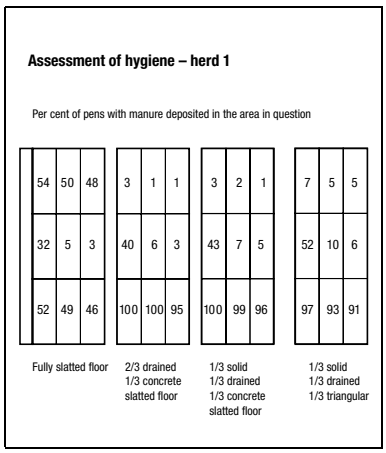
A drained floor has by definition an opening degree of no more than 10%. This means that slots and/or holes constitute a maximum of 10% of the flooring. In comparison, a traditional concrete slatted floor for finishers typically has an opening area of 18-20%.
In order to establish the function of different floor profiles with varying degrees of drained floor, the Danish Applied Pig Research Scheme carried out a test in two finisher herds. The test comprised four groups, and the control group had fully slatted floor.

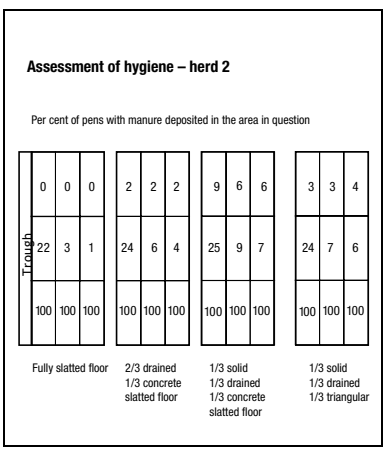
All groups displayed good hygiene. The pigs typically dunged in the dung area and in the activity area as opposed to in the liquid feed trough. There were only a few cases of dung in the lying area. The prerequisite for achieving a good hygiene in pens with varying degrees of solid or drained floor is to somehow manage the pigs' dung behaviour. In this test, it was attempted to manage this by way of a cover in the lying area combined with an appropriately low temperature in the housing section, and sprinkling of the dung area. Thereby the dung area is kept humid and it may cool the pigs in periods of high outdoor temperatures. In the group with fully slatted floor in herd 1, the pigs randomly divided the pens into lying and dung areas. This was not the case in herd 2 where the pens equipped with fully slatted floor also had covered lying areas.

A finisher pen for restrictive liquid feeding may be equipped with
- solid or drained floor in the lying area
- drained floor in the middle area
- regular slatted floor in the dung area
The lying area should be covered and the fittings above the trough should be closed.



The test groups in a test of floors in two finisher herds. The pigs were given liquid feed in a long trough in all groups, and there were sprinklers above the dung area. The lying areas in the pens in groups 2-4 had adjustable cover. In herd 2, group 1 had fully slatted floor and covered lying area.





Number of observations of mess in per cent of all observations in different areas of the pen in the four test groups.

WTF

Developing equipment for pigs housed in the same pen from weaning to finish is a great challenge that involves design of feed dispensers, troughs and covered areas, among other things. During the last year, the Danish Applied Pig Research Scheme has assessed the function of tube feeders, troughs and covered areas used in WTF production.

Tube feeders

The function of six tube feeders was assessed. In all tube feeders, the newly weaned pigs stepped into the troughs and the nipple drinkers to reach the dosing unit. If there was a crowd by the dispenser, the pigs would often place themselves across the dispenser with one or more legs in the through or the nipple drinker, whereby the water would become dirty. None of the dispensers got top grades in the overall assessment. The companies thus have a great deal of work ahead of them before the ideal tube feeder for WTF is developed.

Liquid feeding

WTF pens equipped for liquid feeding should have one third of solid floor and a combination of slatted floor and drained floor in the remaining part of the pen. Feeding should take place in a long trough at one side of the pen.

Results from a pilot test showed that the pigs would go lie in the trough if it was big, had a flat bottom and a platform. This was, however, a limited problem except for the first days with application of liquid feed where the pigs became wet. Therefore, the conclusion was that the best trough is big, has a round bottom and a width of 45-50 cm and height from the floor or platform to the edge of the trough of 14-16 cm. This type of trough results in improved function and the most appropriate behaviour by the trough. A trough with a smaller cubic content causes a risk of overloading and thereby a waste of feed at the end of the growth period.

Table 1. Assessment of the technical performance of tube feeders for WTF

Feeder	Ergo mat	Maxi mat	AP-SWING Maxi	FUNKIMAT (FRATS)	FAABORG 3-I-EN	Domino Starfeeder
Feed waste	***	***	****	***	***	***
Adjustment	***	**	***	***	****	**
Learning	****	****	****	****	****	****
Blockage of feeder	****	***	****	****	****	****
Caking	****	***	***	**	****	**
Cleaning	****	***	***	**	****	**
Work environment	***	**	***	***	***	***
Durability and wear and tear	***	****	***	***	****	***
Technical performance index	***	**	***	**	***	**

A small waste of feed is the result if the pigs lie in the trough as long as the feed dose is adjusted to the pigs' appetite.

Covers

In a pilot test under the Danish Applied Pig Research Scheme four different types of cover were tested in terms of function and temperature.

There were two types of horizontal covers, a tilted type and one type with a drape. They were all fitted one meter above the floor and had a 10 cm bent front edge. The opening area of the tilted one and the one with a drape was only half the size of that of the two horizontal types.

The temperature was six degrees Celsius higher than the room temperature with the two horizontal types. The temperature was 7-7.5 degrees Celsius higher than room temperature with the tilted type and the type with a drape.

To maintain an appropriate temperature under the cover, it should be placed one meter above the floor with a 50-60 cm opening towards the pen. It should have a 15 cm board to prevent draught along the floor.

Batch farrowing

Managing batch size

All-in all-out (AIAO) is becoming increasingly popular in weaner and finisher sections because of improved health, high daily gain, reduced feed consumption and reduced mortality. However, it is difficult to achieve the same high utilization of the housing sections as with continuous flow operation.

In order to achieve a satisfactory stocking density and thereby improve the economy in weaner and finisher sections that are managed according to the AIAO principle, it is important that the producer of weaners delivers as uniform batches as possible both in terms of number as well as weight of the pigs.

A tight management of the sow unit is crucial to ensure deliveries of weaners without too large differences in the number of weaners. If the sow unit is not sufficiently tightly managed, there will invariably be even very large movements in the number of weaned pigs per batch, which results in periodically poor utilization of the housing section and periodical overcrowding.

The Danish Applied Pig Research Scheme has monitored a number of herds that changed their production to multisite. In connection with the study, production data were systematically collected and the herds were regularly questioned about their experiences with the management of their multisite system.

The results revealed that there were very large variations in the number of weaned pigs between batches that had made no major considerations on management to ensure an equal number of weaners.

It is recommended to target production for a variation of 10% of the expected batch size.

The results from the multisite study showed that only one herd was able to meet this target. 88% of the batches in the herd were within ±10% of the average number of weaned pigs per batch. In comparison, only between 25% and 46% of the batches in the other herds in the study were within the target of ± 10% of the average number of weaned pigs per batch.

The management of the herd is influenced by too large movements in the number of pigs per batch. Too many pigs and too few pigs both affect the environment. In both cases, minor problems occur with pen fouling. In cases of overcrowding, there is an increased tendency to tail biting and poor health.

On the other hand, too few pigs result in a poor utilization of the housing sections and thereby a poorer economy. Many therefore feel they should move pigs from overcrowded sections to sections with too few pigs. However, this poses a great risk of transporting infections through different parts of the production system.

The solution is to adjust the number of services to the number of pigs to which the weaner section is dimensioned. An argument against this is that the productivity is reduced if the management is too tight. However, experience from the Danish Applied Pig Research Scheme shows that it is possible to make tight management and high productivity go hand in hand.

Table 1. Variations in the number of weaned pigs between batches in five multisite herds.

