Annual Report 2002

The National Committee for Pig Production

Research and Development

First edition, October 2002

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Graphic production: ProGrafica as
Photo front page: The National Committee for Pig Production, Henrik Clifford Jacobsen and Bo Nymann

ISBN 87-984721-3-5

Preface

A look back…

2002 was characterized by decreasing prices and recession. The pig producers are now busy ensuring the necessary liquidity until harvest in 2003 and generally, lenders have reacted calmly and professionally.

The pigs' new pen mate: welfare

Recession often calls for investment and renovation to ensure that production is optimum when the prices increase again. Many pig producers choose to make thorough changes of their housing units based on the future demands to animal welfare, and this area has been harmonised across the EU. The majority of the regulations were already implemented in Danish legislation, but the requirement of rooting material applying from January 2003 was a surprise. It will be interesting to see how this demand and others are handled across Europe.

Hectic environmental activity

In connection with obtaining environmental approvals, too many people still suffer under long wait and regional, special rules. The harmony area now constitutes 1.4 animal units per ha for pig slurry and particularly the sow herds are now under pressure to obtain the required land. Unfortunately, the possibility of using own nutrients accounts was not included this time and there is no incentive to putting in an extra effort. Nevertheless, the pig producers display an impressive environmental activity e.g. by using phytase in the feed and using new technology for handling slurry.

The National Committee for Pig Production invests many resources in reduction of nutrients through changed feeding procedures and trials in housing units with the aim of reducing odour and ammonia evaporation and in slurry treatment. There is no doubt that the environmental effort is crucial for the pig producers in the years to come and the negotiations of Action Plan for the Aquatic Environment III will be closely followed.

High productivity, but much disease

The breeding system runs smoothly. We are witnessing a genetic improvement that is hardly matched by any other breeding system or company in the world. The increase in litter size is impressive and this progress will continue. The pig producers now complain of too many pigs, which is an unfamiliar scenario. The challenge of the sow herds in tending to many extra pigs is probably only exceeded by the conversion to loose housing of sows.

The removal of antibiotic growth promoters is still causing quite some problems. Fortunately, the expected increase in prescription antibiotics now seems to be stabilised. The attitude of the National Committee is clear: diseases such as Lawsonia must be treated, but any unnecessary use must be avoided and the medication must be carefully selected.

PMWS has become widespread over the last year causing great losses of weaners and despite comprehensive research in many pig-producing countries, the riddle of PMWS has not yet been solved. Is it a new and unknown virus? A special circo virus? Or is it triggered by completely different factors? The National Committee for Pig Production has given top priority to the effort against PMWS and all possibilities of helping the herds suffering will be examined.

The Salmonella surveillance plan is generally a success. The number of herds in levels 2 and 3 decreases annually, and the slaughterhouses are becoming better at avoiding contamination of the meat. With our knowledge today, the special restrictions on DT104 should be removed as soon as possible. It can and should be handled as any other type of Salmonella under the general Salmonella surveillance plan.

Thank you for a joint effort

Across the world, Danish pig production is considered a success and many search for the secret behind our success. One of the answers is the co-operation on research and development with valuable participation from governmental research institutes, companies dealing with feedstuffs and housing systems, advisors, breeders, pig producers and many more. Also, our ability to introduce new systems quickly is important.

One example is the new feed evaluation system. The process has largely been unproblematic, and pig producers, feedstuff companies and advisors have been very active and efficient in using the new and more accurate prerequisites and calculations.

Another example is our surveillance of virulent diseases. This has now been strengthened with the recording of all transfers of pigs. Our system ensures that in cases of disease, it will not take long to establish the cause.

A third example is the co-operation on meeting the quality requirements from the markets, e.g. specialised productions and production for the British market.

We, in The National Committee for Pig Production, would like to thank everybody for their great effort and for the past year.

Yours sincerely
The National Committee for Pig Production
Lindhart B. Nielsen / Orla Grøn Pedersen

The National Committee for Pig Production

Chairman, farmer
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Løgstør.
Elected at the annual meeting

Vice-chairman, farmer
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Elected by Region 2 (South and Southern Jutland and Funen)

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

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 2002

Budget and strategy

The National Committee for Pig Production is founded by four basis 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 regional pig production committees.

The National Committee for Pig Production safeguards strategy, development and information tasks concerning the live pig, and has a net budget for the year 2002/2003 of DKK93.7 million. Furthermore, DKK21.4 million have been set aside for Salmonella DT104 and DKK12 million for mapping of the pig's genome.

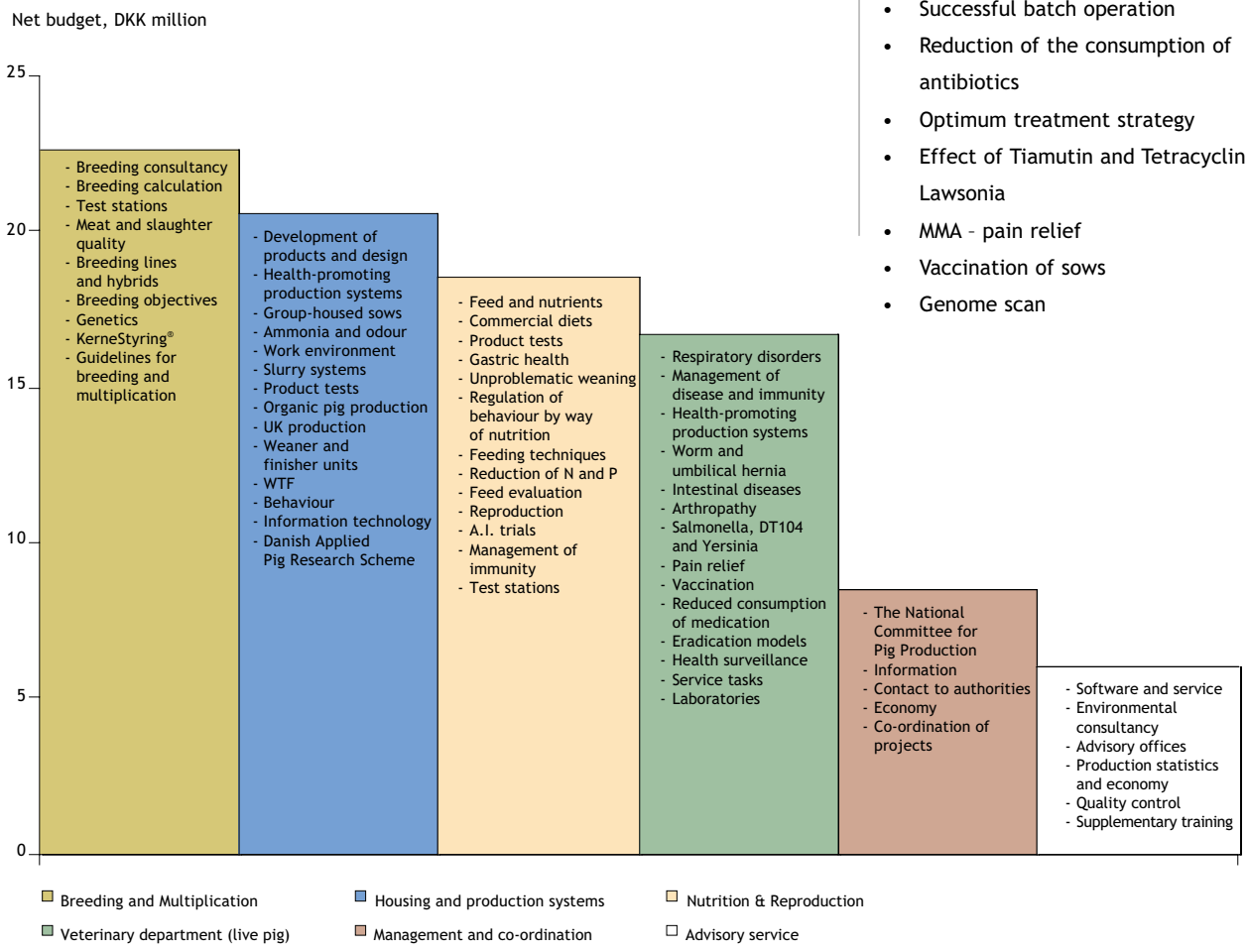
Strategy and new projects of the National Committee

Over the past years, the National Committee has increased the budget to make room for an extra effort in the environmental area on reduction of odour and ammonia. The Sino-Danish co-operation on mapping of the pig's genome has required a strengthening of the genetic effort under the National Committee. The removal of antibiotic growth promoters and the need for accurate recommendations for feeding of weaned pigs have also required many resources.

Lately, the many outbreaks of PMWS have required a great effort and the National Committee has given top priority to this disease.

On adoption of the budget for 2002/2003, the National Committee decided to initiate the following new projects:

- Chronic carriers of Salmonella in the sow unit
- Reduction of dust
- Ammonia and odour (odour nuisances, purification of air, slurry container/emptying, slurry treatment)
- 2.5 FUp per kg gain
- Unproblematic weaning (weaning age, water, diarrhoea/vaccination)
- Citric acid and butyric acid
- Ingredients
- Fat quality
- Production-safe service and gestation units
- Rationalisation of labour
- Farrowing pens for loose sows
- Liquid feed for weaners
- Slurry systems and rooting material
- Floor comfort and bedding technique
- Successful batch operation
- Reduction of the consumption of antibiotics
- Optimum treatment strategy
- Effect of Tiamutin and Tetracyclin on Lawsonia
- MMA – pain relief
- Vaccination of sows
- Genome scan



Sale of breeding stock

Table 1. Sale of animals from breeding and multiplication herds. The sale of purebred boars and gilts has increased slightly, mostly in terms of export. Despite the offer of KerneStyring® the sale of hybrid gilts has increased by approx. 10%.

Sales figures

		Female animals				Boars			
		2000-01		2001-02		2000-01		2001-02	
		DK	Export	DK	Export	DK	Export	DK	Export
Landrace	SPF etc.	1,710	2,492	3,357	3,016	280	231	103	409
	Conventional	733	-	348	-	31	-	30	-
Large White	SPF etc.	1,606	532	926	484	332	237	287	383
	Conventional	306	-	330	-	118	-	46	-
Duroc	SPF etc.	183	440	188	186	1,351	651	1,421	745
	Conventional	7	-	226	-	92	-	61	-
Hampshire	SPF etc.	0	16	106	7	6	435	1	-
	Conventional	0	1	19	-	16	10	4	18
Purebred	SPF etc.	6,950	-	4577	-	3,123	-	1,013	-
	Conventional	1,047	-	697	-	267	-	181	-
Purebred, total		**7,997**	**3,481**	**5,274**	**3,693**	**2,226**	**1,164**	**1,994**	**1,558**
Hybrid	SPF etc.	163,259	17,672	196,826	23,174	3,730	181	4,174	181
	Conventional	34,414	-	17,493	-	228	-	519	-
Hybrids, total		**215,345**	**-**	**237,493**	**-**	**4,139**	**-**	**4,693**	**1,738**

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

Transfers of weaners must be reported as of October 1 2002

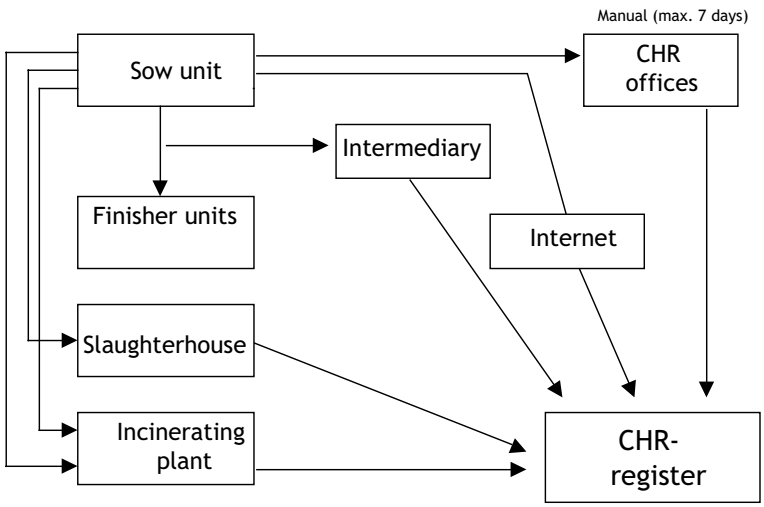
Based on EU regulations, the Danish Veterinary and Food Administration has extended the CHR register so that all transfers of pigs must be reported as of October 1, 2002. Costs for establishment and management are so far paid by the National Committee for Pig Production through the Pig Levy Fund.

The slaughterhouses and the incinerating plants deal with finishers and dead animals so that the seller will only have to concern himself with weaners, breeding stock and animals for export.

The task of reporting can be transferred to the farmer's own intermediary. Transport between CHR numbers owned by the same producer is not included when the transport takes place in his own vehicles, but such exemption must be approved by the Regional Veterinary and Food Control Authorities.

The seller must report all transfers of live animals within seven days stating the number of pigs, time and registration number of the vehicle and CHR numbers of both the herd delivering the pigs and the herd receiving them. For sale for export, it is still sufficient to state the CHR number of the Danish collecting unit.

Farmers handling the reporting themselves can choose between electronic reporting via the Internet and manual reporting to the regional cattle office, which then reports electronically to the CHR register.



Transfer register - extension of CHR/veterinary alert

Productivity

Development

The sow population increased in 2001 reaching 1,130,000, which is an increase of 60,000.

The production of finishers is still increasing reaching 22.9 million in 2001 and is expected to reach 23.4 million in 2002.

Production reports

Sows

Efficiency continues to increase in the sow unit. In 2001, the number of live born piglets per litter increased by 0.2 piglets compared with 2000, while the sows weaned 0.1 piglets more. Thus the result was 0.2 more piglets per sow per year.

The 25% best sow keepers – expressed as number of pigs per year per sow – had six piglets more per sow per year than the poorest 25%. The herds in the best group are significantly larger with an average of 301 sows per year compared with 177 sows per year in the poorest group. Another significant factor separating the groups is use of first parity sows. The best herds used 33.2% first parity sows against 25.2% in the poorest group. The 25% best achieved one live born piglet more, 1.5 more weaned pigs and a daily gain of 27 g more.

Finishers

The gain continued to increase whereas the feed conversion remained unchanged at an average of 2.89 FUp per kg gain.

As in previous years, the difference between the best and poorest 25% of the herds was seen in daily gain and in feed conversion. The best herds used 0.45 FUp less per kg gain and the pigs gained 102 g more per day, which is an increase of the difference of 16 g compared with last year.

Table 1. Development in pig production

Year	1996	1997	1998***	1999	2000	2001	2002*
Sows, 1,000	980	1040	1070	1080	1070	1130	1130
Prod. million**	20.1	21.1	23.0	22.5	22.4	22.9	23.4
Slaughter weight, kg	75.2	76.0	77.2	76.6	77.1	77.9	77.5
Lean meat %	59.8	59.9	60.0	60.0	60.0	60.0	60.0

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

Table 2. Sows and weaners

Year	Average production results 1999 All	2000 All	2001 All	2001 Poorest 25 %	2001 Best 25 %
Weight/sold pig	29.4	29.5	29.8	30.7	29
Feed/prod. pig, FUp*	99.2	99.3	99.3	111	88.3
Prod. pigs/sow per year	22.3	22.5	22.7	19.7	25.7
Litters/sow per year	2.25	2.25	2.24	2.13	2.33
Sows per year	223	230	246	177	301
First parity litters, %	21.6	27.8	28	25.2	33.2
Liveborn/litter	11.7	11.9	12.1	11.6	12.6
Stillborn/litter	1.1	1.1	1.2	1.2	1.2
Weaned/litter	10.3	10.4	10.5	9.7	11.2
Age at weaning, days	29	30	30	32	28
Weaning weight, kg	7.2	7.3	7.3	7.8	7.0
Dead post-weaning, %	3.6	3.4	3.5	5.5	2.1
ADG post-weaning, g	407	410	415	409	436
Age at 30 kg, days	85.3	85.5	85.5	90	80
Non-productive days/litter	17	17	17	24	12

** Not including feed for young sows*

Table 3. Finishers

Year	Average production results 1999 All	2000 All	2001 All	2001 Poorest 25 %	2001 Best 25%
Prod. pigs	2,991	3,180	3,290	2,835	3,649
Daily gain, g	798	817	824	769	871
Feed/kg gain, FUp	2.89	2.89	2.89	3.13	2.68
Weight at transfer to finisher unit, kg	31.0	31.3	31.6	32.0	31.2
Av. slaughter weight, kg	76.6	77.2	78.1	78.0	77.7
Av. lean meat %	60.0	60.0	60.2	60.1	60.3
Dead and rejected, %	3.6	3.4	3.6	4.2	3.0
Incidence of pleurisy rec. at slaughter	15.6	19.7	22.8	24.4	22.5
Total, incl. deductions.	7.3	7.4	8.5	9.1	8.0

Economy

Development

The positive economy of new establishments in 2000 with a result of DKK28 per pig increased to DKK133 per pig in 2001. Unfortunately, however, the bottom line is still characterized by negative figures with DKK-63 per pig in 2002.

Analysis of accounts

A large number of herds prepare 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 price per produced weaner increased from DKK370 to DKK447. The accounts show a decent increase in efficiency of 0.3 produced pigs per sow per year compared with 2001. However, 2001 was characterized by a relatively large increase in the price of feed that corresponded to DKK0.13 per FUp. Overall, the gross margin increased by approx. DKK1,500 per sow per year compared with 2001.

Finishers

The gross margin for finishers also increased considerably from DKK155 in 2000 to DKK188 in 2001. This result is also caused by the increase in prices, which clearly outweighed the increase in feed costs.

Capacity costs

The capacity costs originate only from the pure sow or finisher premises, respectively. This explains the differences in gross margin in the two tables. Maintenance costs in the sow unit increased slightly in 2001, while the costs for depreciation and interest on buildings and equipment decreased in the sow unit and increased slightly in the finisher unit. Overall, the herds obtained good profits when all costs relating to the pigs have been paid.