Deviation in % of average batch size	Herd				
	1	2	3	4	5
0-70	3	0	16	7	2
71-90	40	7	22	16	38
91-110	25	88	27	46	26
111-130	25	5	22	28	29
131-150	6	0	10	3	3
>150	1	0	3	0	2
Total	100	100	100	100	100

Economy and batch operation

Batch systems combined with WTF production is becoming more wide spread. The advantage of this combination is that the sow unit can deliver large batches of weaners to the producer of finishers. This results in rationalisation bonuses and efficient pathogen barriers when combined with all-in all-out production.

In order to compare the financial aspects of batch operation and WTF production, a model calculation has been made in which a traditional herd with weaners and finishers is compared to two batch operation systems that are combined with WTF.

The table shows the total costs calculated per carcass.

Table 1. Costs, DKK per kg carcass

Prod. system	Traditional	WTF	WTF
Sow units	21	12	11
Age on weaning, weeks	4	4	5
Feed	4.72	4.65	4.72
Transport	0.32	0.24	0.24
Breeding	0.05	0.05	0.05
Medication	0.26	0.26	0.27
Advice	0.03	0.03	0.03
Energy	0.24	0.24	0.24
Levies and destruction	0.17	0.17	0.17
Labour	1.15	1.10	1.09
Maintenance	0.18	0.18	0.17
Interest	0.87	0.86	0.86
Profit, herd	0.18	0.18	0.17
Depreciation	0.78	0.77	0.77
Total	8.94	8.72	8.78

The most significant differences in the structure of the costs are found in feed, transport, labour, interests and instalments. The differences in feed costs when comparing a traditional system with 21 sow units with ones with 12 and 11 sow units are found in a better feed conversion of WTF production than in conventional finisher production. However, 11 sow units consume correspondingly more feed in connection with five weeks' weaning, which thus does not result in a total economic difference in feed costs between 21 and 11 units.

In the calculations, it has been presupposed that sow units, weaners/WTF and finishers are located at different premises. The essence of WTF production is that the pigs are moved to a WTF pen post-weaning. When the pigs reach 30 kg, the batch is divided, and one half is moved to a traditional finisher pen and the other half remains in the WTF pen. This method is employed to achieve optimum utilisation of the pen area. This way, half of the pigs are only moved once, which results in different transport costs.

The difference in labour costs depends on the batch sizes of sow units as well as weaner units (there is the same number of sows in the three systems). It is rational to handle large numbers of pigs in few sections. Furthermore, WTF production rationalises the labour as the housing sections need not be cleaned as often as in conventional systems.

There is no difference in interest and instalments between the three systems. However, the batch operation systems with 12 and 11 sow units require considerably more farrowing pens than systems with 21 blocks, which means that there are more costs involved in producing piglets in these systems. Post-weaning, WTF production has correspondingly low costs for interest and instalments.

This is mainly due to the fact that compared with the traditional system, WTF operates with a higher gain of plus 42 and plus 66 g daily. Furthermore, days that would normally be spent on washing between weaner and finisher sections are now utilized for production. Overall, the levels of interest and depreciation are identical in the three systems seen as a whole, but there are great differences between the premises.

The table below shows the total production costs per pig. Interest and depreciation contribute to the increase in difference before and after weaning.

Table 2. Costs, DKK per pig

System	21 sow units	12 sow units	11 sow units
For weaning	179	182	200
Weaning to slaughter 7-100 kg	494	474	461

Table 3. One should not focus on the level, but on the difference between the prerequisites.

Prerequisites	21 sow units	12 sow units	11 sow units
WTF section		11	9
Weaner section	8		
Finisher section	12	7	6
Days for washing	3	3	3
Pigs delivered	3	3	3
Gain, WTF, g 30 -100 kg		920	920
Gain, finishers, g 30-100 kg	900	900	900
WFT FUp/kg		2.7	2.7
Finishers, FUp/kg	2.8	2.8	2.8
Dead from weaning to 30 kg	2 %	2.5 %	2 %
Dead WTF finishers, 30 kg to slaughter		2 %	2 %
Dead finisher pen, 30 kg to slaughter	3 %	3 %	3 %
Price WTF pen, DKK		2430	2430
Price finisher pen, DKK	2370	2370	2370
Price weaner pen, DKK	1425		
Long-term interest rates	7 %	7%	7 %

Organic pig production

Production

In the period 1997 to 2000, the Danish Applied Pig Research Scheme and the Danish Institute of Agricultural Sciences carried out a study of organic pig production in five herds with 60-300 sows and finishers. Reasonable results were achieved in this study and the results were significantly improved throughout this period.

Organic pig production produces approx. 70,000 finishers annually. The production has increased greatly over the last years, and the slaughterhouses have begun exporting organic pork to the UK and Germany, primarily. The costs of establishing organic pig production have, however, increased as a consequence of the new EU regulations that commenced on August 24, 2000 and that will be fully implemented by the year 2005. In particular the increased space requirements result in increased investment costs. Furthermore, the feed requirements have been tightened as the non-organic part of the feed must be reduced to zero over a number of years, and it is no longer allowed to use soybean meal and to add synthetic amino acids to the feed.

In organic pig production, the sow unit is most often outdoors and is therefore governed by the same regulations as outdoor sow units in terms of animal welfare, environmental impact and fencing.

Research

New research projects have been initiated in co-operation with the Danish Institute of Agricultural Sciences with the aim of developing new production systems that comply with the new regulations.
Research includes the following systems:

- Sows and finishers housed outdoors
- Finishers housed in conventionalbuildings
- Sows and finishers housed in farrow to finish deep litter tents

The effort of the Danish Applied Pig Research Scheme mainly comprises:

- Optimisation of the function of the pen and pen utilization in housing section for finishers
- Improved management of reproduction
- Improved management of grazing

Organic pig production is surrounded by various myths:
"This type of production is too expensive

Table 1. Production performance for organic sow units

	1997	1998	1999	2000
Live born per litter	10.7	11.1	11.3	11.8
Weaned per litter	9.2	9.4	9.5	10.0
First parity litter, %	43	15	29	19
Pre-weaning mortality, %	14.0	15.3	15.9	15.3
Weaning weight, kg	14.1	15.9	16.4	15.4
Non-productive days per litter	32	21	22	15
Farrowing rate, %	72	80	78	81
Litters per sow annually	1.87	1.96	1.97	2.05
Weaned pigs per sow annually	17.2	18.4	18.7	20.5

Table 2. Production performance for organic finishers

	1997	1998	1999	2000
Weight on penning, kg	29.9	32.3	19.9	17.4
Average slaughter weight, kg	84.5	82	80.2	78.7
Days to slaughter, days	104	93	120	123
Daily gain, g	788	818	727	701
Feed conversion, FUp/gain	3.37	3.31	2.98	2.85
Lean meat %	58	58.3	58.2	59.2

Table 3. EU space requirements in organic pig production

Space requirements (housing sections)	Indoor space m^2/pig	Solid floor, as part of indoor space, m^2/pig	Outdoor area, m^2/pig (paddock)
Boars	6.0	3.0	8.8
Lactating sows	7.5	3.75	2.5
Dry/gestant sows	2.5	1.25	1.9
Weaners, 40 days-30 kg	0.6	0.3	0.4
Finishers 30-50 kg	0.8	0.4	0.6
Finishers 50-85 kg	1.1	0.55	0.8
Finishers 85-110 kg	1.3	0.65	1.0

and it is impossible to make ends meet financially. Regulations make rational management impossible. Organic pig production is only for ideologists, and furthermore, pigs and ecology do not go hand in hand. Consumers do not request expensive, organic pork."
Despite regulation and difficulties, some farmers are employed fulltime in organic pig production and make a decent living from it.

The export markets for organic pork are looking very promising and the organic slaughterhouses advertise for more suppliers. Furthermore, the ministers of agriculture in the EU focus greatly on organic production and are interested in making this type of production more common.

Management of organic herds

Throughout the last 1 1/2 years, management of organic herds has been studied. During this period, knowledge and information was collected in basically all aspects of organic pig production. We have mapped our knowledge of differences between organic and conventional pig herds. This enables the advisors to distinguish what knowledge works in organic pig herds and where there may be a need for other methods. We have also described in detail how three organic farmers manage their herds.