Table 1. Barometer for Danish pig production for new establishments

Year	1997	1998	1999	2000	2001	2002*
Price, incl. bonus pay-ment, DKK/kg	11.70	8.32	8.02	10.0	11.99	9.50
Av. feed price, DKK/FUp	1.37	1.32	1.21	1.18	1.29	1.36
GM/pig from farrow to slaughter, DKK	383	152	159	315	423	221
Capacity costs, DKK	118	123	127	125	123	126
Financing costs, DKK	187	180	180	162	167	158
Result/pig, DKK	78	-151	-148	28	133	-63

** projection*

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

	Sow units		Finishers	
	2000	2001	2000	2001
Premises	104	131	106	125
Sows per year	240	250		
Prod. pigs/sow per year	22.8	23.1		
Produced finishers			3,430	3316
Weight, kg/prod. weaner	30	30		
Gain, kg/finisher			71	70
FUp/produced weaner	110	111		
FUp/kg gain			2.94	2.98
Price, DKK/prod. pig	370	447	775	923
Price, DKK/FUp	1.33	1.46	1.11	1.19
Gross profit, DKK	8,589	10,549	395	444
Feed costs, DKK	3,375	3,754	232	247
Vet & medication, DKK	334	372	5	5
Other costs, DKK	268	335	3	4
Gross margin, DKK	4,612	6,135	155	188

Capacity costs	Per sow per year		Finishers	
	2000	2001	2000	2001
Gross margin, DKK	4,734	6,170	159	190
Maintenance, DKK	210	221	15	12
Energy, DKK	233	222	8	9
Labour, DKK*	1,735	1,620	51	48
Depreciation, buildings/inventory, DKK**	827	746	33	35
Interest, buildings/inventory, DKK***	916	845	39	42
Interest, herd, DKK***	291	302	10	11
Result/sow per year/finisher, DKK	522	2,215	3	32

** Labour: DKK123/h in 2000 and DKK128/h in 2001*
*** 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 provides an outline of the genetic improvement for the individual breeds over the last four years. Overall, the genetic improvement is identical with that of previous years, but there is great variation in the improvement in the traits between the breeds. This is primarily attributed to different weighting of the traits between dam lines and sire lines.

Hampshire has experienced a decrease in the genetic improvement of DKK1.20 caused by the intensive selection to remove the unwanted RN- allele. The allele frequency for the wanted rn+ allele has increased by 70% the last two years.

The weighting of pH in index determines that the increase in the rn+ allele corresponds to an improvement of DKK14.56 in the Hampshire breed over the last two years. However, the value is conditional upon the four-breed hybrid in the entire production. If, however, the four-breed hybrid is used in only half of the finisher production, the value of the RN- strategy is reduced to DKK7.28 over two years. Thus, if the value of the RN- strategy is included in the calculation, Hampshire has had an increase of the same size as that of Duroc.

The value of the genetic improvement as an average of all breeds was DKK9.16 per finisher per year in 2001. Of this, DKK8.12 are expected to be transferred to production. The decrease compared with the year before was primarily caused by a changed weighting of litter size in the index.

Table 1. Genetic improvement in the last four years, stated per breed and year, and as average per breed per year

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, points	Daily gain (0-30 kg), g/day	pH, units	Killing-out percentage, %
Duroc	2001	16.4	-0.03	0.10	-	0.01	1.4	0.009	0.12
	2000	18.6	-0.03	0.11	-	0.04	2.8	0.009	0.06
	1999	15.2	-0.03	0.25	-	0.02	2.4	0.013	0.00
	1998	22.3	-0.05	0.12	-	0.04	1.9	0.000	-0.16
	Average/years	18.1	-0.04	0.15	-	0.03	2.1	0.008	0.02
Hampshire	2001	0.9	0.01	-0.03	-	-0.03	0.1	0.006	-0.05
	2000	10.6	-0.02	0.08	-	-0.01	2.5	0.002	-0.16
	1999	17.8	-0.02	0.07	-	0.03	3.2	0.000	0.07
	1998	17.7	-0.03	0.10	-	0.03	3.6	0.000	0.06
	Average/years	9.5	-0.02	0.06	-	0.01	2.4	0.002	0.06
Landrace	2001	8.7	-0.03	0.06	0.28	0.06	-0.8	0.001	-0.04
	2000	11.4	-0.03	0.05	0.31	0.10	-0.7	0.001	0.03
	1999	13.1	-0.01	0.06	0.45	0.08	-2.8	0.001	-0.11
	1998	18.8	-0.02	-0.02	0.52	0.09	-4.0	0.001	0.18
	Average/years	12.3	-0.03	0.04	0.39	0.08	-2.1	0.001	-0.08
Large White	2001	13.1	-0.03	0.08	0.08	0.09	1.3	-0.001	-0.04
	2000	10.7	-0.02	0.09	0.31	0.09	-0.4	-0.002	-0.03
	1999	8.2	-0.01	0.01	0.30	0.08	-1.2	0.000	-0.01
	1998	12.2	-0.01	-0.01	0.23	0.10	-0.2	0.002	-0.02
	Average/years	11.1	-0.02	0.04	0.23	0.09	-0.1	0.000	-0.03
Four breeds	Average/years	12.8	-0.03	0.07	0.31	0.02/0.09	0.6	0.003	-0.01

Production level

Tables 1-4 show the production results achieved at test station Bøgildgård and in the nucleus herds in 2001-2002.

The breeding stock still performs production results at a very high level compared with the commercial herds both when it comes to Bøgildgård and performance tests in the nucleus herds. 4,891 animals were tested at Bøgildgård, which is the same as in 2000.

The performance tests in the herds have increased by approx. 6%. Among the sire lines, Hampshire experienced an increase in tests of both sows and boars, while Duroc experienced a slight decrease for sows in 2001 compared with 2000. Among the dam lines, fewer Large White boars were tested while Landrace experienced an increase in tests of both boars and sows. It should be noted that a part of the lowest indexed Landrace and Large White boars are excluded from tests, which explains the uneven distribution by sex for those breeds.

The production level between the breeds cannot as such be compared as only few animals are tested in the same environment (same herd). If levels of gain are compared, one must – besides herd differences – take into account the difference in killing-out percentage between the breeds.

Table 1. Average results from the performance test station Bøgildgård in 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	1,671	960	2.36	59.9	5.67	74.9
Hampshire	599	889	2.43	62.2	5.55	76.7
Landrace	1,275	928	2.44	60.9	5.55	75.1
Large White	1,346	926	2.37	61.7	5.60	76.0
Total	4,891					

Table 2. Nucleus herds - Average production results for boars in 2001

Breed	Number	Daily gain, g/day 0-30 kg	Daily gain, g/day 30-100 kg	Lean meat content, %	Conformation, points
Duroc	9,254	382	1,004	59.5	2.97
Hampshire	1,495	363	847	62.0	2.96
Landrace	16,960	380	962	61.7	2.97
Large White	12,994	371	959	61.2	3.14
Total	40,703				

Table 3. Nucleus herds - Average production results for female pigs/gilts in 2001

Breed	Number	Daily gain, g/day 0-30 kg	Daily gain, g/day 30-100 kg	Lean meat content, %	Conformation, points
Duroc	10,894	381	955	59.5	3.10
Hampshire	2,054	366	817	61.8	3.12
Landrance	22,897	383	927	61.7	3.16
Large White	15,902	371	930	61.2	3.31
Total	51,747				

Table 4. Litter size of purebred litters produced in 2001

Maternal breed	Litter size (purebred litters in nucleus herds)	Percentage of gilts
Duroc	9.8	76.3
Hampshire	8.2	67.4
Landrace	13.7	60.0
Large White	12.2	60.6

Research and development

Breeding for disease resistance

Through biotechnological methods, this project aims at discovering genes or areas (QTL) of the pig's genome that are of significant importance to financially important traits. The project focuses on mapping of genes for traits that are difficult to improve with the traditional breeding methods including genetically conditioned resistance against pneumonia. Furthermore, traits for production and meat quality are included in the project alongside general disease resistance.

The first stage of the project involved collection of phenotypic data and was concluded at the end of 2001. Data have been collected from 9,938 finishers selected among 1,126 litters. The finishers were offspring of 14 selected Duroc A.I. boars and LY/YL sows from three commercial herds. The three commercial herds were selected among herds with prevalence of pneumonia.

Preliminary analyses of the data material show that there was a significant difference in the frequency of both pneumonia and pulmonary adhesive pleurisy in the offspring of the 14 Duroc boars. As expected, there was also a difference in the traditional traits including daily gain and meat quality in the offspring of the Duroc boars.

The second stage of the project will be initiated at the end of 2002 and comprises a genome scan of all the test pigs with the aim of localising the genes or QTLs that contribute to the differences observed between the offspring of the Duroc boars. The difference in disease frequency indicates that it is possible to breed for disease resistance against respiratory disorders possibly through new techniques such as marker genes.

The project is carried out in co-operation with the Department of Animal Breeding and Genetics at the Danish Institute of Agricultural Sciences.

The "supersow" project studies whether supplementing fertility traits can be included in the breeding objective for Landrace and Large White.

Mapping of the pig's genome

The co-operation with The Beijing Genomics Institute in China on sequencing of the pig's genome has now entered its second year and is progressing according to plan. A so-called shotgun sequencing of the pig's genome is to be made. A total of eight million readings will be made, which corresponds to the genome having been "read" once. It is estimated that approx. 80% of the genome is hereby sequenced (read). Approximately three million readings of the planned eight millions have been made by now.

The second task is sequencing of the pig's genes. This is done by sequencing the so-called cDNA libraries. A cDNA library is a collection of DNA fragments from a certain tissue; fragments originating from a coding DNA. A total of 12,000 and 14,000 DNA fragments are collected from a given tissue, which is subsequently sequenced. Such a fragment contains an average of 450 base couples. There are obviously replicates, but typically 3,000 to 7,000 different genes are represented in each cDNA library. The fact that the genes are sequenced several times shows how frequently a given gene is expressed in the tissue. In this connection, the interesting part is the SNPs (the single nucleotide polymorphies), the so-called mutations. Every time 1,200 to 1,500 bases are sequenced, there is a genetic mutation in the genetic code. The values of the mutations differ.

When the sequencing is complete, the remaining material is expected to contain in between 50,000 and 100,000 SNPs. That is a huge amount of information of which only few of the SNPs have a quality that necessitates patenting. It is expected that there are between 2,000 and 4,000 SNPs of high quality, which is also a high number, that cannot be used optimally in the near future. The data from the Sino-Danish project will initially be used for a genome scan of the pigs in the project "Breeding for disease resistance".

Table 1. Comparison of offspring of Hampshire and Duroc boars

	Daily gain, (30-100), g/day	Lean meat content, %	pHh, units	pHl, units	Drip loss, %	A*, units	B*, units	L*, units
Duroc	928	60.0	5.49	5.38	3.90	5.49	5.93	56.2
Hampshire	889	60.2	5.49	5.38	4.25	5.49	5.23	55.0
pH	0.0028	0.50	0.97	0.62	0.34	0.97	0.0001	0.029
No. animals	869	869	353	353	353	338	340	340

pHh = pH in ham, pHl = pH in loin, A = redness of the meat, B* = yellowness of the meat, L* = brightness of the meat*

Presently 100 different cDNA libraries have been created which are ready for sequencing. The cDNA libraries are made from 100 different tissues from the pig. The libraries are being sequenced in China and the analysis task has been initiated at the Danish Institute of Agricultural Sciences and the Royal Veterinary and Agricultural University.

Comparison of Hampshire and Duroc boars

There is an increasing focus on the meat content of finishers. This is partly due to the settlement price of pigs for the British market and partly due to the decrease in meat percentage as a consequence of a higher daily gain.

The National Committee for Pig Production initiated a study in the autumn 2000 to elucidate production differences between offspring of Hampshire boars and Duroc boars after removal of the RN^- gene from the Hampshire breed. Production traits and meat quality were compared in offspring of randomly selected Duroc and Hampshire boars at Danish A.I. stations. The results can be seen in table 1. Hybrid offspring of Hampshire grew slower than offspring of Duroc. The difference in daily gain was 39 g/day and this means that Hampshire hybrids need three more days in the finisher unit to reach slaughter weight. There were no significant differences in meat content, drip loss and pH in ham and loin. The Duroc hybrids tended to have bright and more yellow meat than the Hampshire hybrids.

Offspring of Duroc boars had a higher daily gain than offspring of Hampshire boars free from RN^-.

The "supersow" project

The "supersow" project is an offshoot of the most recent revision of the breeding objectives focusing on the continued development in litter size. The project primarily focuses on vitality, birth weight and milk producing capacity to improve the profit of fertile sows. The project is carried out in all nucleus herds with Landrace and Large White sows.

In the autumn of 2001, five nucleus herds started recording conditions in connection with farrowing and lactation that can be related to maternal traits of the sow. During the spring and summer of 2002, a further 25 of 38 herds have started recording this. At the turn of the year, we expect to have 2,000 litter recordings for each sow breed. A preliminary analysis of the recordings will be initiated during winter 2002.

The objective is approx. 10,000 recorded litters from each of the two sow breeds: Landrace and Large White. This objective is expected to be reached at the end of 2004.

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

Sow experiment at Grønhøj

The project at Experimental Station Grønhøj where different recruitment strategies in the sow unit are compared is well under way. In the project, the combinations YL, (YD)L, and zigzag sows are studied and their efficiency in the same production environment is calculated.

The trial runs for a period of years and will overall produce approx. 1,000 litters of each combination. It is not yet possible to make any conclusions on the trial.

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.

Grønhøj is run as a commercial herd where the animals do not have to live up to a given index level. It is thereby possible to study the correlation between conformation when the animals are 6-8 months old and the degree of osteochondrosis of the animals and the animals' longevity. Furthermore, it provides an opportunity for studying how articular changes develop over time and thereby establish whether animals that do not have articular changes when they are young, subsequently develop articular changes and vice versa.

Assessment of the hooves made in connection with the x-ray will provide information on the influence of the hooves on the sows' longevity and reasons for removal. The project is carried out in co-operation with the Department of Animal Health and Welfare of the Danish Institute of Agricultural Sciences.

Breeding for longevity

Longevity cannot be recorded in breeding and multiplication herds as the removal of purebred sows primarily takes place on the basis of the breeding index. We lack knowledge on the genetic variation for longevity, the association between conformation and longevity and between

"Breeding for longevity" studies the correlation between the index trait "conformation" and the longevity of the production sows (Photo: Axel Søgaard).

production traits and longevity. The project was initiated with the aim of collecting information that might elucidate the above correlations.

The study is made in commercial herds with female animals of known origin. In practice this means that the herds either buy their replacement females or produce them by way of KerneStyring® (nucleus management in closed herds = known origin). A technician from the Dept. for Breeding and Multiplication evaluates all gilts when they weigh approx. 90 kg, and the individual herds submit production results and detailed explanations for removal of evaluated animals. The commercial herds that participate must house the sows in groups to ensure that the conclusions of the project are based on the production systems of the future.

So far, the data material comprises approx. 7,000 evaluated gilts of which approx. 3,500 have been removed. In two to three years data will have been collected from approx. 10,000 sows and heritability of longevity and the genetic correlation to production traits will be

assessed. The value of the present assessment of conformation in the nucleus herds can subsequently be related to the longevity of the production sows. The project is expected to create the basis for evaluating whether the breeding objective should be revised and thereby ensure that finishers and sows do not encounter welfare problems in years to come. The project is carried out as a PhD project in co-operation with the Danish Institute of Agricultural Sciences in Foulum.

Hernia

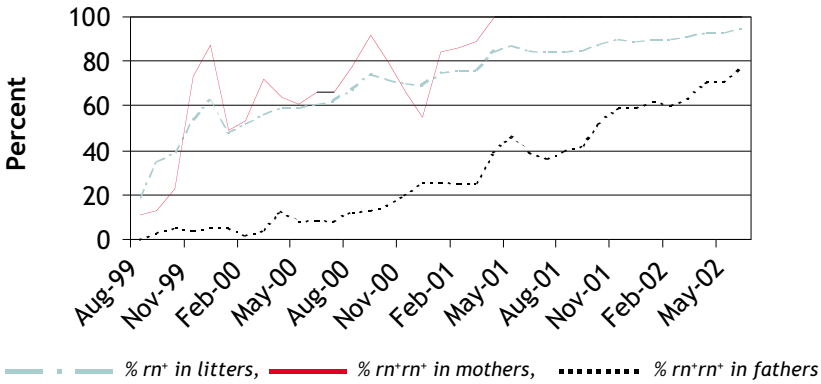
The hernia project is a co-operation between the National Committee for Pig Production and NorSvin in Norway, and the collection of data is nearly complete. The aim is to establish whether one single gene or a few genes cause hernia in pigs. The project focuses on three defects: umbilical hernia, scrotal hernia and cryptorchidism.

The theory that the defects are caused by one or a few genes is studied by carrying out DNA analyses from family members with and without defects with the aim of finding an applicable gene marker/test. Danish breeders contribute with recordings and submit blood from families with defect individuals. The analyses will be made in Norway and DanBred will subsequently gain access to the results for use in our populations. It is expected that the analyses will be completed at the end of 2002.

Elimination of the RN^- allele

In 1999, the National Committee for Pig Production decided to remove the RN^- allele from the Hampshire breed. Pigs with the genotypes RN^-rn^+ and RN^-RN^- have a fairly low pH after slaughter, which results in reduced meat quality and less processing gain. The animals were to be selected by way of a DNA test made from blood samples. At that time, 2% of the animals of that breed were rn^+rn^+. In the efforts to eliminate the gene without causing too big a loss in genetic improvement, a 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 A.I. boars and breeding stock.

The Hampshire breed is expected to be free from the RN^- allele in April 2003.



The frequency of the wanted rn^+ allele has increased quickly in the Hampshire breed.

Three years on, the frequency of the desired allele has increased to 95% for purebred Hampshire litters corresponding to approx. 90% of the piglets being completely free from the RN^- allele. Since April 2001, only boars with rn^+rn^+ were used for service in breeding, and the unwanted allele is expected to be completely eliminated in all breeding stock born after April 2003.

KerneStyring®
(nucleus management in closed commercial herds)

Approximately 300 herds with a total of 112,000 sows participate in the "closed herd nucleus management programme" and they constitute approximately 20% of the commercial sows. The number of sows has increased by 12,000 compared with last year.

Table 1 shows the number of herds participating in KerneStyring® at the beginning of August 2002. It can be seen that mainly large herds use the programme as the average number of sows is significantly above the national average.

Table 2 shows the index level of breeding stock in the herds producing their own replacements with the use of KerneStyring®. The best herds produce LY/YL and zigzag litters with an average index of more than 100 corresponding to the average of gilts from multiplication herds. Such results require that high index semen be used and that time and interest is set aside for selection of sows and gilts.

AMOS

At the end of 2001, AMOS (breeding module for the Integrated Farm Management System) was introduced. AMOS introduced an easy, on-going reporting of data from herds employing KerneStyring® to the Pig Breeding Database.

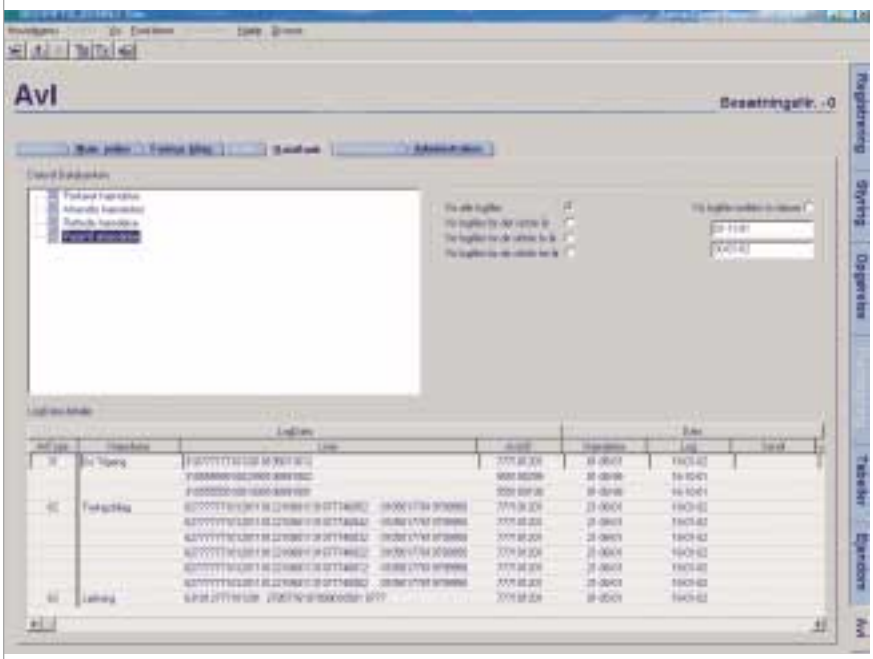
AMOS also makes it possible to transfer information on the animals and data from the Integrated Farm Management System to the Pig Breeding Database. The aim with AMOS is to ease the registration and reporting tasks and thereby enhance focus on inhouse breeding in the herds using KerneStyring®.

Table 1. Number of herds and sows in KerneStyring®, Aug. 2002.

	Nucleus strategy	zigzag	Total
Herds, no.	122	167	289
Sows, no.	50,000	62,000	112,000
Average no. of sows	410	371	388

Table 2. Average index of breeding stock in closed commercial herds using the nucleus management programme, August 2002

	Nucleus		Alternating crossing strategy (zigzag)
	LL	YY	
Female animals	76	82	76
YL/LY litters: all	94	94	-
YL/LY litters: top 20	101	101	-
Zigzag litters: all	-	-	95
Zigzag litters: top 20	-	-	102
Sows used for:			
Purebred mating	96	105	-
Crossbred mating	89	92	-
Boars used for:			
Purebred mating	128	126	-
Zigzag mating	122	125	-
Sows: zigzag mating	-	-	90
Boars: zigzag mating	-	-	123



Reporting to KerneStyring® is eased with the introduction of AMOS.

Longevity of sows

Many sows are removed from Danish herds before their normal retirement age often due to leg problems. It has not been established whether the problems are caused by joints, bones or something completely different.

Bone strength measured by way of DEXA scan

In co-operation with the Royal Veterinary and Agricultural University and Novo Nordisk A/S, a project is carried out of measurement of the bone strength. The aim is to describe the bone strength by way of the bone mineral density in normal, Danish sows expressed as a reference area. The mineral density can be determined quickly, accurately and objectively by way of a so-called DEXA scan (Dual Energy X-ray Absorptiometry). DEXA employs two low-energy X-rays where the X-ray pictures are analysed in an image processing programme.

Approximately 700 bone sets consisting of crus and tail from cull sows were collected and scanned with DEXA. Herd information was also collected by way of telephone interviews. Preliminary figures of the DEXA scans – expressed as gram mineral density per cm2 – provide reference areas of 0.76 to 1.97 for crus and 0.32 to 1.08 for the tail. Weight and type of housing were herd factors with a significant influence on the sows' bone strength. The heavier the sow, the higher the bone strength. Housing the sows in groups in the gestation unit resulted in higher bone strength than housing them individually. It was not possible to prove any connection between bone strength and breed, feed or feed allocation.

It is planned to measure ultimate strength and determine calcium, phosphorus and ash contents of the bone material. Hereby the bone strength can be directly related to the bone mineral density determined at the DEXA scan.

It is also planned to examine bones from sows that in the gestation unit were given feed with a phosphorus content corre-sponding to the Danish standard or below the standard.

Feeding of gilts

A British study showed a correlation between the fat layer of the gilts at first service and the number of produced pigs per sow. The study did not include LY gilts from DanBred and a study of this has thus been initiated. Two feeding strategies are examined for gilts in the growth interval 90-130 kg. The control group is given a lactation diet while the test group is given a diet with a low content of protein and a high content of energy.

The feeding strategy ensures that the gilts in the test group have a thicker fat layer at the first service. The trial is carried out in six herds.

Presently, the transfer of the gilts is complete. A difference was achieved in the fat layer of the gilts between the two groups at the time of service. There was no difference in the number of sows serviced between the two groups. The trial continues for two years during which production results are collected from the six herds.

DEXA scanning of bones.

Artificial insemination (A.I.)

Semen sale

Overall, approx. 57% of all services are made with purchased semen. This figure is based on a population of 1,100,000 sows. In 2001/2002, 3,346,536 semen doses were sold from DanBred's A.I. stations, which is an increase of 12% compared with the year before.

Diluents

The type of diluent used for dilution of semen is of significant importance to the durability of semen doses. The commercial market for A.I. tools sees a constant marketing of new diluents for boar semen. New long-life diluents are thought to increase the durability of the finally diluted semen to more than the presently recommended 2.5 days when the EDTA diluent is used without affecting the reproduction results. A study is therefore initiated of long-life diluents for boar semen in terms of the durability of finally diluted semen doses expressed as motility.

If one or more of the studied diluents improve the durability of the finally diluted semen, the diluent in question will subsequently be tested in a herd trial. A diluent with improved durability will also be included in the project "Development of diluents" where conditions in the epididymis are included in the development of a new diluent.

Antibiotics added to semen

Amoxicillin and gentamycin combined are today used as addition to processed semen doses from DanBred's A.I. stations. A study of the durability of antibiotics combination in aqueous solutions showed that the activity of the antibiotics can last for up to 28 days.

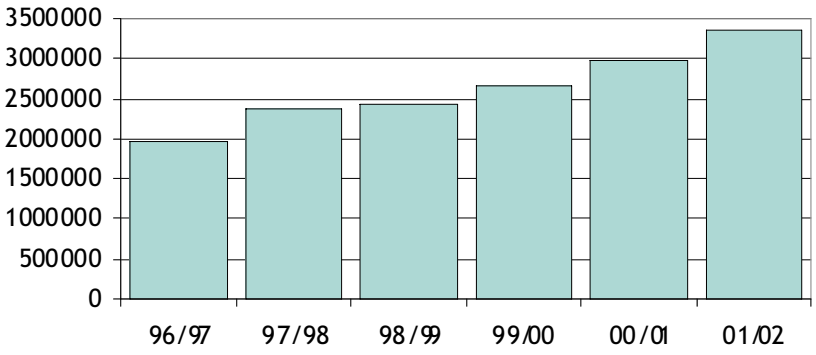
Control of finally diluted semen

DanBred's A.I. stations perform control of finally diluted semen doses. Resistance is monitored on the new antibiotic combination of amoxicillin and gentamycin and the semen doses are also examined for germ number. The upper contamination limit is 300 colony formed units per ml diluted semen.

Furthermore, concentration of finally diluted semen is expected to be determined on random samples soon.

Reduced semen concentration

A new trial will establish whether the present concentration of 2 billion progressive, motile sperm cells in a semen dose can be reduced. The aim of the trial is to compare reproduction results expressed as the total number of piglets born per litter and farrowing percentage for sows inseminated with 2, 1.5 or 1 billion progressive, motile sperm cells.



Semen sale the last six years

Furthermore, different insemination techniques are examined in the group with 1 billion progressive, motile sperm cells. Thus the 2-step insemination is tested, where at first initially diluted semen is used for insemination and subsequently the cervix is "rinsed" with diluent.

On-farm A.I. versus purchased semen

A study (Report 552) of on-farm A.I. semen and semen produced at A.I. stations showed that there were no differences in the production results expressed as the total number of piglets born per litter and farrowing percentage. Thus, seen from a reproductive point of view it does not matter whether purchased semen or on-farm A.I. is used.

Flow cytometry

In co-operation with the Royal and Veterinary Agricultural University and the Federation of Danish A.I. Societies, a project is continued where flow cytometry is used for determination of chromatin structure in the sperm cell and the acrosomal reaction of the sperm cell.

Post-cervical insemination

During post-cervical insemination, a traditional catheter is initially used where the stopper is fastened in the cervix. A thin tube (the inner tube) is led through this catheter through the cervix. It is thereby ensured that the semen enters the uterus completely. It might thereby be possible to use fewer motile sperm cells per insemination. This means that ejaculates from the best boars can be distributed to more sows. Perhaps it will also be possible to achieve better results by using frozen semen. Both Danish and foreign studies show that post-cervical insemination with the pre-

sent semen concentrations does not yield better results than traditional insemination.

The way through the cervix of the sow is blocked by several rows of cushions making it difficult to introduce the inner tube. As a result, the Danish Veterinary Health Committee has decided that post-cervical insemination of pigs is not warrantable. With permission from the Experimental Animals Authority it is examined whether post-cervical insemination inflicts injuries to the uterus and what type of injuries they may be.

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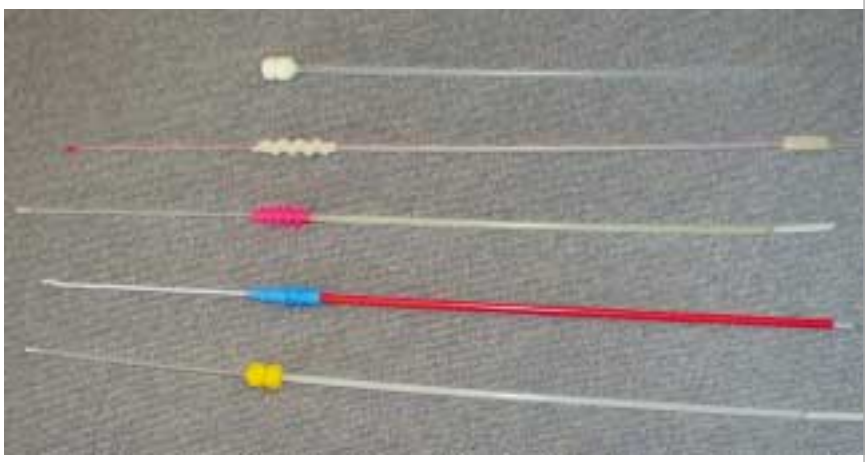
Stress as a consequence of housing and its effect on reproduction

In co-operation with the Swedish Agricultural University in Uppsala it is examined whether the reproduction results of the sows are affected by stress caused by the housing conditions. Preliminary results do not indicate any differences in cortisol, the stress hormone, regardless of whether the sows are housed in crates or in pens.

The project is financially supported by Norma & Frode S. Jakobsen's Fund.

Process and storage temperatures of Yorkshire semen

The trial studying the temperature of Yorkshire semen is continued. The temperature of the semen is observed from the semen is collected at an A.I. station, during the dilution process, during transport to the herd and until application in the service unit.



Catheters for post-cervical insemination - the one at the top is a traditional catheter

Management in A.I. service units

Experiences are being collected concerning management and design of service units in herds with good production results and this will establish which mistakes are made in herds with poor production results.

Feeding of gestating sows

Restrictively fed gestating sows will go to great lengths to get extra feed and can have behavioural problems because they are constantly hungry. One way to avoid this is to feed sows ad lib. Two trials studied two different principles of ad lib feeding and compared them with restrictive feeding.

Restrictive feeding and roughage ad lib

Restrictive feeding and ad lib roughage (pectin feed) was studied in two herds. The sows were given approx. 1.6 FUp via the feed station, and the rest of the feed they needed could be obtained from a feeder with pectin feed. This feeding principle was compared with restrictive feeding where the sows were only given feed via the feed stations. The sows had free access to straw in both feeding principles as the lying areas were bedded with straw.

The trial showed no differences between the two feeding principles in terms of reproduction results, but a significant difference was found in the weaning weight of the piglets. Sows given pectin feed in the gestation period weaned litters that weighed 3.0 kg less than litters from sows fed restrictively (73.8 kg versus 76.8). There were no differences in the litter weight at farrowing. This result was unexpected as previous trials with sugar beet pulp showed higher weaning weight because the sows ate more in the lactation period.

It was expected that ad lib access to feed would make the sows more calm and less aggressive than sows fed restrictively. Many restrictively fed sows were removed from the pen due to poor legs or because they had been attacked. This may indicate that sows with ad lib access to roughage in fact are less aggressive and more calm. However, examinations of bites showed no differences regardless of feeding principle. Thus, there was the same level of aggression in both feeding principles. The trial period is extended to examine whether sows react differently if the roughage consists of HP pulp (sugar beet pulp).

Dry feed ad lib

Ad lib feeding with dry feed via feeders was studied in two herds. In one herd, the ad lib feeding was compared with "feeding on the floor" and in the other with "trickle feeding". The sows fed ad lib were given two different diets in the gestation period. The diet given to the sows in the beginning and the end of the gestation period was very rich on starch to benefit implantation and birth weight.

The farrowing percentage in both herds was 2-3 percentage units lower among the sows fed ad lib. In the herd with "feeding on the floor" the sows fed restrictively had a total of 0.7 more piglets per litter than the sows fed ad lib. In this herd, the litter weight of sows fed ad lib was 1 kg lower at farrowing than that of the sows fed restrictively.

The level of aggression among sows under the two feeding principles was studied by recording bites on the ears. There was a clear difference in the number of bites on the sows in the two test groups. The sows fed ad lib had considerably fewer bites than the sows fed restrictively. This difference was clear in both herds.

In one herd there was an average feed consumption of 2.9 FUp among the sows fed ad lib ranging between 2.7 and 3.3 FUp. In the other herd, the feed consumption was 3.5 FUp ranging between 2.5 and 4.4 FUp. The feed consumption of the sows fed restrictively could not be determined, but was generally significantly lower.

The increased feed consumption among sows fed ad lib and a high price of the feed used make this feeding principle is unprofitable.

Ad lib feeding showed a positive effect on the behaviour of the sows, but the sows eat too much, which makes the principle unprofitable.

The farrowing unit

Low mortality, high weaning weight, and uniform piglets are among the requirements to the farrowing unit. These three requirements are difficult to meet at once. Low mortality requires many transfers of runts. These transfers result in a drop in weaning weight. A high weaning weight necessitates the potential of each piglets being fully used and as a result the piglets are not uniform at weaning. The requirement of uniform piglets means that the piglets are not the same age when they are weaned. This involves many removals, including removals between weekly batches with transfer of disease and a reduced weaning weight as a consequence.

Low mortality

The past years have seen an increase in mortality in the farrowing unit. Studies show that primarily the smallest piglets at birth die, particularly within the first days. It is not clear whether a small piglet dies because there is something wrong with it or because it cannot manage among the large piglets in the litter. Small piglets have an average temperature drop of 4ºC after birth, while the temperature only drops 1ºC in large piglets. This drop in temperature draws heavily on the limited energy reserves of the piglets, which affects the piglets' intake of raw milk and reduces their resistance against disease. If there is a high mortality among the smallest piglets, farrowing should be monitored, and there must be heat behind the sow so that the smallest piglets are ensured warmth and wiping off.

High weaning weight

The weaning weight is efficiently increased by increasing the weaning age. The weaning weight also increases if each sow has fewer piglets. This implies that some of the piglets are transferred to nursing sows. When many nursing sows are used, it is necessary to add a new wing, reduce the sow unit or reduce the weaning weight of the piglets that are removed from sows to be placed with nursing sows. The latter solution is not noticed during the daily management as the piglets weaned earlier to make room for the runts are "big enough". As the large piglets have the greatest gain they no longer contribute to the gain in the farrowing unit and consequently the weaning weight will drop again.

Uniform piglets

Uniform size at weaning is mainly achieved by weaning the large piglets first and transfer the remaining piglets. This is an efficient way of ensuring that the weaned piglets are "uniform" or "big enough". The disadvantage is that the piglets are at different age levels at weaning. Transfer of piglets will result in transfer of disease between litters, weekly batches and compartments. At the same time, each transfer of one piglet will result in an 800 gram lower weaning weight in this piglet. Finally, as a consequence of the transfer, the piglets in the litter receiving a new piglet will each weigh 50 gram less at weaning.