Tools

Besides research within the aspects characteristic to the three individual herds, we have also researched the general as-pects. We now have tools for:

Calculation of space and size of paddocks
This calculation provides a quick idea of the individual paddock sizes needed for the individual types of pigs.

Management of paddocks
This provides an answer to how a grazing area is established and what type of seed to choose for gestant sows that are able to utilise the grass and for lactating sows that do not eat very much.

Recommendations on nutrition
Present feedstuffs such as grain, protein feedstuffs and roughage are listed with the recommended amounts for the individual groups of pigs as are their advantages/disadvantages and test results. It is necessary to think along alternative lines on nutrition as feed must 100% organic in the near future.

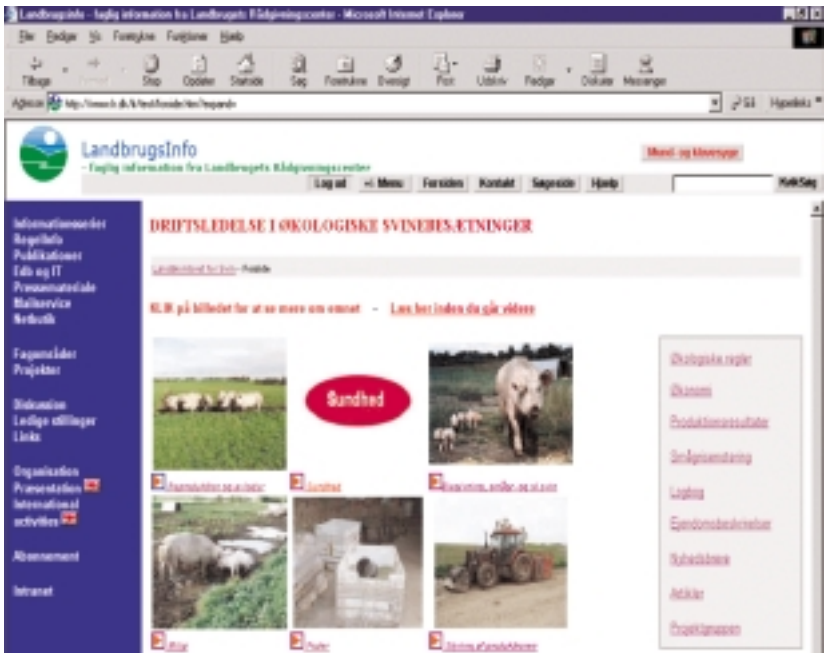
Service, service paddocks and service sections
Seven weeks' weaning makes it difficult for the sows to reach heat at the desired point in time. It is recommended how to ensure heat in the paddocks and how to design indoor service sections.

Housing finishers in existing buildings
It is here recommended how the ideas of the farmer may be adjusted to the regulations applying so that the housing section becomes as good as possible.
Replacement and breeding in the herd
Only 20% of new young females and gilts can be bought from conventional herds. If the meat quality and the general development in breeding should be utilised, it is important to have a strategy for what breeds one would like to have and how the production of these breeds may take place in the herd.

Proto types of management tools
A notice board on which the paddocks have been drawn up on a whiteboard provides the farmer with the necessary general information. Magnets indicate what sows are where, what sows are vaccinated, have been visited by the fox, etc. Weekly schedules with the daily tasks help the staff remember the various tasks and guarantee the farmer that they are being done.

Key figures
The key figures from the production reports of the three herds have been collected, and together with data from the organic study herds, it is possible for those interested to see how the actual figures from organic herds may look.

Information on the project and preliminary results may be obtained from the website: www.lr.dk.



Presentation of this knowledge and our experiences can be seen at our website: www.lr.dk. Management of organic pig herds.

Act on Animal Protection and UK pigs

Legislation on the protection of animals has been a hot topic the last few years both nationally and in the EU. The Act on pigs housed outdoors came into force on March 1, 2001 and as of January 1, 2003 changes of the EU legislation will come into force.

The production of pigs for the British market has increased concurrently with more pig producers establishing group-housing systems for sows. Demands from the British have necessitated changes of the control in the herds.

Act on outdoor pigs

The main content of the Act is requirements of minimum amount of space in huts for the individual categories of pigs:

- Gestant sows: 1.30 m^2 per sow
- Gilts: 0.95 m^2 per gilt
- Farrowing and lactating sows: 3.80 m^2 per sow
- Boars in their own hut: 3.00 m^2 per boar
- Weaners 20-30 kg: 0.25 m^2 per pig
- Finishers 85-110 kg: 0.55 m^2 per pig

The huts must be insulated and must be equipped with ventilation. Straw should be applied in the huts.

All pigs weighing more than 20 kg must be able to wallow in mud. However, this may be replaced by a sprinkling system if the animals have access to shade.

Transition periods – national legislation:

Act on indoor housing of gestant sows and gilts

The main requirement is that gestant sows must be housed loose from no later than four weeks after service and applies to

- new buildings as of January 1, 1999
- all buildings as of January 1, 2014

Act on indoor housing of weaners, breeding stock and finishers

The act prohibits use of fully slatted floors and applies to

- new buildings as of July 1, 2000
- all buildings as of July 1, 2015

Act on housing pigs outdoor applies to

- new herds as of March 1, 2001
- all herds as of March 1, 2006

EU legislation on animal protection

The directive adopted in 1991 concerning minimum requirement on the protection of pigs has now been revised. The new directive will apply to new buildings from January 1, 2003 and to all buildings from January 1, 2013.

New EU requirements:
Sows and gilts

- Housed in groups from no later than four weeks after service
- Open floor area of 2.25 m^2 per sow and of 1.64 m^2 per gilt. If less than six animals + 10%. If more than forty animals –10%.
- Solid or drained floor – 1.3 m^2 per sow and 0.95 m^2 per gilt.
- Application of rooting material and high-fibre feed.

Table 1. Dimensions of concrete slatted floors

	Max. slot width.	Min. slot width
Piglets	11 mm	50 mm
Weaners	14 mm	50 mm
Finishers	18 mm	80 mm
Sows, gilts	20 mm	80 mm

Depending on future negotiations, the listed dimensions for concrete slatted floors will apply only to fully slatted floors and are therefore of little importance to Danish pig production. The appendix of the directive must be adopted by the Commission. The most significant issues are age at weaning and rules on castration and tail docking.
Furthermore, a report will be made on space requirements of floors for weaners and finishers and on pen types for lactating sows.

Production of UK pigs

Today, approx. 1,900 herds produce approx. four million finishers on contract to the British market. In 2001 and 2002, ap-proved pigs are settled with a bonus of DKK0.30 per kg. Also for 2003, two companies have agreed on a bonus of DKK0.30 per kg for approved pigs. A group representing the three slaughterhouses, The Danish Bacon & Meat Council and The National Committee for Pig Production ensures that the production and control meet the requirements from the British market. New requirements of independent control are the reason why the control function has been passed on to the Danish Agricultural Advisory Centre. The local advisors still carry out the control in the herds, but they are not allowed to provide both counselling and control in the same herd.

Supervision and management

Farm*Watch*®, more languages, more networks, more options

The latest version of Farm*Watch*®, contains several novelties, for example selection between two different networks and three languages, remote supervision, improved functions of warning, etc.

The National Committee for Pig Production has co-operation agreements with e.g. SKOV A/S and Skiold ECHBERG A/S on installation of Farm*Watch*®, in Denmark. This means that Farm*Watch*®, now can communicate with both P-Net and Info Matic, network. It is thereby possible to utilise existing networks and save costs for establishment of a new network.

In future, Farm*Watch*®, will be delivered with three language versions as standard on the same CD-Rom: Danish, English and German. One can thus switch freely between the three languages, which is a great advantage to herds employing foreign staff.

Practical experiences with Farm*Watch*®

Experiences with Farm*Watch*®, in the daily work are good as illustrated by the following examples:

Notification of diarrhoea

The consumption of water among weaners increases in connection with outbreaks of coli diarrhoea. Farm*Watch*®, typically notes changes in drinking pattern approx. 24 hours before visible symptoms in the pigs. If there is a warning of increased consumption of water during the first week post-weaning, it is a typical sign of an impending outbreak of diarrhoea, and in such a situation medication is added to the water.

Notification of incorrect diet

If a diet is incorrectly composed, it is shown in the consumption of water. For instance, a diet that by mistake contained too much soybean meal resulted in a heavy increase in the consumption of water in the sections given that particular diet.

General overview

In the daily management, Farm*Watch*®, may be used to get a quick overview of the situation in the housing sections. The consumption of water is checked two to four times daily and if abnormal drinking behaviour is seen in one or more housing sections, the staff tends to those pigs as quickly as possible. When a batch is finished, the production report is printed immediately, and the results are discussed with the staff in question.

Source: Landsbladet, Jens Tønnesen

Integrated Farm Management System

Integrated Farm Management System (IFMS) is a programme for planning, management and computation of pig production. Now it also contains the option of registration of data by way of a handheld terminal.

Handheld terminal

Information of the latest activity and the expected activity on active parent animals in the herd is transferred from IFMS to the handheld terminal. Then activities such as service, contagious bovine abortion, farrowing, equalization of litters and weaning are recorded.

It is also possible to record information on sales of pigs – sold, dead, moved between housing sections – data on health and consumption of medication.

The handheld terminal may be delivered with an input unit facilitating reading of e.g. ear tags from Aflex, which will be very beneficial in loose housing systems and outdoor sow units.

Nucleus management and IFMS

With the release of version 3.38 of Integrated Farm Management System in autumn 2001, Avls Modul Svin (AMOS) is intro-duced to the market. AMOS can be used by the nucleus management herds for electronic report on breeding data according to the guidelines laid down in Regulations for Nucleus Management.

Specifically, AMOS handles transport of data between Integrated Farm Management System and the pig breeding database, including validation of breeding data, e.g. concerning pedigree information, and correct registration of one's bonus on young female with ID number and name in a given number pool. It is then up to the user to send the reports by way of the Internet to the database.

The introduction of AMOS simplifies the on-going report of data to nucleus management considerably, but there is a large amount of work connected to the implementation of AMOS in the individual herds as there are comprehensive requirements to information on individual animals. For example, mothers and fathers of the sows entered in the nucleus management programme must have valid ID number.

AMOS can be ordered by producers that are registered in the nucleus management programme, and the lease is DKK1,100 annually.

Salmonella

Ingredients and commercial products

The effect of sugar beet pulp, potato protein concentrate, a diet from Aarhusegnens Andel (barley/wheat: 1:1 and 4% oats) and zinc gluconate for finishers was compared with a wheat-based, pelleted control diet.

The results showed that meal feed and addition of 10% sugar beet pulp to pelleted feed reduced the prevalence of Salmonella compared with control, cf. table 1. Furthermore, meal feed improved the microbial balance in the gastro-intestinal tract compared with pelleted feed, though it resulted in a significantly poorer production value. Addition of 10% sugar beet pulp did not affect the production value or the microbial system significantly.

Potato protein concentrate, the diet from Aarhusegnens Andel and addition of zinc gluconate did not affect the prevalence of Salmonella, the productivity or the microbial system in the gastro-intestinal tract.

Texture in pellets

The effect of coarsely ground grain in pelleted feed for finishers was studied, cf. table 2.

Due to very few salmonella-positive pigs, it was not possible to establish the effects of the different diets on Salmonella. The feed in groups 5 and 6 resulted in the same changes as did meal feed in the physico-chemical traits in the digestive tract. The feed in group six resulted in the same changes in the microbial system as seen in the group that was given meal feed. Thus, it is expected that these two diets will be able to reduce the prevalence of Salmonella in finishers without reducing the production value as when meal feed is used.

Meal or pellets for sows

Meal feed and pelleted feed for sows was tested in one herd with recurrent problems with Salmonella. The sows were di-vided into batches that were given either meal feed or pelleted feed from transfer to the gestation section and until weaning. In selected batches, the test continued in the weaner section where the weaners were given the same type of diet as the sows. There were no significant differences in the excretion of Salmonella in the sows or in the weaners in the two groups. Only exotic salmonella-types were found during the test, and no S. Typhimurium was diagnosed.

The test revealed a clear connection between diagnosing Salmonella in the sows and their weaners. This underlines the importance of ensuring that purchased animals originate from a herd that does not have problems with Salmonella.

Grain that is neither heat-treated nor pelleted for sows

It is studied if the prevalence of Salmonella may be reduced in weaners if regular, pelleted sow feed is replaced by sow feed where part of the grain is neither heat-treated nor pelleted. Herds that have done this are compared with corresponding herds that have not changed diets. Preliminary results show no difference in Salmonella measured in weaners between the two groups.

Still fewer Danes become ill due to Salmonella in pork

Calculations made by the Danish Zoonosis Centre reveal that the number of Danes that become infected by Salmonella is substantially decreasing. The surveillance plan made by the pig industry was an efficient tool for halting Salmonella in Danes. Since the initiation of the surveillance plan in 1995 when approx. 1,100 people fell ill from Salmonella in pork, the number has decreased. Thus, in 2000 only 166 Danes fell ill from Salmonella in pork, which is the lowest number since the initiation of the Salmonella surveillance plan.

Table 1. Prevalence of Salmonella in Danish fresh pork 1996-2000

Year	1996	1997	1998	1999	2000
% positive	1.2	1.1	1.2	0.9	0.7

*Table 1. Productivity and relative risk ** of a pig being salmonella-positive measured by way of blood samples*

Diet	Control, pellets	Meal	5% potato prot. concentrate	Commercial diet from Aarhusegnens Andel	10% sugar beet pulp	0.05% zincgluconate from ScanFeed
% positive	30.2	10.3	22.5	20.0	17.5	22.2
Relative risk**	1	0.19*	0.56	0.46	0.40*	0.56
Production value						
GM/place unit/year	723	569*	778	701	702	700
Index	100	79	108	97	97	97

* Values marked * are significantly different from group 1, $p < 0.05$

** Relative risk denotes how much higher the risk is of a pig being positive when a certain type of feed is used. The relative risk is stated in relation to group 1.

Table 2. Feed texture in pellets - groups

Group	1	2	3	4	5	6
Diet	Wheat	Wheat	Wheat	Wheat	Wheat	Wheat/barley (1:1) + 0.6% Formi LHS
Form	Meal	Pellets	Pellets	Pellets	Pellets	Pellets
Grinding	3 mm hammer mill	2 mm hammer mill	5 mm hammer mill	Rollermill medium coarse	Rollermill all coarse	Barley: 3 mm Hammer mill. Wheat: Roller mill, all coarse

New method for measurement

January 1 2001 saw the introduction of a new method for surveillance of Salmonella in carcasses where three clearly defined areas (ham, chest, jaw) of 100 cm2 each are swabbed on a total of five carcasses per slaughter day per slaughterhouse. This method is more sensitive than the one used so far, and the share of positive samples is therefore expected to rise slightly. This should only be seen as an effect of improved surveillance and not as an expression of an increased prevalence of Salmonella, cf. figure 1.

New, increased measures

During the last year, the surveillance plan was further tightened among others in the areas of primary production and of the slaughter process. Meat juice surveillance of finisher herds was also tightened as of August 1 2001. The limit of when a meat juice sample is considered positive is reduced from 30 to 10, a weighting of the meat juice samples is introduced so that the last month counts three times as much as the previous two months. The result of the meat juice surveillance is provided as a finisher index that replaces per cent of positive samples. The result is a more sensitive surveillance system where the herds reach levels 2 and 3 faster when the excretion of Salmonella is high and exit the levels faster when the problem is solved.