Optimum use of the sow

Most sows have 14 teats or more. However, each piglet grows less as more piglets are placed with the sow. In a trial where the sows had either 11 or 12 piglets and where the piglets were subsequently tended to according to the normal practice of the herd including moving strategies, it cost approx. 400 gram per piglet at weaning to place 12 piglets with the sow. However, 9% less nursing sows were used, which made room for 9% more farrowings. In a trial where the piglets were distributed among litters with either 11 or 13 piglets in the litter, this difference in litter size implied that each piglet in the litters containing 13 piglets weighed 700 gram less at weaning. Mortality was 2% higher in the litters containing 13 piglets.

Table 1. Effect of number of piglets with the sow

Piglets/litter	11	13
Birth weight, kg	1.6	1.6
Weaning weight, kg	7.5	6.9
Mortality in the lactation period, %	8.2	9.9

Increasing litter size increases the challenge in the farrowing unit.

Segregation of dry feed

Segregation, inaccurate doses and imperfect mixing may be reasons why feed mixed on-farm does not contain the nutrients expected when the feed is in the trough.

If segregation of feed takes place consistently at feeding it must be assumed that it affects the productivity and possibly longevity of the pigs negatively.

Segregation of dry feed

A study of feed mixed on-farm compared with purchased pelleted feed and purchased meal feed showed a certain risk of segregation at feeding. The ingredients were identical in the three diets. The content of copper and calcium in feed mixed on-farm was 17% lower in feed collected from the last feeder compared with the content in feed collected from the first feeder. There was only a difference of 2-3% in the content of copper and calcium in purchased pelleted feed and meal feed. In terms of crude protein there was a deficiency of 4% in the feed mixed on-farm and of 1% in both of the purchased diets in the last feeder.

Preliminary studies were made in five herds in connection with a trial on segregation when either dry or liquid mineral feed mixes was used. Samples of feed containing dry mineral feed mixes showed that segregation can be found in even more extreme cases than shown in the above trial, cf. table 1.

It is not yet clear whether the values found for segregation are seen every time in these herds, but this is elucidated in the trial as is the importance of adding minerals to liquid or suspended aqueous solutions.

Accuracy of dosing

The reason why the feed does not always contain the expected content of nutrients may be that the equipment for mixing the feed on-farm is not sufficiently accurate during dosing. The accuracy of dosing of mineral feed mixes was examined in six herds with different types of equipment for on-farm mixing.

Preliminary data show that there are great differences in the dosing accuracy of the mixing systems. It was among others found that one individual mixing system consistently under-dosed that mineral feed mix by 10%. This enhances the effect of a possible segregation of feed in connection with feeding. In ten other systems the deviation was 1-2% compared with what was expected.

Effect of admixture percentage

The ability of mixers to mix a homogenous diet with admixture percentages of 0.5, 2.0 and 4.0 was studied in six herds. The types of mixers studied were paddle mixers, diagonal mixers and horizontal mixers. Microtracer (small, coloured iron particles) was used as tracer. No differences were found between the three admixture percentages.

On the basis of this study it was not possible to conclude whether one type of mixer is better than another – nor was that the aim of the study. The study indicated an effect of mixing time and thereby that the homogeneity of the feed in some of the participating herds could be improved by increasing the mixing time.

Analyses of the distribution of the added minerals in the feed showed a more homogeneous mixing than what was indicated by the analyses of Microtracer. This may indicate that under the trial design used here, Microtracer is not applicable when testing the mixing ability of mixers.

Table 1. The content of the first and the last feeders in the poorest and the best herds. The value states the content in per cent of e.g. calcium in the first feeder compared with the average content in all feeders

	Category	First	Last
Calcium	Poorest	158.7	48.7
	Best	106.8	94.3
Copper	Poorest	155.8	35.8
	Best	95.3	101.7
Zinc	Poorest	127.0	78.1
	Best	100.3	99.1
Phosphorus	Poorest	112.0	85.2
	Best	99.7	100.0
Crude protein	Poorest	93.5	108.1
	Best	99.1	100.2

Feeding of weaners

New threonine standard

The results of a trial showed that it is beneficial to increase the content of threonine, an essential amino acid, in feed for weaners (6-30 kg). An increase of digestible threonine to 6.1 g/FUp in the feed for pigs in the growth interval 9-30 kg resulted in an increase in productivity of 11%. Thus, the results of this trial changed the threonine standard for weaners in the weight interval 9-30 kg.

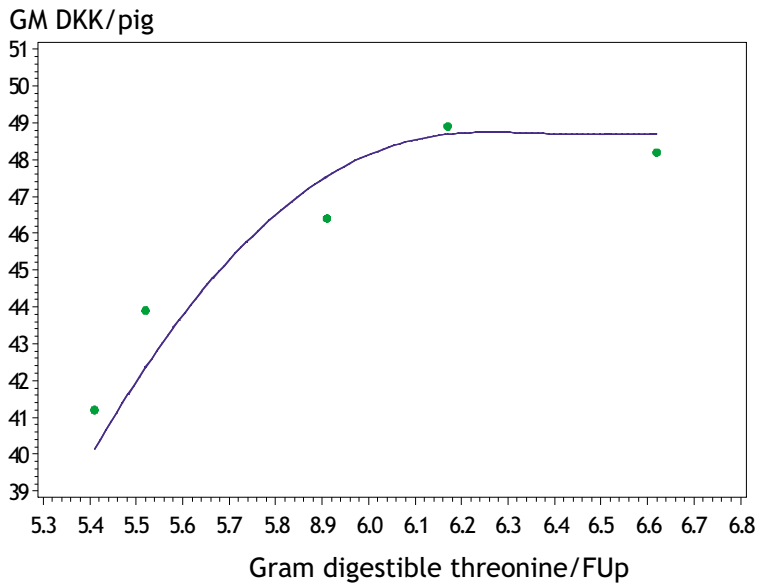
With a dose of 5.4-6.1 g digestible threonine per FUp, the productivity, i.e. gross margin, increased with increasing content of threonine. A dose of more than 6.1 g digestible threonine per FUp provided no further increase in productivity in terms of gross margin per pig (cf. the figure). Thus, the maximum productivity was achieved by adding 6.1 g digestible threonine per FUp.

Table 1. New threonine standards for weaners

Weight interval	6-9 kg	9-20 kg	9-30 kg	20-30kg
Gram digestible threonine per FUp	6.5	6.2	6.1	5.7
Gram digestible threonine per FUgp (new feed evaluation system)	6.5	6.1	6.0	5.6

Table 2. Productivity

Group	1	2	3	4	5
Weaner diet (6-10 weeks, 9-30 kg)					
Digestible threonine (g/FUp)	5.4	5.5	5.9	6.2	6.6
(% of standard 2001)	(97)	(98)	(105)	(110)	(118)
Daily gain, g	539	554	579	594	586
Daily feed intake, FUp	1.10	1.09	1.13	1.13	1.12
FUp per kg gain	2.06	1.98	1.95	1.91	1.92
Production index	94	100	106	111	110
Production index corrected for increased content of threonine	96	100	103	107	103



Productivity (GM: DKK/pig) in relation to the threonine content.
** states the achieved gross margin.*

An increase in the content of threonine in the feed can be achieved either by increasing the content in the diet of ingredients with a high threonine content or by adding more synthetic lysine to the diet. Both measures make the diets more expensive and the productivity (gross margin) is reduced. The actual productivity where the price of the feed is corrected for addition of synthetic threonine (price of threonine: DKK31/kg) can be seen in table 2.

Tested products and diets

The National Committee for Pig Production has studied commercial products for weaners during the past years. As the market abounds with products it can be difficult to see which products have a positive effect. In the past year ten trials have been made of products and three roughage diets for weaners have been studied. The results are shown in table 3.

None of the tested products showed significantly positive effects on the productivity. Fermented maize compared with regular maize showed a significant reduction in productivity of 9%.

Besides testing products, complete diets are also tested. Two sets of diets from DLG showed a significantly better productivity than the control group and the Full Farmer Concept reduced the number of days spent on treatment for diarrhoea by 61%, while mortality was not affected. However, the Full Farmer Concept showed a negative effect on the productivity (-13%) compared with control.

Feeding of weaners

EAW added to water

Besides the usual trials, a study of addition of EAW to drinking water was also carried out. EAW is electrochemically activated water produced by salt water passing through an electronic cell twice. The pigs were given EAW in the water for the first two weeks post-weaning beginning with 10% the first week and reducing it to 0% on day 15 post-weaning. There was a significantly better productivity the first two weeks post-weaning (+40%). There were no differences between the two groups during the entire trial period (4-10 weeks of age). There was no effect on mortality or the number of days spent on treatment for diarrhoea. Addition of EAW to drinking water also showed that the number of germ and coli bacteria was reduced to 0 in the drinking water (Report no. 578).

Commercial diets

In the spring, a trial was carried out of commercial diets selected in Southern Jutland for weaners. The diets from Ewers and KFK yielded a significantly higher productivity than control and the diets from DLG and ATR. There were no differences in productivity between control and the diets from DLG and ATR. The diet from ATR was significantly poorer than control and the diets from KFK and Ewers (Report no. 555). The trial resulted in the following index calculated on the basis of the productivity:

Control . . . . . 100 (a)
First Class, Starter Molke
ATR . . . . . 83 (b)
Topstart and Primastart UK
Ewers . . . . . 127 (c)
Fut 1 and Organica Promax 5
KFK . . . . . 118 (c)
Grisling Acid F1, Prima 9 and 15 Acid F1
DLG . . . . . 90 (ab)
Different letters = significantly different productivity.

Which product are they giving us now?

Table 3. Commercial products and roughage diets tested for weaners

Effect on productivity is stated in relation to the control group. *=tendency, *=significant difference. Index values can only be compared within the same trial (same report).**

Company	Product name	Product type	Dose 1)	Index	Report
-	Maize	Regular	20% of dry matter	100	531
		Fermented	20% of dry matter	91***	
Borregaard	SoftAcid II	Formic acid with lignin	1.0%/1.0%	108	537
			1.5%/1.5%	108	
			20.%/2.0%	102	
Nature	Gustor	Dry acid	0.3%/0.3%	102	544
Biomin GTI HmBH	Biomin P.E.P	Fructooligosacharide + extract	2 kg/ton /2 kg/tonne	110	554
Agrosom	Biogreen	Etheric oils	0.5kg/ton/0.5 kg/tonne	99	562
Alltech	BioMos	Mananoligos-acharides	4kg/ton/1 kg/tonne	102	562
Chem Vet	Biacton	Freeze-dried lactic acid bacteria	2kg/ton + 1 kg/ tonne in drinking water	103	575
DLG	DLG Test 1/Prima 9 Super	Closed diets	Roughage	120***	553
	DLG Test 2/Startpiller LT TOP	Closed diets	Roughage	116***	
Hejsager	Full Farmer Concept	Rolled wheat with supplementary feed	Roughage	87***	570

1) Where two doses are stated, the first one is the dose in the weaning diet (4-6 weeks of age) and the other one is the dose in the end diet (6-10 weeks of age).

Post-weaning diarrhoea

During the past year, the National Committee for Pig Production has carried out trials with weaned pigs concerning feeding strategy, drinking water quality and importance of milk products.

Restrictive feeding

A current trial studies the effect of number of daily feedings under restrictive feeding. The feed is given via floor feeding and is dosed automatically from feed boxes above the pen.

Preliminary results from two herds show that four daily feedings reduced mortality and also gain than when feeding ad lib (control). The level of treatments for diarrhoea was generally surprisingly low and there was no difference between the groups.

Gruel feed

A current trial studies the effect of feed allocation to piglets in the lactation period (dry, gruel, nothing). The effect is measured on health and productivity both before and post-weaning. The pigs were given either dry or gruel feed post-weaning.

Preliminary results show that feed allocation (dry, gruel, or no feed) the last nine days of the lactation period does not have any influence on the weaning weight (weaning after 28 days). If the weaning age is increased, supplementary feed is likely to have an effect.

In the post-weaning period it has so far not been possible to measure a positive effect when gruel feed was used compared with dry feed. However, preliminary results were affected by disease post-weaning (PMWS, Lawsonia, Coli diarrhoea) in the trial herd. Thus the preliminary results indicate that it is apparently not particularly profitable to use gruel feed (instead of dry feed) in a herd hit by disease. Whether the effect is better in herds with less severe disease outbreaks could not be established form this trial.

Water quality

Poor hygienic quality of the water can be a risk factor for the prevalence of post-weaning diarrhoea. This was established in a pilot trial where the water quality in 12 herds with diarrhoea in weaners requiring treatment was compared with the water quality in nine herds with no problems. Analyses of the drinking water showed a tendency (p=0.056) towards an increased germ number at 37°C in the group of herds with problems. The germ number at 37°C expresses the number of bacteria in the drinking water due to pollution. There were no significant differences between the groups in other analysis parameters.

It is recommended to check the water quality once or twice annually with a simple water analysis.

Milk products

A review of literature was carried out on the use of milk products in feed for weaners (report no. 21, 2002).

It can generally be concluded that addition of milk products to weaning diet affects the feed intake and gain positively.

The content of lactose in the milk products is underlined as an easily digestible carbohydrate source. The pigs may get an energy deficiency if they do not get enough easily digestible carbohydrates immediately post-weaning. However, the effect of lactose depends on the age and weight of the pigs.

The content of protein in the milk products is also assigned a certain value as easily digestible protein source with a good amino acid profile. However, it has been discovered that other easily digestible protein sources can replace milk proteins without problems.

The content of lactose is often low in Danish weaning diets (4-12%) compared with foreign recommendations (5-30%). How-ever, foreign recommendations are often based on a lower weaning age than in Denmark.

The conclusions of the report will be followed up with focus on reducing the prevalence of diarrhoea.

Gruel feed for weaners. A current trial was not able to confirm the positive results achieved in previous trials with feeding with gruel feed.

Feeding of finishers

Fermented liquid feed

Fermentation of liquid feed for finishers has both negative and positive results. The results depend on the feed components included in the fermentation.
Fermentation of the grain only increased the productivity by 11% (Report no. 547).

Subsequently, fermentation of feed mixed on-farm and pelleted feed for finishers was studied (reports no. 566 and 567). In both trials all components were fermented except the mineral feed mix containing synthetic amino acids. Even though the synthetic amino acids were not included in the fermentation in the tank, the production results were very poor as can be seen in table 1. Both trials found a lower feed intake and this may be caused by pH being too low (pH 4.2-4.3). In the trial with fermented grain, pH was higher in the finished diet (pH 4.5-4.6). Furthermore, loss of synthetic lysine during fermentation in the pipeline may partly explain the low meat percentage in the trial with pelleted feed.

On the basis of the present knowledge on fermented liquid feed, it can only be recommended to ferment the grain.

Feed mixed on-farm versus pelleted feed under dry and liquid feeding conditions

The effect of fresh/daily-made feed mixed on-farm based on the farm's own cereal (stored in a gastight container) was studied versus a purchased, complete diet, pelleted or meal, in a herd applying dry feeding ad lib.

The composition of ingredients was largely identical in the three groups. In table 2 it can be seen that pelleted feed yielded better production results than meal feed regardless of whether the meal feed was mixed on-farm or purchased.

Production results from a herd with restrictive liquid feeding where the diet was purchased either as pellets or meal are also shown in table 2. It can be seen that the difference in feed conversion between pellets and meal was only approximately half of the difference seen with dry feeding. The difference in productivity was the same as seen in the trials with dry feeding. The explanation is an increased difference in daily gain.

Phytase

Phytase is an important tool in reducing the content of phosphorus in feed and manure. The recommended doses and the expected effect of the two products primarily used are shown in table 3. It is currently being studied whether the effect of phytase in pelleted feed is as expected. In feed mixed on-farm the effect of added phytase is lower than in pelleted feed due to natural phytase in non-heat-treated grain. The recommended doses of addition of phytase are therefore lower in feed mixed on-farm.

Table 1. Production results for finishers when fermented liquid feed is used

	Liquid feed mixed on-farm for finishers (41-106 kg) (Report no. 566)		**Pelleted feed in liquid feed for finishers (27-96 kg) (Report no. 567)**	
Feed	Non-fermented	Fermented	Non-fermented	Fermented
Daily feed intake, FUp	2.53	2.38	2.12	1.91
Daily gain, g	890	847	818	733
FUp per kg gain	2.84	2.82	2.59	2.60
Meat percentage	60.6	60.9	61.3	60.0
Productivity, index	100 a	95 b	100 a	77 b

a, b: significant difference within the same trial

Table 2. Production results for finishers when pelleted feed or meal feed is used

	Dry feeding of finishers (32-100 kg)			**Liquid feeding of finishers (28-105 kg)**	
	Pelleted feed	Purchased meal feed	Meal feed mixed on-farm	Pelleted feed	Purchased meal feed
Daily feed intake, FUp	2.38	2.44	2.46	2.55	2.49
Daily gain, g	881	866	870	919	875
FUp per kg gain	2.70	2.82	2.83	2.78	2.85
Meat percentage	60.1	59.9	59.5	59.2	59.4
Productivity, index	100 a	91 b	88 b	100 a	89 b

a, b: significant difference within the same trial.

Table 3. Recommended dosing of phytase and expected content of liberated digestible phosphorus in the feed

	Pelleted, complete diet		**Feed mixed on-farm**	
Product	Natuphos	Ronozyme-P	Natuphos	Ronozyme-P
Phytase units per kg feed	500 FTU	750 FYT	300 FTU	450 FYT
Liberated phosphorus, g digestible per kg feed	0.67	0.67	0.39	0.39

New feed evaluation system

The feed evaluation system consists of a new energy evaluation system and a new protein evaluation system. The system has now been implemented in feed formulation programmes and in the official table works of InfoSvin.

The majority of the feedstuff industry started using the new system in the summer 2002. In the season 2002/03, application of the new system is voluntary as the Danish Plant Directorate still controls energy values according to the old system. This means that the feedstuff industry in most cases states both the new and the old feed units (FUgp, which is a feed unit for growing pigs and FUgs, which is a feed unit for gestating sows, versus the old FUp).