Levy on Salmonella

The pig industry has agreed on a new, increased levy on Salmonella. The aim is to promote the reduction of Salmonella as much as possible in herds with antibody-positive samples. In practice, this means that the pig producer and his advisers draw up an intervention plan on Salmonella to reduce the prevalence of Salmonella as quickly as possible. The requirement that a vet and a pig adviser sign the intervention plan no longer exists nor is it necessary to submit declarations to the slaughterhouse. The size of the levy on Salmonella is linked to the level of the herd:

Levy on Salmonella in % of the slaughter value
Level 1: 0%
Level 2: 2%
Level 3: 4%

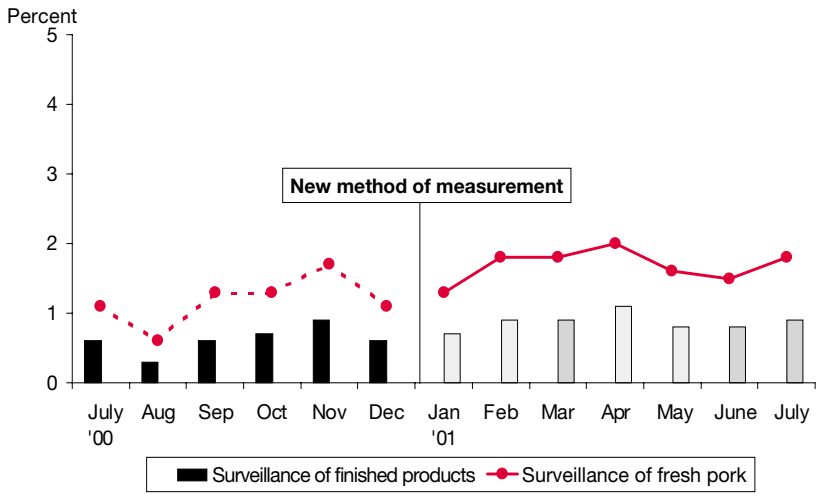


Figure 1. Surveillance of finished products vs. surveillance of fresh pork

New strategy for DT 104

In autumn 2000, the authorities and the livestock industries drew up a new, joint strategy for DT 104 that introduces the concept Zoonosis Restriction (ZR). Infected herds are subjected to ZR, which includes requirements of an intervention plan on Salmonella, restriction on sales and on handling slurry.

The intervention plan ensures continued measures for the reduction of Salmonella in the herd for a minimum of 12 months while the sales restrictions prevents spreading DT 104 to other herds.

Finishers from herds infected by DT 104 may either be slaughtered as level 3 pigs with obligatory subsequent heat-treatment or they may be subjected to decontamination. In principle, this is basically a regular hygienic slaughtering where, after removing the organs, the carcasses are scalded in hot water. The carcass is showered in large amounts of water (80°C) for approx. 15 seconds. The large amounts of water drastically reduce the number of bacteria on the surface of the carcass. In each batch, five carcasses per herd are examined after the decontamination with the aim of verifying the bacteriological effect of scalding. If no Salmonella is found, the entire batch can be used for fresh consumption.

Conclusion

The surveillance plan on Salmonella has significantly affected the prevalence of Salmonella in pork and the number of people suffering from a salmonella-infection. The surveillance plan is continuously revised in order to ensure a further decrease in the prevalence of Salmonella.

Objective assessment of health status

The project is carried out in the context of the Research Centre for the Management of Animal Production and Health in which the Danish Institute of Agricultural Sciences, the Danish Institute of Agricultural and Fisheries Economics, the Danish Veterinary Laboratory, the Royal Veterinary and Agricultural University, and the National Committee for Pig Production also participate. The comprehensive data from the project are still being computed, and therefore only extracts of the preliminary results are presented.

Herds and data basis

The research project involves participation of 112 sow herds, 182 integrated herds and 103 finisher herds. The herds are chosen among commercial herds by the Danish Institute of Agricultural and Fisheries Economics. Telephone interviews were made with all the participating herds. In the finisher herds, the producers recorded treatments for diseases, and veterinary technicians from the National Committee further examined the occurrence of disease and validated the questionnaire during visits to the herds.

Housing section and management in the herds were described by way of interview with the 397 producers. In 34% of the sow herds, some or all of the sows were housed in groups in the gestation section. Among the 103 finisher herds, 55 employed all-in all-out batch operation in the entire herd, of this 18 had consistent clearing and cleaning. The remaining herds used both types of management in different housing sections. Few of the integrated herds employed all-in all-out operation in the finisher section.

Respiratory disorders

The finisher herds were blood tested for two important respiratory disorders. 29% of the herds housed no sero-positive against Mycoplasma hyopneumoniae (pneumonia) or Actinobacillus pleuroneumoniae type 2 (AP2). 65% housed at least one sero-positive against M. hyopneumoniae, but only 28% housed at least one sero-positive against Actinobacillus pleuroneumo-niae type 2. The serological methods developed in this research can also be used in connection with meat juice.

Health

A total of 55,712 pigs were examined, i.e. an average of 1,300 pigs in each herd. Results from the other herds are not yet available. Results from visits to 43 of the finisher herds reveal that the veterinary technicians found ear and tail biting in 3.4% and 1.0% of the pigs, respectively, that 2.2% of the pigs coughed, and that 1.7% of the pigs suffered from lameness.

Treatment with antibiotics

Producers recorded all treatments for a period of two months. The number of treatments varied greatly. Most herds (76%) initiated an average of less than one day's treatment with antibiotics per produced finisher (30-100 kg). Some herds (21%) needed an average of up to ten days' of treatment with antibiotics, while very few herds (3%) had a large need for treatments. The majority of all treatments (86%), mainly for diarrhoea, took place by way of feed of water. When individual animals were treated with injections, the most common cause was by far leg injuries (43%), followed by respiratory disorders (15%) and diarrhoea (11%).

Chronic adhesive pleurisy

The Royal Veterinary and Agricultural University and the National Committee have examined 36 risk factors of chronic adhesive pleurisy on slaughter. The basis of this study is a total of 259 finisher herds or integrated herds. Poor health status, high density of pigs in a range of five km and slaughter in the summer are all connected to an increased frequency of chronic adhesive pleurisy. Herds that employ all-in all-out operation and use dry feed generally experience fewer cases of chronic adhesive pleurisy, while mixing pigs from different pens as part of continuous operation increases the number of cases of chronic adhesive pleurisy.

The size of the herd is not as such important to the occurrence of chronic adhesive pleurisy.

Veterinary technician visits a herd.

Post-weaning diarrhoea

There is still no such thing as an easy solution for herds with problems with post-weaning diarrhoea. However, in a number of herds it was possible to reduce the problems at weaning without the use of antibiotics.

Optimised management

In seven weaner herds with poor health and low productivity, tests were made with optimised management. The aim was to see if the problems might be reduced by optimising the production conditions as much as possible – table 1 provides an outline of the improvements made.

Table 1. Outline of possible measures of improvement implemented in group 3 (optimised operation)

- Gruel feed (before and after weaning)
- Restrictive feeding (first 14 days)
- Additional water (trough, drinker)
- Reduced batch size
- Reduced stocking density
- Systematic use of relief pens
- Improved immediate environment
- Improved hygiene/infection control
- Protective diets
- Gradual changes in feed over seven days

The measures in the test group were compared with the normal practice of the herd with and without use of an antibiotic growth promoter (Avilamycin) in the feed, respectively. In the two herds, there were only two groups (optimised and with/without antibiotic

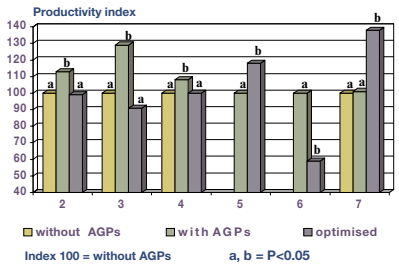


Figure 1.
Effect of optimisation on productivity

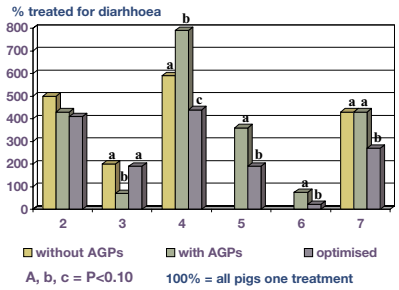


Figure 2.
Effect of optimisation on treatments for diarrhoea.