Control of the energy content according to the new system requires that a new analysis of enzyme digestibility of dry matter in ileum (EDDM) be implemented at all feedstuff laboratories and that the analysis accuracy has been tested in order to establish the latitude for energy in the new system. This is currently being worked on, and control exclusively according to the new system is expected as of summer 2003.

The tables show some fundamental changes in the new system.

An important change is the re-evaluation of energy of grain and protein feedstuffs. The energy value of grain has increased, while the energy value of protein feedstuffs has decreased. This means that feed formulation increasingly results in diets low in protein – and a slight drop is expected in the protein content of sow and finisher diets. However, it is necessary to add more of the free amino acids. The new system does not involve great changes in the protein content of weaner feed as that was already very low due to health reasons. However, because of the new amino acid digestibilities it becomes easier to produce a weaner diet with optimum amino acid composition.

Overall, the new system provides a more correct ratio between contents of amino acids and energy. The new system is also expected to improve the correlation between the stated feed units and the actual feed conversion of the pigs.

The introduction of the new feed evaluation system has resulted in a thorough review of the analysis basis for the ingredients and it is now clear that there is a need for updating the table values to adapt them to today's ingredients. This in particular applies to the new analysis of enzyme digestibility of dry matter in ileum (EDDM). Analyses of the ingredients will therefore be carried out to ensure a correct data basis when the new system is introduced as official control system.

Table 1. Fundamental changes in the new feed evaluation system

Feed evaluation system	Old	New	New
Relative energy value	FUp	FUgp	FUgs
Starch	1.0	1.0	1.0
Fermentable carbohydrates	1.0	0.6	0.77
Crude protein	1.24	0.85	0.85
Crude fat	2.20	2.71	2.23
Amino acid digestibility	Faeces	Ileal	Ileal
Amino acid digestibility	= crude protein	Per amino acid	Per amino acid

Table 2. Changes in energy content in barley, wheat, soybean and complete diets

Feed type	FUp/kg	FUgp/kg
Barley	0.98	1.05
Wheat	1.10	1.16
Soybean	1.14	0.88
Complete diet, 115 g digestible crude protein	1.04	1.06
Complete diet, 130 g digestible crude protein	1.04	1.04
Complete diet, 145 g digestible crude protein	1.04	1.02

New environmental regulations

Definition of animal units (AU)

As of August 1, 2002, one animal unit (AU) in pig production is the number of pigs that on partially slatted floor produces 100 kg nitrogen (N) in livestock manure (ex slurry tank). In pig production, one AU is:

- 4.3 sows per year with pigs for weaning (7.2 kg) or
- 175 weaners from weaning to 30 kg or
- 36 finishers from 30 kg to 100 kg.

Gilts are considered as finishers until they weigh 100 kg.

At deviating weaning age/weight and other weight limits for weaners and finishers, the number of AU is adjusted as follows:

- 0-40 kg: 4,000 kg gain = 1 AU
- 40-87 kg: 2,500 kg gain = 1 AU
- Above 87 kg: 2,000 kg gain = 1 AU

The new conversion factors apply from August 1, 2002. Companies approved according to the regulations applying until that date are still approved until new/other decisions are made.

Neighbouring buildings in rural areas

Establishment, increase of production or change of facilities or manure tanks must be approved by the regional environmental authority if the facilities are located within 50 m from neighbouring buildings or less than 300 m from dwellings in settlements in rural areas.

The neighbouring building is part of a settlement in rural areas if more than six other dwellings are located within 200 m. Houses at farms and dwellings owned by the applicant do not count. Beyond these distances and extension or change of production and facilities within the distances that does not result in increased pollution can be carried out without the abovementioned approval.

Cover of manure tanks

The requirement of cover of manure tanks can be met by establishing and maintaining a natural floating layer or some other tight cover and by the owner initiating an self-check scheme investigating and recording the condition and tightness of the cover in a log book at least once a month as of February 1, 2003. The general requirement is firm cover in the form of a floating layer, canvas or the like.

Tanks with manure and not with daily additions and compost containing more than 30% DM stored in the fields must be covered with a "compost cloth" or some other airtight material immediately after addition to the tank.

Harmony area

Pig herds and arable farms must not spread livestock manure from more than 1.4 AU per ha. For mixed farms – premises with pigs and other livestock – the harmony area is calculated on the basis of the part of AU constituted by pigs and other livestock, respectively.

Surplus livestock manure can be disposed via:

- Agreement with one or more farms
- Agreement with a biogas company/joint systems
- Processed livestock manure

Processed livestock manure must be declared according to fertilizer legislation.

New limits for requirements of environmental approval and EIA

The limit for requirement of environmental approval for pig production (250 AU) has been changed so that sow herds where at least 90% of the AU are sows with weaners below 30 kg, may be up to 270 AU, while herds with finishers (above 30 kg) cannot be more than 210 AU before environmental approval must be obtained prior to establishment, extension or change of the production or dsign.

The limit for other types of pig production is still 250 AU.

In terms of obligatory EIA screening and approval (EIA = Environment Impact Assessment), the limit for sow herds where at least 90% of the AU are sows with weaners up to 30 kg has been increased from 250 AU to 270 AU. "Systems for intensive livestock production" is still governed by the regulations for screening etc. if the system due to its type, dimensions or location is assumed to have a significant impact on the environment.

Table 1 shows the size limits and production in number of animals.

Table 1. Limits for environmental approvals and EIA

	Until August 1, 2002		After August 1, 2002	
	AU	No. animals	AU	No. animals
Environmental approval and EIA	250			
Sows with weaners (4 weeks, 7.2 kg)	250	1,150	270**	1,161
No. weaners, 7-30 kg	250	34,000	250	43,750
No. finishers*	250	7,500	210/250****	7,560/9000
No. pigs, 7-100 kg	250	6,000	250	7,468
Sows with 23 pigs to 30 kg	250	648-668***	270**	741
Sows with 23 pigs to 100 kg	250	213	250	250

** The weight interval is 30-98 kg before and 30-100 kg after August 1, 2002.*
*** At least 90% of AU are sows with weaners up to 30 kg.*
**** Two methods of calculation – both are legal.*
***** 210 AU for environmental approval, 250 for EIA.*

External environment

The Danish Applied Pig Research Scheme has initiated a number of trials to study different methods for reducing emission of ammonia and odour from housing units. Some of the trials are already looking very promising.

Reduce the slurry surface

V-shaped channels of different designs have been studied throughout the 1990s in Holland, among others. Presently, the Danish Applied Pig Research Scheme is testing four different designs where one type is combined with a flushing system. A previous trial showed that frequent emptying is possible and necessary to obtain the desired reduction of ammonia emission and odour from the housing unit.

Remove cold slurry quickly

Quick removal of slurry is a widely used technique in relation to odour. When faeces and urine are mixed and stand in oxygen-free conditions as in slurry, micro-organisms quickly produce new substances of which many have a fairly strong odour.

Besides frequent emptying of V-shaped channels, wire-type barn cleaners is one of the techniques used for quick removal of the slurry. Presently, two trials with wire-type barn cleaners are conducted; one in a finisher unit and one in a gestation unit. These are in both cases combined with cooling in the slurry gutter. Cooling is a well-documented method for reduction of ammonia and odour.

Sulphuric acid added to the slurry

Addition of sulphuric acid to slurry is a recently developed technique that looks very promising. The system is developed by a farmer/inventor in Vendsyssel, Denmark. Staring Maskinfabrik A/S, a Danish company, has developed it further and is now marketing the system.

When sulphuric acid is added to slurry and subsequently mixed with air in the first tank, pH is reduced to approx. 5.5. When pH is that low, ammonia can hardly evaporate. Furthermore, measurements indicate that the low pH can also be maintained during storage and spreading of the slurry. This is an interesting perspective in relation to fertilisation, and LandboNord SvineRådgivning has therefore measured the emission of ammonia during storage and spreading of slurry mixed with sulphuric acid.

Preliminary measurements of ammonia from the trial units look very promising. However, a long trial period is necessary to cover operational safety, consumption of sulphuric acid and energy. Furthermore, safety issues in relation to application of concentrated sulphuric acid and prevention of release of hydrogen sulphide must be evaluated. The influence of sulphuric acid on the durability of concrete and on other affected inventory also needs clarification. A pH of 5.5 does not pose any problems to the concrete. However, the high content of sulphate ions may damage certain types of concrete.

Purification of outlet air

The Danish Applied Pig Research Scheme tests and participates in the development of three different principles for purification of air: microbiological purification, chemical purification with sulphuric acid and addition of ozone to the outlet air.

It is difficult to predict whether purification of air will become a widespread principle in future. Efficient purification of the housing air is technically possible today, but the real challenge is to adjust the systems to the ventilation systems in the housing units. If – as opposed to common practice today – the air in the housing unit is collected in one or few exhaust pipes instead of several exhaust pipes, this will clearly make purification of air cheaper and simpler.

Mixing the slurry with sulphuric acid takes place in the first tank. At the bottom of this tank, concentrated sulphuric acid is added in a dose of 5 kg per tonne slurry. To avoid creation of hydrogen sulphide, the slurry is mixed with air before it is used for flushing of slurry from the housing unit.

Slurry treatment and economy

During treatment of slurry, the crude slurry is divided into an aqueous fraction and one or more fractions rich on nutrients.

Treatment of slurry is relevant when the nutrient fraction can be spread on land with a low livestock population or be processed into a commercial fertilizer. According to the new order on livestock manure, exemption can be granted in such cases from the land requirements for spreading of slurry.

Low-technological treatment methods

During decantation centrifugation, the slurry is separated in a solid fraction constituting approx. 15% and containing up to 80% of the phosphorus of the slurry and approx. 30% of the organic nitrogen. If the aqueous phase alone is maintained on the premises it can be spread onto approx. 70% of the area required for crude slurry. Furthermore, it is expected that odour and ammonia emission are reduced at spreading.

With methods where the solid particles are precipitated and clot, an even larger phosphorus separation might be achieved.

High-technological treatment methods

With high-technological treatment methods the nutrients are separated completely, so the product that remains is water that with a sufficient amount control can be led to the water course.

The fertilizers are typically split into three fractions. The methods used for separation are different. Funki and others use the evaporation principle. BioScan applies reverse osmosis. Systems are being developed that combine different methods. Some types of systems include pyrolysis to biogas as part of the treatment. The surplus energy from this may make the process the cheaper.

Documentation - development

Function and economy of the systems for slurry treatment only is very sparsely documented.

Generally, known components and methods are used that are known from e.g. sewage treatment. However, different types of slurry can de difficult to handle. Only few methods have been completely developed, which is why at purchase one must be certain of their technical performance. It is furthermore not established how the different nutrient components should be stored and spread or possibly processed.

Low-technological

Decantation centrifuges
- **Pieralisi**
- **Alfa Laval**
- **Westfalla**

Precipitation/fluccolation
- **Ansager**

Ventilated composting
- **Echberg Manutech**

High-technological
- **Funki Manura**
- **BioScan**
- **Green Farm Energy**

More systems are being developed.

In co-operation with the Danish Institute of Agricultural Sciences and The Danish Agricultural Advisory Centre, the Danish Applied Pig Research Scheme is working on development and documentation of methods for slurry treatment. Projects have been initiated on storage and application of the solid fraction during decantation and technical, logistic, and economic conditions of mobile decantation systems. Studies of other treatment methods are being planned.

The decantation centrifuge delivers the solid fraction with a DM content of more than 30 %.

Mobile decantation systems may be a good solution for small productions.

Net costs of slurry handling

To ensure a general overview of the total economic influence of slurry handling, the calculations include all relevant factors relating to storage, transport, slurry separation and handling of the slurry before and during spreading. Furthermore, the nutritive value has been calculated on the basis of the plants' consumption. A comparable estimate is obtained if all costs are compared from the slurry leaves the housing unit and until it has been used in the field.

The calculations focus on four alternatives of slurry handling and are based on the existing knowledge.

Pig producers in the calculations own land according to the ownership requirement. This means that there is a nutrient surplus from the ownership requirement up to the harmony requirement. This is covered by slurry agreements.

The four alternatives are:

- Traditional slurry treatment / the nutrient surplus of the herd is transported by tractor and slurry truck
- Traditional slurry treatment / the nutrient surplus of the herd is transported by truck
- Simple separation (decantation centrifuge) / the nutrient surplus of the herd is transported by truck
- Advanced treatment system (Manura 2000) / nutrient surplus of the herd is transported by truck

In the Funki Manura system the aqueous phase is concentrated after decantation.

Table 1. Prerequisites

Depreciation period	Ten years
Interest	6 %
Investment, 500 AU traditional	DKK1.5 million
Investment, 500 AU simple	DKK2.3 million
Investment, 500 AU advanced	DKK5.9 million
N, nutritive value, kg	DKK3.98
P, nutritive value, kg	DKK6.98
K, nutritive value, kg	DKK1.95

The price of nutrients corresponds to 75% of the price of commercial slurry.

When costs of this type are assessed, it is important to focus on the difference between the alternatives within the AU categories as the prerequisites vary. Simple separation (decantation centrifuge) involves medium costs.

Investment and operation costs in connection with advanced separation are now so high that there is presently no economics in investing in advanced slurry separation of this type unless this is combined with a change in the structure of the herd e.g. extension of the pig unit combined with an exemption reducing the ownership requirement to land. Traditional slurry handling will still be the preferred alternative for many pig producers.

Table 2. Net costs of slurry handling, DKK/m3 treated slurry

AU	1,000	750	500	250
Traditional, tractor 10 km	7	9	9	11
Traditional, truck 50 km	7	12	14	21
Simple separation	18	23	32	55
Advanced separation	50	64	89	167

Purchase of land versus exemption from land requirement

The present legislation provides very little incentive for investing in slurry treatment. If legislation is changed to allow for selection between ownership requirement or affiliation with an advanced slurry system, e.g. Manura 2000, it is relevant to assess how high a price of land can be accepted compared with investment in advanced slurry treatment.

Calculated example

A pig producer has a farrow-to-finish herd with 250 AU and owns 77 ha corresponding to the land requirement. The pig producer would like to extend his herd to 500 AU. The neighbouring premises are for sale and cover the new owner requirement of 256 ha.

Based on table 1, a real interest rate of 5% and a gross margin II in the field of DKK3,000 per ha, the maximum price is ap-prox. DKK140,000 per ha for the neighbouring premises. Besides inflation, price increases of land have not been included in the calculation.

Ventilation

Pollution from electrical currents

Potential differences in the immediate environment of pigs have in periods been related to e.g. earth rays. Experiences from climatic studies made by the Danish Applied Pig Research Scheme show that deviating behaviour such as tail biting has in several cases been directed to lacking potential equalisation.

Equalisation

On April 1, 1994, a new order on power current was initiated. When this order is followed, animals in the housing units are secured against minor currents that are not directly dangerous but may be enough of a nuisance to the pigs to make them change their behaviour.

Main equalisation of water supply to the housing unit.

Electrical installations in buildings for livestock are described in a separate paragraph in the order on power current. There are two types of equalisation: main equalisation and supplementary equalisation.

Main equalisation

Main equalisation connects the conducting parts and the protective conductor (earth) to the equalisation slide in the elec-tricity cabinet or the electricity switchboard. There must not be more than 10 m between the conducting parts and the equalisation slide.

Supplementary equalisation

Supplementary equalisation, which is made in housing units particularly, connects conducting parts in the housing unit again. According to Byggeblad 104.03.00 from the Department of Farm Buildings and Machinery it is recommended to make the supplementary equalisation in a power supply system for every 20 m.

Supplementary equalisation of fittings, water and feed pipes in the housing unit.

Ventilation in service and gestation units

The sows' requirements to the immediate environment vary throughout the gestation period. The production of heat increases by up to 45% from mating to the last day of the gestation period. Also, there is often a relatively uneven stocking density in the housing unit. Combined with buildings with a relatively large solar radiation, deep litter and poor insulation etc., these factors make high requirements to the ventilation in service and gestation units for group-housed sows.

Diffuse air intake

Diffuse air intake is only recommended in housing units with a uniform production of heat. Often, housing units for group-housed sows are arranged with uneven stocking and often the heat production varies between the individual batches. Diffuse air intake is therefore not recommended in these housing units.

Extra heat

Climatic studies show that there is a need for up to 150 W/pig place in some housing units due to a relatively low stocking density. The need depends on the stocking density, the arrangement and the insulation of the building. The need for heat should therefore always be estimated in each individual case.

Solar radiation

A large amount of sunlight through the ridge is positive in the housing environment. However, during the summer it has a negative effect as more heat is added to the housing unit. If only half of this heat is transferred to the housing unit, the need for ventilation is increased by 50% in several types of housing unit.

Increased heat from solar radiation via roof light from the ridge can be avoided by screening off the solar radiation during the summer instead of extra ventilation capacity.

Closed pen partitions

Increased focus on protection against disease has resulted in increasingly closed pen partitions in both new and renovated housing units over the last years. In that same period, diffuse ventilation with air intake via the ceiling has become a much-used ventilation principle. Diffuse air intake is cheap to establish and has greater liberty in terms of e.g. pen orientation. A uniform stocking density and heat production will prevent draught from ventilation.

However, ventilation problems may occur if the pen partitions are completely closed since closed pen partitions make the air in the pens warm, humid, stagnant, which the fresh air added diffusely and at low speed cannot penetrate.

Computer simulation of air currents, the so-called CFD programmes (Computer Fluid Dynamics), clearly shows that the creation of the mentioned, impenetrable heat layers.

A study in the Air Physic Lab at Research Centre Bygholm equipped with diffuse air intake and pen partition heights of 100 cm and 60 cm also showed differences in temperature in the pen.

Recommended height

If ventilation is made through diffuse air intake in finisher units, it is recommended to use partially open pen partitions. The pen partitions that must fit closely to the bottom of the pen should not be closed for more than 60 cm except the part of the pen with covered areas.

Frequency-regulated motors

In co-operation with Research Centre Bygholm, the Danish Applied Pig Research Scheme has initiated a study of frequency-regulated motors for ventilation of housing units.

These motors are characterised by being energy-saving, faint and pressure stable.

Energy is saved as the motors have a very low power consumption in the low-ventilation area. In the area of 10-50% ventilation, the power consumption is approx. 33-50% of what is normally used by triac-regulated motors.

The energy-saving is noticeable as a typical ventilation system works in the area 10-50% ventilation for more than half of the hours of a year.

Preliminary figures from a commercial herd show that the energy consumption per produced pig dropped from 10.6 kWh to 5.6 kWh with normal, triac-regulated motors and frequency-regulated motors, respectively.

Partially open pen partitions

Weaner and finisher units

WTF

WTF production (weaning to finish in the same pen) contains two different models. One is called single WTF where the pigs remain in the same pen from weaning to finish. The other one is called double WTF where half of the pigs are moved from the pen at the beginning of the growth period.

The pigs in single WTF had a higher daily gain in the weaner period. However, this development came to a halt due to the increased stocking density in the finisher period. In the herd with liquid feeding in a trough with one feeding point per pig, there was not enough room for all the pigs (from approx. 60 kg until slaughter) in single WTF to eat at the same time. In the herd with dry feeding ad lib more pigs shared the feeding space in single WTF than in double WTF.

Table 1. Daily gain with single WTF or double WTF

	Herd 1 Dry feeding		Herd 2 Liquid feeding	
	Single WTF, 0.55 m^2/pig	Double WTF, 0.30/0.65 m^2 per pig	Single WTF, 0.55 m^2/pig	Double WTF, 0.30/0.65 m^2 per pig
Blocks	20	14	15	19
Daily gain, weaning to 30 kg, g/day	514a	465b	454	429
Daily gain, 30 kg-finish, g/day	977b	1018a	724	738
Daily gain, weaning to finish, g/day	789a	774b	645	644
No. feeding days, 7-100 kg	118a	120b	145	145

a, b: different letters indicate significant difference, p<0.05

The Danish Applied Pig Research Scheme compared single WTF with double WTF in two herds with dry feeding ad lib and liquid feeding in troughs with one feeding point per pig, respectively. The herd with dry feeding had one tube feeder per pen that in the weaner period was supplemented with simple dry feeders according to the number of pigs in the pen.

Preliminary results show that single WTF and double WTF resulted in almost the same daily gain. Single WTF probably has a slight advantage if the feeding system is dry feeding ad lib. In the herd employing dry feeding, single WTF was better in the weaner period while double WTF was better in the finisher period when the pen was bedded as a regular finisher pen. The herd employing liquid feeding experienced no significant differences between the groups.

The large differences in production results between dry feeding and liquid feeding were caused by the trial being carried out in two herds with different management methods and illustrate the great variation that can be found in production results between herds.

Removed pigs from double WTF

The study of single WTF and double WTF also included an analysis of the gain of the pigs removed from the pens in double WTF. It was not possible to transfer them to another herd for various reasons relating to the trial. The pigs were selected randomly and mixed in connection with the removal and transferred to the same section in pens that had been empty in the period 7-30 kg.

It was expected that the pigs that were removed from the WTF pens at 30 kg would have a lower gain than the pigs that remained in the pen, as the removed pigs had to get used to a new pen and be mixed with new pen mates. In most cases, the removed pigs would also have to be transported in connection with transfer to a new herd.

Seen over the entire production period, single and double WTF apparently result in the same gain.

Table 2. Daily gain after 30 kg of the pigs that were removed and those that remained in double WTF systems. The pigs that were removed were selected randomly.

	Herd 1 Dry feeding		Herd 2 Liquid feeding	
	Single WTF, 0.65 m^2/pig, 0,65 m2 /gris remaining pigs	Double WTF, 0.30/0.65 m^2 per pig, removed pigs	Single WTF, 0.65 m^2/pig, 0,65 m2/gris remaining pigs	Double WTF, 0.30/0.65 m^2 per pig, removed pigs
Daily gain, weaning 30 kg to 100 kg, g/day	1,018	1,025	738	746

The results showed no differences in average daily gain whether the pigs remained in the pen or were mixed and moved to another. The results indicated that the pigs were not noticeably stressed by being moved within the same compartment.

Liquid feeding of weaners

The Danish Applied Pig Research Scheme has studied different liquid feeding principles for weaners. The trial comprised four groups:

1. Ad lib trough, four pigs per feeding point
2. Trough in one side, one pig per feeding point
3. Trough in both sides, one pig per feeding point
4. Ad lib trough, two pigs per feeding point

The liquid feeding was planned to start immediately after weaning, but results showed that it was difficult to handle liquid feeding in a trough for newly-weaned pigs with one feeding point per pig due to the very small amounts of feed, which partly were difficult to distribute in the trough and partly difficult to allocate to several feedings. Furthermore, there was a risk of microbial conversion of added synthetic amino acids as analyses of liquid feed samples showed that the content of synthetic lysine was reduced. Therefore, dry feed had to be added during the first two to three weeks post-weaning. This limited the potential of using liquid feed for weaners as the liquid feed was supposed to show its worth in the first weeks post-weaning. The possibility for automatic allocation of a certain amount feed with lactic acid several times daily should have a beneficial influence on the digestion of the pigs.

Table 3. Preliminary results from a study of different liquid feeding principles for weaners

	Group			
	Ad lib trough, four pigs per feeding point	Trough in one side, one pig per feeding point	Trough in both sides, one pig per feeding point	Ad lib trough, two pigs per feeding point
Blocks	32	35	33	37
Daily gain, g	414a	375b	379b	426a
Age at 30 kg, days	82a	85b	84b	81a
Average feed strength, FUp/pig	0.75a	0.82b	0.83bc	0.86c
Feed conversion, FUp/kg gain	0.79a	2.16b	2.18b	1.99c
Mortality, %	0.5	1.0	0.8	1.1
Treatment frequency for diarrhoea, %	229a	179b	119c	193b

a, b, c: different letters denote significant difference, p<0.05

Preliminary results indicate that the highest gain was achieved in the group fed ad lib. This group correspondingly achieved the best feed conversion. There were no differences between the groups in mortality. The groups with one feeding point per pig and least competition for the feed had the lowest frequency of treatments for diarrhoea.

Liquid feeding of pigs in ad lib trough with two pigs per feeding point.

Liquid feeding of weaners in a trough in both sides of the pen with one pig per feeding point.

Weaner and finisher units

Behaviour during feed intake among newly-weaned

It is important that newly-weaned pigs achieve a good feed intake after weaning. High levels of aggression in the post-weaning period may stress the pigs unnecessarily. A current trial studying the effect of feeding strategy on the prevalence of diarrhoea records the activity of newly-weaned pigs in connection with feeding. The aim is to clarify whether feeding several times a day affects the level of aggression during feed intake. The pigs are fed ad lib the first three days, and then the feed strength is reduced to 75% of the feed intake on day three. From day four to day nine the pigs are fed according to this strategy:

Table 4

Group 1:	Ad lib via feed box hanging from the ceiling
Group 2:	Restrictive feeding on the floor twice daily via feed box hanging from the ceiling
Group 3:	Restrictive feeding on the floor twice daily via feed box hanging from the ceiling and allocation of ground barley ad lib from a simple dry feeder
Group 4:	Restrictive feeding on the floor four times daily via feed box hanging from the ceiling

The activity of the weaners during feed intake is studied by way of recordings of behaviour on days 2, 5 and 9 post-weaning.

Preliminary results from the trial show no clear effect of feeding strategy. However, the results indicate that there is a significant effect of the herd on aggressions during feeding as the level of aggression differed in the herds. The reason for this is probably the pen hygiene in the individual herd. The feed may be contaminated by faeces if the floors are dirty. This will lead to more competition for the feed during feeding and more aggressions.

Weaners fed on the floor

Alternative housing units for finishers

The majority of the new housing units for finishers are built as "traditional, production-safe housing units". However, alternative types of housing units for pigs are also being designed.

The new and alternative housing types are naturally of great interest to the pig producers. The Danish Applied Pig Research Scheme has therefore drawn up a concept for evaluation of such housing units. The evaluation is made on the basis of one visit to the herd, and it is not a complete evaluation of function, but does indicate pros and cons of such a system. The alternative housing units are typically built as pre-fabricated systems, with climate control and a ventilation system, often based on natural ventilation.

Economic evaluation

There are no studies that document the effect of the alternative housing units. The economic comparison is therefore based on requirements to the feed conversion. Differences in requirement to feed conversion expresses how a producer of finishers loses on the feed efficiency before a better or poorer financial result is achieved. If the requirement to feed conversion is higher than in a conventional housing unit it means that the possibilities for profitability are also reduced, cf. table 5.

The calculations show that Miljøstald requires the least to feed efficiency and thereby has the best possibility for a good profitability, while PEP and Fynbostalden require the most of the feed efficiency. However, the difference, compared with the conventional housing unit, is fairly modest.

Generally, alternative housing units make higher demands to the herdsman and his ability to interpret the signals of the animals. Qualified labour is therefore a prerequisite.

Table 5. Economic comparison of alternative housing units

Prerequisites	**Conventional**	**Miljøstald**	**Fynbostald**	**PEP-stald**
Price/place unit, DKK	2,600	2,500	2,200	2,100
Depreciation, inventory, year	12	12	12	12
Depreciation, buildings, year	27	27	17	17
Work hours, hours per finisher	0.2	0.2	0.24	0.24
Differences in demands to feed conversion, FUp/kg	0.00	0.02	-0.06	-0.03

Miljøstald

Advantages:

- Flexible wall design and pen design
- Good immediate environment and good covered areas
- Well-defined dunging area and dry lying area
- Simple ventilation with controlled air exchange and low energy-consumption, no noise from ventilator
- Light housing unit

Disadvantages

- Accumulation of manure in the inspection alley
- No supplementary water supply
- Risk of messing during high temperatures and no wind
- Common thermometer probe for sprinkling
- Risk of draught during high wind speeds

Fynbostald

Advantages:

- Pre-fabricated and standardised construction
- Good immediate environment
- Good surveillance possibilities
- Frost-proof water
- Well-defined dunging area
- Simple ventilation, low energy consumption, no noise from ventilator
- Separate entry/exit and no passage between sections

Disadvantages

- Risk of cold/heat radiation
- No individual regulation of covered creep areas and risk of high temperatures in lying area
- Difficult to dry
- Requires impact from wind to be ventilated
- Inappropriate work height in covered creep areas
- Cold housing unit during winter

PEP stald

Advantages:

- Pre-fabricated and standardised construction
- Pen partition constitutes wall elements
- Good immediate environment in lying area
- Good surveillance possibilities
- Well-defined dunging area
- Simple ventilation, low consumption of energy and no noise from ventilator

Disadvantages

- Risk of cold/heat radiation
- Risk of high temperatures in lying area
- Risk of draught in lying area caused by slurry ventilation and no climate board
- Requires frost-proof water

Loose housing of sows

As of January 1, 1999, pens for gestating sows must be built for group-housing. Service units must be organized as loose housing in relation to contract productions for the British market, and loose housing in farrowing units is the objective in connection with specialised productions.

It is possible to achieve a high efficiency with loose housing, but a number of factors still need elucidation. Thus the systems need further development in relation to both efficiency and labour.

Service unit

Housing of sows in crates is still an option in the service and control units. During the last years, a number of trials have been carried out in service units for loose housed sows, as the sows for production of pigs to the UK must be loose from weaning.

A trial made by the Danish Applied Pig Research Scheme showed that sows housed in small groups (10-12 sows) with access to feeding and insemination stalls are able to achieve results identical with those achieved in individual pens.

Furthermore, the results indicate that sows housed in groups reach heat faster than sows housed individually. This is probably because the sows are able to stimulate each another, which is important to the work routines in the service unit.

When sows are housed in large groups, one must expect increasing demands to management in connection with service and protection of sows of low rank. Trials have therefore been initiated to establish the consequence of sorting the sows according to age or housing them in crates during heat.

Pens with insemination pens

Experiences have been collected systematically from four Swedish and two Danish herds with insemination pens and use of surprise effect by a boar. Experience shows that extra time is spent on fetching the sows, but the time spent on stimulating and inseminating the sows is reduced. Insemination pens allow for a systematic handling of the sows during heat control and insemination, and is also relevant in service units with sows housed in crates.

Table 1. Reproduction results from a trial where the sows were housed in individual pens or in groups with feeding and insemination stalls. Differences in farrowing percentage are probably caused by the sows in the individual pens having been mated too early in their heat.

Housing	Individual pen	Group with feeding and insemination stalls
Produced litters after first service	1,331	1,280
Total number of piglets per litter*	13.7	13.8
Farrowing percentage, after first service	77a	81b

** Live born + stillborn adjusted for litter number*
a, b = significantly different, P<0.05

Insemination pens have more room than a crate. There are also good facilities for establishing stationary installations for the insemination equipment.

Bedding

A study of different bedding materials showed that application of shavings results in significant reproductive problems. The reason is probably native substances in fresh wood. It is therefore recommended to use straw.

Drained deep litter

A current trial of drained deep litter mats in the service unit for group-housed sows is showing very positive effects. Preliminary results show that the consumption of bedding material – compared with a deep litter mat without drainage – can be reduced from 800 to 200 kg per place unit/year. The aim is to completely eliminate the need for cleaning out.

Table 2. Reproduction results for sows housed in pens with shavings and straw, respectively.

	Straw	Shavings
Produced litters after first service	546	411
Total number of piglets per litter*	14.1b	
Farrowing percentage, after first service	84a	74b

** Live born + stillborn adjusted for litter number*
a, b = significantly different, P<0.05.

Tests of stalls

A test of stalls for group-housed sows showed that only few stalls meet the requirements one should make to e.g. access of the herd manager and safety of the sow.

Requirements to stalls:

- Easy access for the sow to the stall
- Once in the stall, the sow must be safe from the other sows
- Stall width must be 60 cm (measured on the inside)
- The length of the stall - measured from the back of the trough - must be 190 cm (measured on the inside)
- It must be possible to lock the stalls both centrally and individually by the herd manager in connection with feeding, insemination and vaccination. The herd manager must have good access to the stall in all these situations.
- The herd manager must be able to guide a sow into and out of a stall.
- All handles must be placed in sensible heights.
- The stall must not inflict injuries upon the sow.

In a pen with drained deep litter, bedding is distributed on top of the slatted floor covering the entire activity area. The slatted floor is lowered 20-30 cm compared with the crates. A wire-type barn cleaner is established under the slatted floor.

The general purpose of a stall is to ensure the sow an individual feed ration and allow the herd manager to give extra feed to a skinny sow. In the service unit, the stall is also used in connection with stimulation, heat control and insemination. In both service units and gestation units, there are many hierarchy fights and - in the service unit - often many mounts. It is thus important that the sow is safe once in the stall.

Table 3. Evaluation of technical performance of feeding and resting stalls. Several of the companies have subsequently improved the unfortunate conditions of the stalls.

Brand	Langkjær	Sdr. Vissing	Egebjerg	Jyden	Fremtiden	Birk-Dahl
Accessibility for the sow	***	***	***	***	***	***
Safety for the sow	***	***	**	***	***	*
Accessibility for herd manager	**	**	****	**	**	**
Central locking	****	***	****	***	**	***
Lock on crate	***	****	***	*	***	***
Front gate	****	****	****	**	**	****
Durability and wear	****	****	**	***	**	*
Technical performance index	**	**	**	*	*	*

** = poor, ** = less good, *** = good, **** = very good*

Table 4. Evaluation of technical performance of feeding and insemination stalls. BoPil/Schauer have subsequently stopped marketing of their product.

Brand	Langkjær	Sdr. Vissing	Egebjerg	Jyden	BoPil/Schauer
Accessibility for the sow	***	****	****	****	***
Safety for the sow	*	***	***	***	**
Accessibility for herd manager	***	***	****	***	*
Central locking	***	***	****	***	**
Lock on crate	**	****	**	**	**
Front gate	****	****	****	***	***
Durability and wear	**	****	****	****	*
Technical performance index	*	***	***	**	*

** = poor, ** = less good, *** = good, **** = very good*

Loose housing of sows

Gestating sows

One feeding and resting stall per sow

Pens for gestating sows with feeding and resting stalls can basically be designed with one or two rows of stalls and with limited amounts of bedding or a lying area with deep litter.

This type of pen is considered successful if the sows use the area outside the stalls. It must be possible to use bedding and the need for cleaning of the solid floor must be limited.

The designs have so far made it difficult to divide the pen into a dunging area and a dry, bedded area. It has thus not been possible to actually allocate bedding and the sows have dunged on the solid floor.

A one-year study was carried out in two herds.

The results related to pens with deep litter in the lying area, showed that the following factors were essential to achieve good pen hygiene simultaneously with the sows using the activity area:

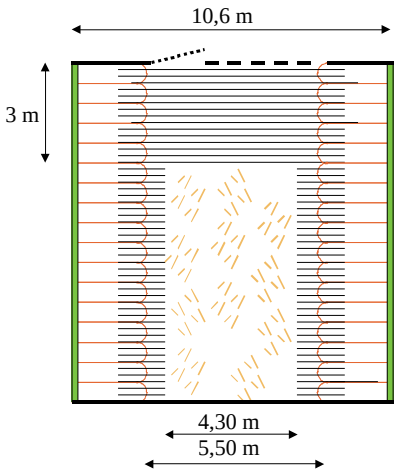
- Low housing temperature
- Slatted floor at the back of the stalls
- Slatted floor in the dunging area, placed at one end of the pen
- Open pen partitions in the dunging area, which must be oriented towards another pen
- Space for the sows to walk behind the row of stalls on the slatted floor area

Table 5. Costs of handling bedding and slurry in two different arrangements of pens for gestant sows. The pens are equipped with deep litter in the lying area and one feeding and resting stall per sow. Prerequisites: DKK0.3 per kg straw and DKK140 per hour in pay for cleaning and strewing.