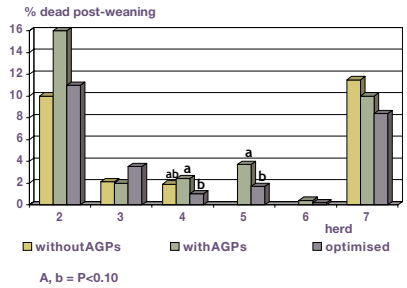


Figure 3.
Effect of optimisation on mortality

growth promoter). The results are shown in figures 1, 2 and 3. Overall, the tests showed that optimising the production conditions benefits the health of the pigs, but it is apparently harder to reach the same level of productivity as the use of an antibiotic growth promoter. In some herds, preventive medication may be necessary in order to avoid an unacceptably high mortality.

Other activities

The effect of single measures for prevention of post-weaning diarrhoea is also studied. The following tests have been initiated:

Anti-secretory factor

One of the factors regulating the loss of fluid from the intestines is called anti-secretory factor. Pigs that are given feed that stimulates anti-secretory factor should lose less fluid if they contract post-weaning diarrhoea. Preliminary results from two herds showed a slightly lower mortality and fewer treatments for diarrhoea among those pigs, but the differences are not significant.

Biacton (lactic acid bacteria)

Addition of lactic acid bacteria has previously had the biggest effect on very young animals. Experiences from practice indicate that massive addition of lactic acid bacteria around weaning to sow and piglets prevents post-weaning diarrhoea. No results are yet available.

Restrictive feeding

A test is made to see if it is possible to feed restrictively without manual labour (floor feeding). The effects of two and four daily feedings on health, behaviour and dust load are studied.

Lawsonia

Together with the National Veterinary Laboratory (NVL), the National Committee for Pig Production has initiated studies to elucidate the infection path of Lawsonia at herd level, the influence of the infection on weight gain, and to see if it is possible to eradicate the disease.

Eradication of Lawsonia

Preliminary results indicate that in some cases it is possible to eradicate Lawsonia in newly established herds. In six out of eight herds Lawsonia was apparently eradicated by medicating boars and young females in two periods separated by transfer to newly cleaned housing sections. In connection with the transfer, the hooves were disinfected in a footbath. Tiamulin was used for medication in five herds, two herds used tylan, and one herd used lincospectine. The pigs were typically medicated either in sales herd or after entering the new herds, or a combination.

To verify whether it is possible to eradicate Lawsonia by way of medication, the National Committee, together with NVL, initiated a follow-up scheme for the herds that have attempted to eradicate Lawsonia. The eradication attempts took place in newly established herds as described earlier or under the same medication scheme in existing herds where all animals under the age of ten months were removed (as when eradicating pneumonia).

Herds are examined every four months after the medication period for a two-year period beginning when the first pigs weigh 30-50 kg. Twenty faecal samples and twenty blood samples are collected from the same animals. Preliminary results are shown in table 1.

Table 1. Preliminary results from eight herds where eradication of Lawsonia was attempted.

Herd	Medication	Observation period, months	Positive samples	
			Manure	Blood
1	tia[1]	22	16/60 [4]	n.e. [5]
2	tia[1]	21	15/20	n.e.
3	tia[1]	19	0/20	0/20
4	tyl[2]	17	0/60	0/40
6	tia[1]	13	0/60	0/40
7	tyl[2]	13	0/40	0/40
8	tia[1]	13	0/40	0/20

[1]= Tiamulin, [2]= tylosin, [3]=lincospectine, [4]= positive samples/tested pigs, [5]=not examined

Time of infection

Even though probably 90% of the Danish herds are infected by Lawsonia, our knowledge on the bacteria is very limited. To-gether with NVL, the National Committee has therefore carried out a number of tests aimed at elucidating:

- When the pig is infected by Lawsonia
- For how long Lawsonia is excreted from an infected animal and to where the infection spreads (housing section)
- How does the Lawsonia infection affect the daily gain of the individual animal
- Assessment of a new blood sample test for Lawsonia
- Assessment of whether slaughterhouse material (intestinal tract) may be used for assessment of the infection/disease status of a herd

In this test, 20 pigs in five herds were observed from weaning to slaughter. Every 14 days, the pigs were weighed and blood and faecal samples were collected. Preliminary results indicate that most pigs excrete Lawsonia when they are 8-14 weeks old and that they excrete Lawsonia in the manure for 4-6 weeks. Among the 100 examined pigs, Lawsonia was diagnosed in 66 pigs. Figure 1 shows the preliminary results from part of the test.

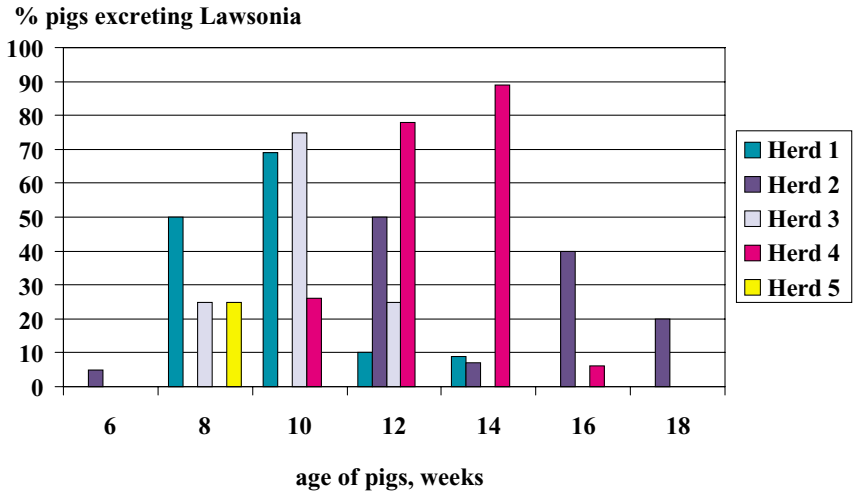


Figure 1. Excretion of Lawsonia in manure in 20 pigs in five herds

PMWS and PDNS

PMWS

Post-weaning Multisystematic Wasting Syndrome (PMWS) was first described in 1991 in a Canadian herd with a high health status. In subsequent years, the disease was diagnosed all over the world both in the USA, Europe and in the Far East. PMWS has a very varying clinical picture in the individual herds. Frequent symptoms are chronic wasting, pale skin colour and decreased growth rate. Other symptoms frequently seen are coughing, diarrhoea, icterus, and puffing. The symptoms are unspecific and can easily be mistaken for other diseases such as intestinal or respiratory disorders. PMWS is mainly seen in pigs in the age 4-12 weeks, and other countries have reported of great problems with chronic wasting, pale skin colour, decreased growth rate, and mortality in affected herds.

The cause of PMWS is an infection by a virus Porcine circovirus type 2 (PCV2), but besides this, the presence of other factors is required before the disease develops. These factors have not been established, but simultaneous infection with parvovirus and PRRS seems to aggravate the disease. PCV2 is widely spread, and antibodies against PCV2 can be found in herds without symptoms of PMWS. It is diagnosed by comparing the clinical symptoms, discoveries from autopsies and microscopic discoveries. During the microscopic examination, characteristic findings are multi-nucleus giant cells and dark bodies (basophile inclusion bodies). The disease cannot be cured, but abates after a period of time.

PMWS in Denmark?

In co-operation with the Danish Veterinary Laboratory and the Danish Veterinary Institute for Virus Research, the National Committee initiated an examination in 2000 with the aim of elucidating if PMWS exists in Denmark. Eight herds were visited, and pigs were put down and submitted for laboratory examinations, and blood samples were collected for examination of antibodies against PCV2. Antibodies against PCV2 were found in all the visited herds, but only two of the herds suffered from the disease PMWS. In both herds, the disease was a milder version than seen abroad, and none of the herds housed any of the microscopic elements that are characteristic of PMWS. The conclusion of the study is that PMWS is present in Denmark, but in a significantly milder version than what has been seen abroad.