Slatted floor in one end of the pen.	**Slatted floor behind a row of stalls**
	
Consumption of bedding per place unit/year	
300 kg corresponding to DKK90	375 kg corresponding to DKK113
Labour required for strewing of pens, per place unit/year	
7.6 minutes, corresponding to DKK18	9.3 minutes corresponding to DKK22
Labour required for cleaning of pens, per place unit/year	
5.6 minutes, corresponding to DKK13	7.2 minutes, corresponding to DKK17
Total costs of bedding, strewing and cleaning of pens, DKK/place unit/year (excl. interest on equipment)	
DKK121	**DKK152 (+20%)**

In pens with limited bedding, the climatic conditions were the most important factor to the function of the pen. The air quality apparently affected the location of the animals in the pen. Group size did not influence the location of sows. Pre-studies concerning transfer of sows to loose housing showed that fixation of the sows in crates the first four weeks after service seemed to reduce their use of the activity area in the remaining part of the gestation period.

A study of the diurnal rhythm showed that there were more sows in the activity area during the evening/night than during the day.



One of the pen concepts with feeding and resting stalls included in a coming trial. The solid floor outside the stall is lowered approx. 30 cm.

Current trials with new pen designs with limited bedding will show whether a good pen hygiene can be achieved simul-

taneously with the sows staying primarily in the activity area.

Electronic sow feeding

In two herds, 50 and 70 gestating sows, respectively, per feed station were compared. Experiences from the trial showed that there are very significant requirements to the feed stations and teaching/training of new animals in a group-housing system and that these are considerably increased as the number of sows per station is increased. It is possible to achieve satisfactory production results in systems with a large deep littered area, solid floor or slatted floor in the dunging/activity area and 70 sows per feed station. However, the results also showed that when the production level is high, there is a risk of affecting the farrowing percentage negatively when there are 70 sows per station compared with 50 sows per station. In one herd the farrowing percentage was 92 with 50 sows per feed station and 89 with 70 sows per feed station.

In large nesting areas, bedding can be allocated without risk of puttying of the slatted floor, and they are attractive places for the sows to lie down.

The annual costs per sow per year only increase by DKK40 by changing the number of sows per feed station from 50 to 70. This should be seen in relation to the risk of poorer production results.

In housing units with electronic sow feeding, there has been focus on the design of the lying areas during the last few years. Lowered lying areas of approx. 4.5 x 6.0 m have turned out to contain a number of advantages compared with small lying areas level with the slatted floor. Firstly, bedding can be kept in the lying area and the risk of puttying of the slatted floor is reduced, and secondly the possibility of creating an attractive, draught-free lying area for the sows is increased. If approx. 75 kg straw is used per place unit annually there is rooting material in the pen permanently, and the straw acts as a buffer in relation to regulation of temperature and humidity.

Lactating sows

In Denmark, the majority of farrowing and lactating sows are housed in farrowing crates. However, both in Denmark and within the EU it is recommended to work towards alternative types of housing that allow room for display of the animals' natural behaviour. A study has been initiated of the dimensions of Danish hybrid sows and piglets. The aim is to establish an improved biological basis for dimensioning farrowing crates and pens. Furthermore the results will be part of the development of pens for loose, lactating sows, farrowing huts and crates as the sows have increased in size in the last years. At the same time, the litter size and weaning weight and age have increased.

The Innovation Act granted funds for a five-year research project with participation from the Royal Veterinary and Agricul-tural University, the Danish Institute of Agricultural Sciences and the National Committee for Pig Production. The project will help ensure that it becomes financially profitable to produce piglets in pens that benefit the welfare of the sows more than the present farrowing crates and the present systems for loose, lactating sows. The results of the project may also be used for reducing piglet mortality in organic production and in outdoor herds where mortality is also a restraint on the welfare of the piglets and for the income basis.

New pen types

In order for loose housing systems to gain a foothold in Danish pig production, it is important that the technical reliability is high and that increased operating costs are compensated for by an increased productivity. Therefore, the Danish Applied Pig Research Scheme is making a systematic evaluation of production and technical performance of the farrowing pens for loose sows that are on the market today with the aim of evaluating whether they are an actual alternative

Loose housing of sows

to the traditional farrowing pens.
The study of loose pens also comprises pens where it is possible to restrict the freedom of movement of the sow in the

A study made by the Danish Applied Pig Research Scheme will show if the development of pen concepts for loose, lactating sows has come so far that one or more types can be recommended.

days of farrowing.

Outdoor farrowing
A number of conditions must be clarified if the outdoor sow unit is to become the future housing system of loose, lactating sows. The efficiency and level of production must be high. Labour must be at an acceptable, possibly low, level and work environment must be good. Furthermore, the impact on the environment from the outdoor sow unit must be limited.

Design of farrowing huts
Existing farrowing huts generally do not provide enough support for the sow when it lies down. Furthermore, the huts have very limited ventilation possibilities, and the surveillance is often limited. A co-operation has therefore been initiated with an architect student with the aim of designing a new farrowing hut. A prototype of the hut is expected to be tested in 2003.

Rape, barley or wheat straw in farrowing huts
A study was made where rape, barley or

Sow with piglets in farrowing hut.

wheat straw, respectively, was used as bedding. It was expected that if a non-absorbent material were used in the form of rape or wheat straw, the bedding would absorb less humidity from the ground. Thereby the immediate environment of the piglets should be improved just as the labour required for strewing after farrowing would be reduced.

Mechanical distribution of bedding in farrowing huts

Experience with application of rape straw for strewing showed that the rape straw was more evenly distributed in the hut compared with the other types of straw and that the rape straw did not absorb humidity from the ground. However, there was interaction between herd and groups in terms of mortality of piglets. In herd 1 there was no difference between the treatments, while piglet mortality was significantly lower when wheat straw was used than when barley and rape straw was used in herd 2.

Rape can be used for strewing in huts, but there is a need for distribution of e.g. barley or wheat straw on top of the rape straw so the piglets can dig into this.

Water temperature and consumption in farrowing paddocks
Experience showed that if the water pipes are buried in 80 cm depth, it is possible to maintain a stable, low water temperature regardless of the outdoor temperature. This is expected to influence the water intake of the sows considerably and thereby influence their well-being.

Water supply in farrowing paddock

Animal welfare and UK production

In the autumn 2001, the EU Commission and the Council of Ministers adopted two new EU directives tightening the minimum requirements for protection of pigs. The changes must be implemented in the member states as of January 1, 2003. As a consequence, a number of Danish acts and orders will have to be revised or drawn up:

- Act on indoor housing of gestating sows and gilts (Act no. 404)
- Act on indoor housing of weaners, breeding stock and finishers (Act no. 104)
- Order on protection of pigs (Order no. 998)
- Order of tail docking and castration of animals (new order)

Changes of acts and orders will be implemented during the autumn 2002.

Consequences of changed regulations

The present Danish legislation on animal welfare is in most areas tighter than the new EU requirements, but some areas will need tightening.

Pen space – sows and gilts
The EU requirements almost correspond to the Danish requirements for gestating sows and gilts, but are for some group sizes tighter.

Relief – sows and gilts
It has so far been possible to use crates as hospital pens for sick and injured sows. In future, animals with a need for relief must be housed in a pen that allows them to turn around.

Satiating materials – sows and gilts
As of January 1, 2003, all gestating sows and gilts must have access to sufficient amounts of satiating or fibre-rich feed such as straw that provide the animals with a feeling of satiety.

Rooting material – weaners and finishers
As of January 1, 2003, all weaners and finishers must have permanent access to rooting material regardless of housing.

Pen space – boars
Pens for boars used for natural mating must after January 1, 2005, have a freely accessible area of 10 m^2.

Furthermore, the transition regulations for existing housing units are tightened. In the act on indoor housing of gestating sows and gilts and in the act on indoor housing of weaners, breeding stock and finishers, the transition period is changed so that as of January 1, 2013, all housing units must comply with the requirements.

Pigs for the British market

Approx. 1,650 herds have been approved for production of pigs to the British market with an annual production approx. 3.5 million finishers. Approved pigs were settled with a bonus of DKK0.30 per kg in 2002. Thirty-three local advisors function as inspectors in these herds. The inspectors have found deviations, which results in follow-ups in approx. 10% of the herds. The deviations were primarily shortcomings in the documentation that could not be found at the time of inspection.

Table 1. Effect of changed EU legislation on Danish rules for housing of pigs.

Animals	Requirements	Consequences
Sows	Group-housing	None
	Pen space	Changed
	Minimum measurements	Not established
	Floor design	Not established
	Hospital pens	Changed
	Cooling	None
	Rooting material	None
	Satiating materials	Changed
Weaners/finishers	Pen space	None
	Floor design	None
	Cooling	None
	Rooting material	Changed
Boars	Pen space	Changed

Organic pig production

In 2000, common EU rules were introduced for organic livestock production. The regulations include e.g. minimum space requirements to housing systems, which involve high investment costs.

Housing units for finishers

Based on the above, a number of activities are carried out in the Danish Applied Pig Research Scheme with the aim of optimising pen function and utilisation of the housing unit for finishers.

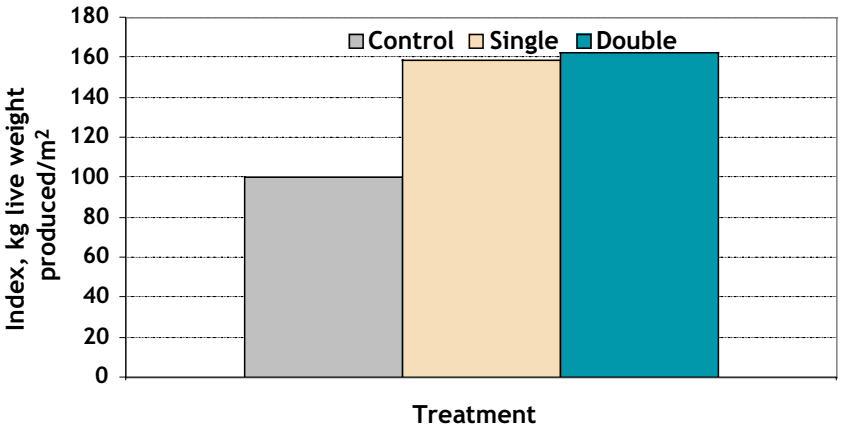
Large groups

When pigs of different sizes are housed in the same pen, the housing utilisation can be improved. The potential of this concept was initially analysed in a pilot trial carried out in co-operation with the Danish Institute of Agricultural Sciences. This pilot trial comprised a control block where all the pigs were of the same age. The test pigs consisted of one block with three litters with an age difference of approx. six weeks and one block with six litters that in pairs were the same age, but with a difference of six weeks between the three age groups.

The results of the pilot trial showed no difference in daily gain between the static group and the large groups with mixed sizes. The feed conversion for all groups was approx. 2.3-2.9 FUp per kg gain.

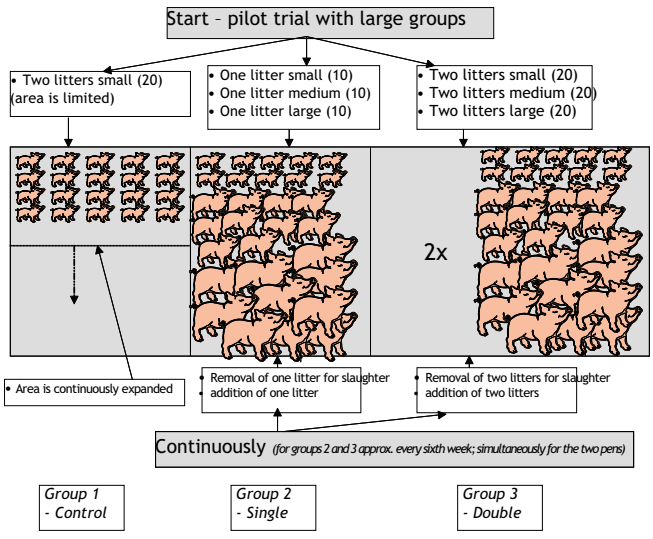
Table 1. Average age and weight of the three sizes of pigs in the control group, the group with one litter per age group (single) and the group with two litters per age group (double), respectively.

Size	Small			Medium			Large		
Group	Control	Single	Double	Control	Single	Double	Control	Single	Double
Av. age, days	60	55	55	101	92	92	134	126	126
Av. weight, kg	22	21	19	51	43	42	88	79	79



Produced kg live weight in pens with a static group (control) compared with pens with one litter (single) or two litters (double) added every sixth week.

A very limited amount of scratches and wounds was recorded on the pigs after mixing. There were approx. 0.6 aggressions per pig in the pens on the first day after mixing. Less than one aggression per pig during 24 hours is very little. The pilot trial indicated that in terms of production and welfare, the system with finishers in large groups seems to have potential. However, it needs further development in terms of immediate environment for both newly-weaned pigs and finishers, nutrient supply to different age groups and health management.



Schematic diagram of trials with finishers in large groups with different age groups in the same pen.

Feeding with lupin

A trial was carried out that studied Lupin Prima as an alternative organic protein source in finisher feed. It was concluded that up to 15% lupin could be used without negative effects on productivity.

Information

Further information on organic pig production can be found at the website www.lr.dk/oekosvin.

Pigs of different sizes in the same pen.

Surveillance and planning of production

Farm*Watch*®

Farm*Watch*® is a management tool for weaners and finishers based on surveillance of drinking patterns among others.

Alarm via text messages

Besides giving alarms via the computer screen, Farm*Watch*" now also transmits alarms via text messages. This means that with a mobile phone, a status of the weaner/finisher units can at all times be obtained.

Improved production control

The production control module in Farm*Watch*® has been extended so that it is possible to make a complete statement of productivity, feed conversion and economy at batch level. This means that now Farm*Watch*® is the only management tool needed in weaner/finisher production.

Completed FarmTest

A study was made among the users of the computer-controlled management tool Farm*Watch*®. The programme can be used for surveillance of weaners and finishers produced in all in-all out systems. The surveillance is among others based on a continuous recording of the pigs' water consumption.

*The drinking pattern is observed by Farm*Watch*®.*

The conclusion of the study was that the users see Farm*Watch*® as a useful and profitable management tool for weaner and finisher production in all in-all out systems. The study included visits and subsequent follow-up in ten herds that had all used Farm*Watch*® for at least one year. The result is based on interviews of the daily users and evaluations made in the individual herds.

Focus was mainly on studying the stability of the programme and seeing how Farm*Watch*® was used as a management tool. It was generally agreed that the user interface seems logic and is easy to use. The alarms are easy to understand.

The system provides an appropriate number of alarms – when an alarm sounds, there is usually something wrong. Outbreaks of diarrhoea (both Coli and Lawsonia) are noted approx. one day before the pigs show any visible symptoms. This provides for early treatment with a reduced consumption of medication and increased productivity as a result. Other conditions such as respiratory disorders, feed problems and technical defects also affect the drinking pattern of the pigs.

It is not enough to just look at the screen. The herd manager must decide if and how to intervene.

The majority of the users that were interviewed said that Farm*Watch*® had helped them improve management and in several cases the result was reduced medication consumption. An average Farm*Watch*® system costs between DKK15,000 and DKK30,000, including water gauges and network for collection of data. Initially, many users were hesitant at spending that much money on a surveillance programme, but none regretted their investment in the programme and its equipment.

Integrated Farm Management System – Pigs

Feed formulation FUgs – FUgp – (FUp)

The new feed evaluation system, which changes of the energy and protein evaluation systems, has been incorporated into the feed formulation programme, and now formulations can be made on the basis of FUgp, FUgs or FUp. These three options make it possible to evaluate the influence of the new feed evaluation system on the composition of the feed in relation to the "old" FUp.

As the new protein evaluation system is based on standardised digestibilities of amino acids, all ingredients have been up-dated so that each amino acid now has its own digestibility. This has also resulted in new amino acid standards.

These new possibilities in terms of formulation makes the programme automatically pick a diet with a low content of protein as these diets are in most cases the cheapest.

Handheld terminal – a relief during recording

The handheld terminal for Integrated Farm Management System – Pigs can record the following data: activities of parent animals, removal of pigs, and medication while one is working in the housing unit.

If the sows are housed in groups and equipped with an electronic ear tag, the handheld terminal can catch the signals from the ear tags, which quickly provides the number of the sow and via the sow file, an overview can quickly be created of the sow's results. This might be average number of liveborn piglets, weaned pigs and non-productive days.

The handheld terminal can be used in two ways in the Integrated Farm Management System; either as an integrated part or in co-operation with the

Surveillance and planning of production

advisor preparing the production report. When used together with the advisor, the computer must have access to an E-mail as the advisor transmit the herd data by way of E-mail. These data are transferred to the handheld terminal, which is then ready for use. A week later, new data are sent to the advisor who updates the herd and returns the updated data. This eases work in the housing unit – data are recorded only once – and also the work of the advisor as data are already in the computer. They are now automatically transferred to the Integrated Farm Management System.

Weighing by way of image processing

In modern finisher production, knowledge of the weight of the animals is important to be able to monitor the gain of the pigs and for delivery of pigs for slaughter within the correct weight interval.

In co-operation with the Danish Institute of Agricultural Sciences and the Royal Veterinary and Agricultural University, the National Committee for Pig Production has started development of a weighing system based on digital image processing. The system will consist of a number of removable cameras photographing the pigs from above and a computer translating the picture of a pig to a weight estimate. The computer must be able to provide the average weight of the animals in a pen and the number of pigs in a pen ready for delivery to the slaughterhouse.

The weighing system is expected to be ready towards the end of 2004 and will probably be marketed at a significantly lower price than the mechanical weights on the market today.

Recording of coughs

The prevalence of coughs in a housing unit is a typical way of diagnosing respiratory disorders. The degree of pneumonia is often established by listening to the cough of the pig.

In co-operation with the Danish Technical University, the National Committee for Pig Production carried out a project with the aim of developing a method for automatic recording of coughs. The recording takes place by way of a microphone placed centrally in the housing unit and hooked up to a computer. By way of the methods used for automatic speech recognition, the coughs are detected from the overall acoustic image.

With this method is was possible to detect 80% of all coughs in a housing unit, which is sufficient to establish a change in the general level.

It is expected that this method will be used both in health surveillance and for behavioural studies.