PDNS

PDNS is a skin and kidney disease that mainly hits growing pigs and finishers. The disease is characterised by skin lesions on the hind part and around the forelegs, oedema on the legs and haemorrhages in the kidneys. The skin lesions are punctiform haemorrhages that may coalesce to larger areas with haemorrhages. The disease is common in England and Spain. It hits few pigs in the herds, but mortality among the pigs hit is high. The pigs become depressed and often lie down. The symptoms are very similar to classical swine fever, and in relation to classical swine fever it is a very important differential diagnosis. The National Committee visited a herd where one pig was discovered with typical signs of PDNS. The herd was observed by the National Committee for a period of time, but no more cases were found. The cause of PDNS is an inflammatory reaction in the blood vessels. This reaction is caused by an immunological reaction, though the factors or pathogens that trigger this reaction are not yet discovered. However, PCV2 may contribute to the development of PDNS.

Conclusion

The studies of the National Committee thus reveal that PMWS does exist in Denmark in a milder version than what is seen abroad. The reason for this is not established. One explanation may be that PCV2 virus in Denmark is not as pathogenic as the foreign virus strains. Another explanation may be that in Denmark other factors such as management and environment reduce the disease.

Pig suffering from PDNS

Risk factors of low weight at weaning

The study examined the relative effect of breeding, nutrition, immediate environment and health on weaning weight in three sow herds where the sows were fed liquid feed in the farrowing section.

Data

Information on boar, sow, pen number, farrowing date, birth weight, weaning date and weight was compared with recordings of the herd owner on the sow's transfer and departure weights, her feed intake, litter equalisation, treatments for diseases of both sow and weaners.

Weekly visits

The first and third weeks after farrowing, a technician assessed udder, farrowing rails, performance of water valves for sows and piglets, leg position, stance, wounds and scratches on head, neck, shoulder, legs, hooves and accessory digits on the sow.

Results of the individual pig

All recorded factors were analysed. Table 1 shows the factors important to the pig's weaning weight when adjustment is made for the other factors. The factors are listed with descending importance for the individual pig. Average daily gain of piglets in the farrowing section was 201 g/day.

Positive effect on the individual pig

Table 1 shows that the pig's daily gain in the farrowing section is positively affected by weak pasterns on the sow, increasing birth weight, female gender and feed intake of the sow on the day of weaning.

Negative effect on the individual pig

The pig's daily gain in the farrowing section is negatively affected by treatment for diarrhoea, arthritis, and chronic wasting and decreased growth rate, ulcers on fore knees of the pigs and a slack udder on the sow in the third week post-weaning.

Effect on the entire litter

Disease may have a dramatic effect on the individual pig, but it does not necessarily affect the gain of the entire litter in the farrowing section. To illustrate the importance of factors that affect the entire litter, table 2 shows the effect on the overall litter weight.

Positive effect on the litter

Weak pasterns on the sow, increased birth weight and a high feed intake of the sow positively affect the weight of the litter at weaning.

Negative effect on the litter

The weight of the litter at weaning is negatively affected by a slack udder towards the end of the nursing period.

Conclusion

Of all the factors influencing litter weight, only the sow's feed intake may be affected by the herd owner. However, he can easily affect the pigs' health, which only to a minor degree affects the overall litter result though, but is of great importance to the individual pig. Improved health can be reached through changes in management and improved supervision of the pigs.

Table 1. Factors influencing the gain of the individual pig in the nursing period

Factors	Calculated importance
Weak pasterns on the sow	+
Birth weight*	+
Female pig	+
Sow's feed intake at weaning/FUp	+
Ulcers on knees	-
Weak udder three weeks post-weaning	-
Pigs treated for chronic wasting and decreased growth rate	-
Pigs treated for arthritis	-
Pigs treated for diarrhoea	-

Table 2. Factors influencing the entire litter, stated as change in litter weight with ten weaned pigs at 28 days' nursing period

Factor	Calculated $importance to end weight (kg) of the litter
Weak pasterns on the sow	+3,9
Birth weight*	+2,5
Sow's feed intake at weaning/FUp	+0,6
Slack udder three weeks post-weaning	-3,9

* effect of 1 kg extra birth weight per litter

Healthy pigs and high feed intake of the sow in the farrowing section helps ensuring a high weaning weight.

Causes of death in pigs

As part of the project Breeding for disease resistance (cf. page 10) in which genetically determined disease resistance is mapped, all the test pigs that died during the project were subjected to a post-mortem examination.

The collection of data from the three test herds ended in September 2001 when approx. 12,500 test pigs were monitored from farrow to slaughter.

Below, the post-mortem findings in the pigs submitted from the beginning of the test and until July 13, 2001 are described.

The three participating herds have different health statuses and the findings vary from herd to herd. The figures are general and thus do not reveal differences between the herds.

Dead pigs

Pigs that died were recorded by the herd owner and placed at refrigerator temperature. Twice weekly they were collected and transported to the laboratory in Kjellerup for post-mortem examinations. The aim was to find the cause of death.

Table 1. Test pigs

Test pigs	Farrowing section	Controlled env. section	Finishers
Number	12,481	11,190	10,646
Dead	1,011	377	204
	8.1%	3.4%	1.9%

Table 1 shows how many test pigs have been through farrowing section, controlled environment section and finisher section, respectively, in the three herds. The number of dead/autopsied pigs is higher in the farrowing section with 8.1% against 3.4% in the controlled environment section and 1.9% in the finisher section.

The fact that the number of pigs that died in the farrowing section is not higher than that may be due to the fact that not all pigs in the herd participated in the test just as some of the litters that were included in the test were later removed.

Table 2. Post-mortem findings

Diagnoses	Farrowing section Diagnoses	Share of diagnoses	Controlled env. section Diagnoses	Share of diagnoses	Finishers Diagnoses	Share of diagnoses
Starvation, born weak, crushed	638	52.9%	6	1.3%	0	0%
Pneumonia	45	3.7%	81	17.9%	60	23.9%
Ileitis	56	4.6%	94	20.8%	11	4.4%
Blood poisoning, arthritis, etc.	262	21.7%	178	39.4%	114	45.4%
Other	205	17.0%	93	20.6%	66	26.3%
Total		100%		100%		100%

What does the pigs die of?

Table 2 shows the primary causes of death found during post-mortem examination of the test pigs. The diagnoses have here been computed as total-diagnoses, and thus cover more detailed diagnoses. The number of diagnoses for the housing section is summarized and subsequently their distribution in per cent is calculated. The result is then the distribution of the diagnoses within the individual housing sections.

It is clear that a large part of the pigs died from starvation, were born weak or were crushed in the farrowing section.

The number of pigs that died as a consequence of blood poisoning is high in all housing sections. Blood poisoning is the most frequent total-diagnosis in the finisher section, and second-most frequent in the two other housing sections.

Here blood poisoning is a wide total-diagnosis covering all types of bacteria spread via the blood. Thus the diagnosis includes arthritis, osteomyelitis, cerebrospinal meningitis, otitis media, pericarditis, endocarditis, peritonitis, and pleurisy.

As the pigs grew older, the diagnosis "blood poisoning" increased in prevalence. However, this should be seen in relation to the decreasing number of dead pigs within the housing section.

This tendency also applies to the diagnosis pneumonia that climbs from 3.7% in the farrowing section to 23.9% in the finisher section.

The final set of data enables a closer analysis of causes of death in pigs. Here the differences between the three herds will be revealed as will differences over time in the individual herds.

GIS as a tool for herd consultancy

A Geographical Information System (GIS) is a computer programme in which herds are recorded electronically on digital maps of Denmark.

The Danish Bacon & Meat Council developed the first version of the system to be better prepared for the fight against classical swine fever or foot-and-mouth disease. Now GIS also benefits the individual pig producer in connection with establishment of new herds or with eradication of disease in existing herds. By way of GIS it can be assessed if the premises are located at a place where the herd has a good chance of avoiding a range of airborne pathogens.

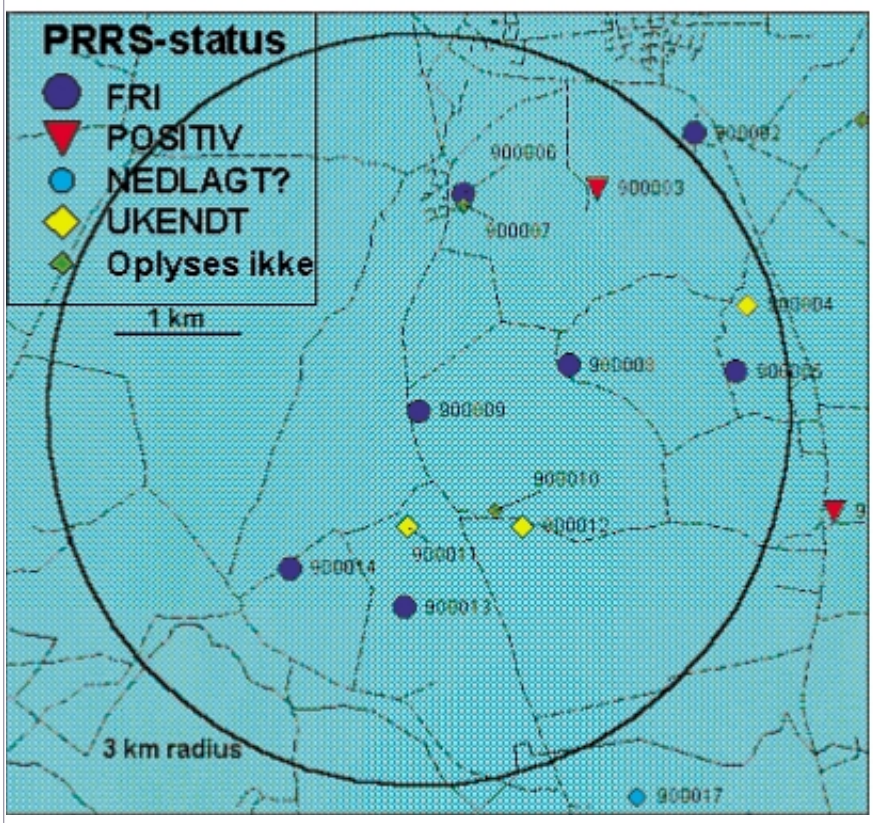
A herd's risk of contracting e.g. pneumonia, PRRS, pleuropneumonia and pig influenza highly depends on its location in relation to other herds: the further away from other pig production, the better.

When assessing the location of the herd in relation to infected neighbours (in terms of SPF diseases + PRRS), a so-called GIS report may be of good help. Today, the GIS report contains a topographic map with the herd in question placed at the centre and with other herds (and their SPF statuses) located within a distance of three km.

In addition to this map, calculations have been made of the likelihood of the herds avoiding mycoplasma pneumonia for one year. This calculation is based on studies of re-infections of Danish SPF herds. Furthermore, the report contains a list of all herds within a range of three km, and two further maps: one map with PRRS status and one with the size of the neighbouring herds.

Each year, farmers must opt out of or enter their herd in the public CHR register stating the number of sows and finishers on the premises. Regularly, this information is electronically transferred to the GIS where the herds are placed electronically on the map as a dot on the built-on area. Information on the SPF statuses and the PRRS statuses of the herds are regularly combined with the databases of the SPF Company and the National Committee for Pig Production, respectively. The maps are used as the basis of a discussion between the pig producer and his advisors of the risk of infection after having critically assessed whether the information on the map is correctly recorded. In general, it is important to be aware of the distance to the neighbours, of the size of neighbouring herds and of what diseases are present in the area.

The GIS report can be obtained from the local offices of the Danish Bacon & Meat Council in Kjellerup, Vodskov, Vejen, Roskilde or at Axelborg in Copenhagen (tel.: +45 3311 6050). The report costs DKK500 per CHR number.



Example of a GIS map

Information and reported results - October 2000 - October 2001

Reports:

No. 18: Feeding boars – a literature study with focus on the boar's performance in reproduction

No. 19: Pig production costs in vari ous countries

Experience:

No. 0012: Swiss farrowing pens for loose, lactating sows (Oct. 2000)

No. 0101: Function of sprinkling systems in finisher units (Jan. 2001)

No. 0102: Slatted floors for finishers in pens with partially slatted floor (Jan. 2001)

No. 0103: Optimisation of organic finis her pens (Feb. 2001)

No. 0104: Product test of ad lib feeders for group-housed, gestant sows (Feb. 2001)

No. 0105: Group-housed, gestant sows fed by way of a British Bio-fix system (July 2001)

No. 0106: Air passage in diffuse air intake (Aug. 2001)

Test Reports:

No. 489: Effect of Formi LHS, Acid One and Expandat on the preva lence of Salmonella, gastro-intestinal health and produc-tivity in finishers (Oct. 2000)

No. 490: Products for weaners: benzo ic acid and the combination of lactic acid and formic acid (Nov. 2000)

No. 491: Health in multisite systems (Nov. 2000)

No. 492: Commercial products for weaners: the acid product HSK 2000 (Nov. 2000)

No. 493: Service section with individu al pens or group-housing (Nov. 2000)

No. 494: Feeding finishers according to sex (Dec. 2000)

No. 495: Sprinkling of the dung area in pens for gestant sows (Dec. 2000)

No. 496: New antibiotics combination as addition to boar semen (Dec. 2000)

No. 497: Commercial products and a commercial mix for weaners – DLG Starline, Blodplasma AP820 and VEPRO 75 PSCF and VEPRO 75 BC, and Orega rom (Dec. 2000)

No. 498: Natural content of methioni ne in finisher feed (Jan. 2001)

No. 499: Optimised, continuous mana gement – production results and extended health control (Jan. 2001)

No. 500: High-fibre nursing mix (Jan. 2001)

No. 501: Pectin for weaners (Jan. 2001)

No. 502: Betafin for finishers (Jan. 2001)

No. 503: Betaine in organically compo sed feed for finishers (Jan. 2001)

No. 504: Solving problems in connecti on with removal of AGPs for weaners (1) – Formi LHS as a replacement for Avilamycin (Feb. 2001)

No. 505: Ready-mixed feed mixed with not-heat-treated grain – effect on prevalence of Salmonella in finishers (Feb. 2001)

No. 506: Mycotoxins in wheat – effect of fungicides (Feb. 2001)

No. 507: Solving problems in connecti on with removal of AGPs for weaners (2) – optimised management (several measu res at once) (Feb. 2001)

No. 508: Comparison of two diluents for boar semen (Feb. 2001)

No. 509: New programme for micro biological control of finally-diluted semen doses (March 2001)

No. 510: Fermented liquid feed for weaners (March 2001)

No. 511: Weaners' ability to compen satory growth (April 2001)

No. 512: The homogeneity of dry feed when using mineral feed mixes (April 2001)

No. 513: Strategy for feeding gestant sows and gilts with the aim of achieving a high milk per formance (April 2001)

No. 514: Determination of boar semen using flow cytometry (May 2001)

No. 515: Study of different age and concentration of boar semen (May 2001)

No. 516: M.M.A. – blood values in sick and healthy sows (May 2001)

No. 517: PMWS (May 2001)

No. 518: Heritability of drip loss in Landrace, Large White and Duroc (June 2001)

No. 519: XTRACT Pig Starter XT 6950 and formic acid for weaners (July 2001)

No. 520: Commercial products for weaners – HP300 and HP730 as alternatives to soybean for weaners (July 2001)

No. 521: Yersinia and Salmonella in multisite systems (July 2001)

No. 523: Novo Nordisk Brewer's yeast in water for weaners (Aug. 2001)

No. 524: Commercial diets for wea ners – Northern Jutland 1 and 2 quarters 2001 (Aug. 2001)

No. 525: Digestibility of nutrients in feed to which 60% dried sugar beet has been added (Aug. 2001)

No. 526: Commercial products for weaners – NuPro 2000 as an alternative protein source for weaners (Aug. 2001)

No. 527: Commercial diets for wea ners – Eastern Jutland 2 quarter 2001 (Aug. 2001)

Information material:

At http//www.lu.dk you can find various information material in PDF formats.

Earlier information material, signs etc. may also be ordered from this site.

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Subject index for the annual report 2001

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

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