Batch operation

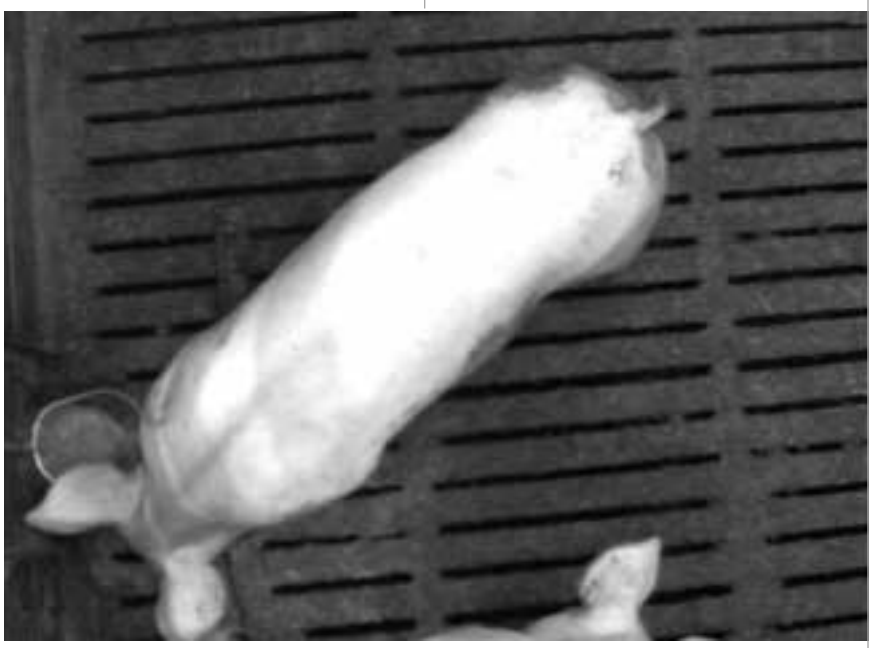
In batch operation systems with more than two weeks between the batches, it may be difficult partly to ensure an even number of pigs per batch and partly to ensure that the pigs are fairly uniform in size upon delivery to the finisher producer.

Equalisation of batch sizes

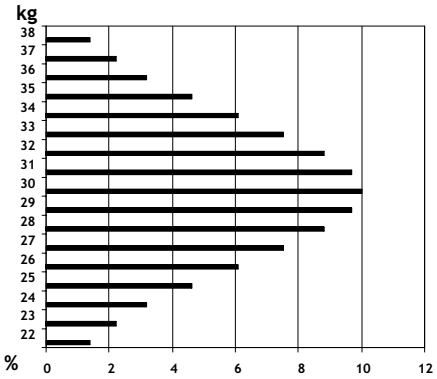
When a batch of sows is weaned in weekly batch operation, it is always possible to delay or move forward the weaning by one week. Thereby a partial equalisation of the number of sows weaned per batch is possible. Batch operation with more than two weeks between the farrowing batches virtually excludes "moving forward" litters from the subsequent farrowing batch at weaning. This lacking option of equalisation between the batches makes far larger requirements to the management of the size of the farrowing batches than weekly operation.

Management of batch operation

The lacking option of moving sows back or forwards between farrowing batches requires a lot of the management of a batch operation system. Management of the size of the farrowing batch consists in mating e.g. 15% more sows/gilts than the aim of the number of sows in the farrowing batch. Thus, e.g. 57 sows and gilts must be mated if the aim is to have 50 sows for farrowing each time.



On the basis of the image, the computer calculates the size of the pig, which is then translated into a weight estimate.



Spread in the weight of pigs, kg

Management of batch operation requires particular knowledge and planning when replacing the sows and thereby addition/purchase of gilts. The replacement must be planned ahead to ensure the correct number of gilts ready for mating, which is a prerequisite for mating the right number of sows/gilts for each sow unit.

Uniform pigs

At weaning, there is typically a weight spread of 1 kg, and at 30 kg the spread is approx. 3.8 kg. The weight of the pigs will then typically vary from 22 to 38 kg.

The weaner producer must then establish the necessary buffer capacity in order to handle the variation in weight and in the number of pigs per batch.

Buffer pens can be used either at weaning or in connection with emptying of weaner units. Therefore, there ought to be one or two small compartments with a capacity corresponding to 15-20% of the capacity of a weaner unit. The buffer compartments must be operated as all in-all out exactly as the other weaner compartments.

Batch operation programmes at www.LU.dk

To ease the planning, the National Committee for Pig Production in co-operation with pig advisors has developed programmes for planning, designing and management of batch operation systems.

The programme contains suggestions for different batch operation systems. Furthermore, there are proposals for dimensioning of all housing compartments creating an overview of the necessary housing capacity. The programmes can be found at www.lu.dk.

Agreement on production conditions in a network

When a networking begins, there is often a tendency to focus on the financial/legal arrangements and on delivery plans/failure of delivery etc., but it is also important to focus on the production so that all parties in the network achieve quality pigs from farrow to slaughter.

By discussing the practical factors related to production, the participants in the network touch upon issues that the individual pig producer often – incorrectly - regards as congenial. This might be:

- Preparing a housing unit/compartment before transfer of pigs
- Cleaning and disinfection
- What is the temperature in the housing unit (seller and buyer)?
- Important information to make transfer as easy as possible for the pigs
- Delivery conditions
- Partners' conditions
- Guidelines in the network on cleaning, disinfection and change of boots
- Weaning procedure
- How are the pigs handled at weaning?
- Are the litters mixed at weaning?
- What agreements exist in the network?

The National Committee for Pig Production and the Production Economy group at the Danish Agricultural Advisory Centre focus on these issues in a new leaflet containing e.g. a checklist of conditions related to production that might be discussed.

The rational workplace

When optimising pig production it is important to focus on staff management and planning of work. Several farmers find it increasingly difficult to get qualified labour, which makes it crucial to create the optimum work conditions for the existing staff. Management is about setting goals and making plans for the company, making things go smoothly and ensuring that the staff is satisfied.

The idea behind the material we call "the rational workplace" is to give ideas and inspiration as to how a pig producer can run the herd, objectives, and how to conduct work on an everyday basis. This can be indicated by e.g. making a description of the premises with objectives for production, scope and housing system, etc.

Daily management is about showing that you appreciate the effort of the employees and that the employees feel that their effort is necessary.

"The rational workplace" is a new theme site on Agricultural Info: www.lr.dk.

The National Committee for Pig Production, Annual report 2002

Tail bites and ear necroses

A new and an old problem

Tail biting is a disorder that has been known for many years as opposed to ear necroses, which is a disorder that seems to have emerged recently. For unknown reasons the prevalence of ear necroses has increased within the last 2-3 years in Denmark as well as abroad. Both disorders are seen in weaners and finishers.

Risk factors

The causes of the two disorders have not yet been established. Therefore the National Committee for Pig Production initiated a risk factor study with the aim of identifying environmental and management factors associated with a high prevalence of tail bites and ear necroses.

Previous studies have indicated that factors such as housing climate, feed composition, stocking density, floor type, and bedding affect the prevalence of tail bites.

The cause of ear necroses is still unknown. Ear necroses are often considered a result of a behavioural disorder, as is the case with tail bites. However, there are indications that the disorder is not primarily caused by the pigs biting each other's ears. Infections with bacteria or other microorganisms or toxins in the feed might also be possible causes of ear necroses.

The risk factor study was carried out in 98 finisher herds. Information on housing and management was recorded through a combination of telephone interviews and visits to the herds:

- Floor type
- Use of bedding
- Mixing of pigs
- Number of pigs per pen
- Water supply
- Feeding strategy
- Feed type (dry/liquid)
- Type of feeder / trough
- Stocking density and air volume
- Type of ventilation
- Health status
- All in-all out management and cleaning

The number of pigs with tail bites and ear necroses, respectively, was counted twice at an interval of two months in all herds.

Tail bites

The results of the risk factor study showed that the prevalence of tail bites was highest among pigs weighing 60-70 kg. The prevalence varied greatly between the herds. In approx. 70% of the studied herds the prevalence of tail bites was below the average prevalence of 1.2%.

In housing units without bedding, the risk of a pig having tail bite was approx. 3.5 times higher than in units with bedding. Mixing the pigs after introduction to the herd increased the risk of tail bites by approx. 1.5 times. This could imply that the hierarchy among the pigs is disturbed during mixing.

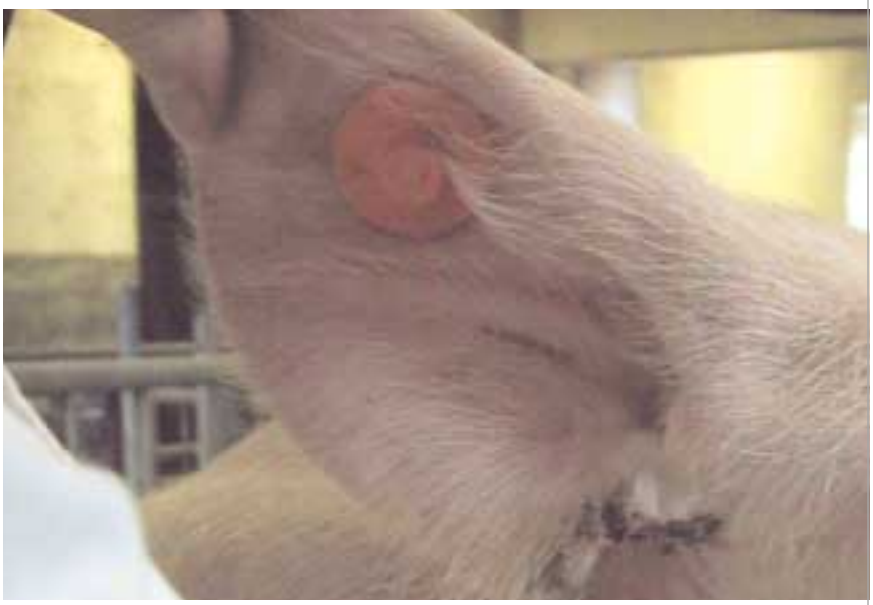
Ear necroses

The prevalence of ear necroses was highest among the smallest pigs (30-40 kg) and decreased drastically during the production period. As with tail bites, the prevalence of ear necroses was below the average of 4.3 % in approx. 70% of the studied herds.

Use of dry feed increased the risk of ear necroses by approx. 1.5 times compared with liquid feed. It is not possible to determine whether this effect was caused by the feed itself or by the feeding systems used for dry feed and liquid feed. The risk of ear necroses increased by approx. 1.8 times for pigs on slatted floor compared with pigs on solid floor. Housing units with a large air volume per pig had a reduced prevalence of ear necroses.

The future

Current trials will elucidate the effect of different types of rooting material and feed composition on the prevalence of tail bites. These studies are carried out in co-operation with the Danish Institute of Agricultural Sciences.



Ear necroses are often located on the lower edge of the ear.

Risk factors of lameness

Lameness in finishers

The prevalence of lameness in finishers in 98 herds was related to housing and management. Three veterinary technicians monitored disease symptoms on a total of 154,347 finishers. Lameness was found in 1.8% of the pigs and was the third most frequent disease symptom. Ear necroses (4.3%) and respiratory tract disorders (2.1%) were the two most frequent disease symptoms. Lame pigs were seen in almost all housing units (93%) and within the housing units the lame pigs seemed to be distributed randomly among the pens.

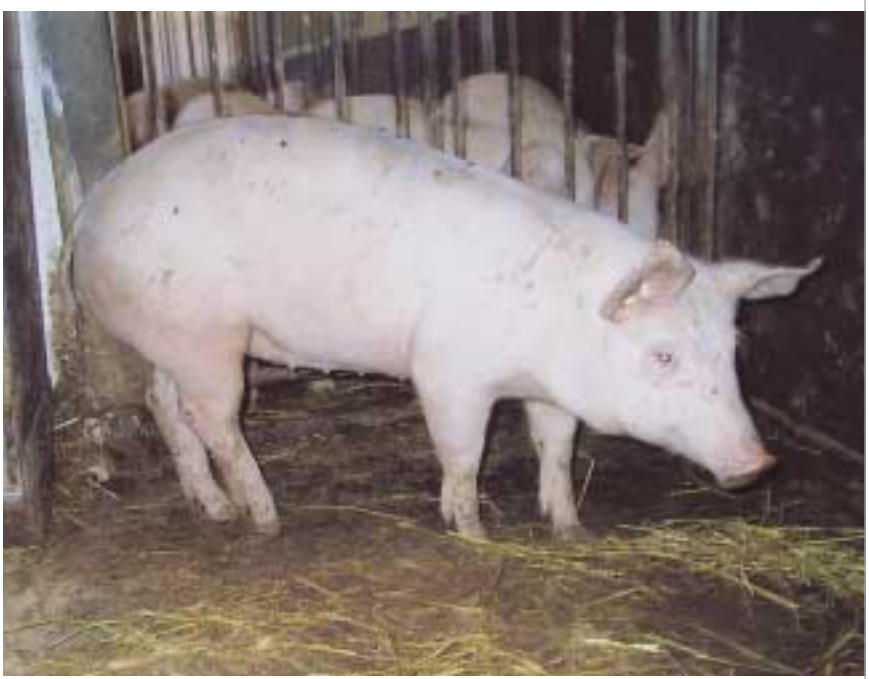
Effect of floor

The design of the floor was closely associated with the prevalence of lameness. The lowest frequency of lame pigs was found on deep litter. Pigs on solid floors had a prevalence of lameness that was approx. 1.8 times higher compared with pigs on deep litter. Pigs on partially slatted floor had a prevalence of lameness that was approx. 1.9 times higher, and pigs on fully slatted floors had a prevalence of lameness that was approx. 2.4 times higher compared with pigs on deep litter. Large finishers also had a higher prevalence rate; there were 49% more lame pigs weighing 100 kg compared with pigs weighing 30 kg. Finally, the pigs given complete diets had a frequency rate that was approx. 1.3 times higher, and for batch operation with a one-week interval between two batches the prevalence of lame pigs was approx. 1.3 times higher. These factors may be of importance to lameness in itself, but they may also cover unknown factors.

Herd size and status

The size and the health status of the herd did not influence the prevalence of lame pigs. It was also studied if the prevalence of lame pigs had any correlation with cleaning and disinfection of the housing unit or with change of boots and clothes upon entry to the herd. However, these factors did not seem to be important to the prevalence of lame pigs. The observed cases of lameness may have different causes and therefore the found risk factors may not necessarily be of the same importance in all herds.

The trial was carried out in co-operation with the Research Centre for the Management of Animal Production and Health (CEP-13).



Finisher that is lame on both hind legs.

Shoulder sores on sows

Recording of shoulder sores at meat control

In October 2000, the meat control of the slaughterhouses began recording shoulder sores on sows. Since, shoulder sores have been recorded on 4-5% of the sows. The percentage of cull sows with recordings of shoulder sores differs between the suppliers. Among cull sows from 875 suppliers, who delivered at least 20 sows over a period of six months, 20% of the suppliers had no recordings of shoulder sores, while 25% of the suppliers had more than 10% recordings of shoulder sores. Deep shoulder sores may introduce bacteria into the blood stream, which may lead to blood poisoning and thereby to complete rejection of cull sows.

Thickness of fat and nutritional status

Prevalence of shoulder sores in 1,300 cull sows was correlated with other slaughter data such as slaughter weight, thickness of fat and of meat. It was found that the sows' risk of shoulder sores was very closely related to the thickness of their fat. When the slaughtered sows were sorted according to thickness of fat and subsequently divided into four even groups, the risk of shoulder sores among the quarter of sows with the thinnest fat was six times as high as among the quarter that had the thickest fat.

Among lactating sows there was also a clear correlation between the nutritional status and their predisposition to shoulder sores. The one quarter of the animals with the poorest body condition defined as body weight divided by age had a risk of shoulder sores that was up to three times higher than that of the quarter with the best body condition.

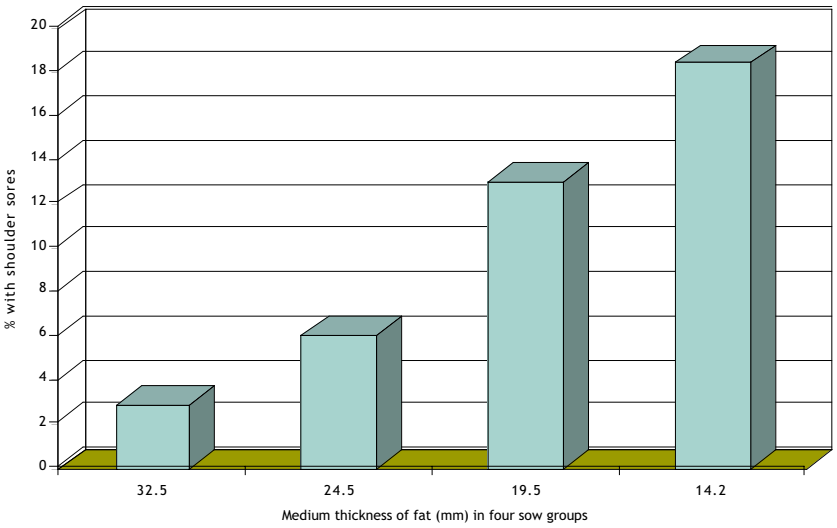
Age and cycle

The prevalence of shoulder sores in lactating sows was clearly higher in the third week of lactation than in the first. Several studies show that shoulder sores mainly occur during the sows' stay in the farrowing unit and the sores largely heal in the dry and gestation periods.

Older sows generally had more shoulder sores than younger sows. The correlation between shoulder sores and age is probably caused by the increased weight and reduced motility of older sows.

Prevention

Shoulder sores normally occur as a consequence of much strain on the skin. Pressure is the main cause, but also friction from the foundation is of importance. If the skin is not robust either due to wear or humidity, the risk of developing shoulder sores increases.



Frequency of shoulder sores correlated to thickness of fat.

Sow with shoulder sore.

Shoulder sores are seen more often on sows in the farrowing unit than on sows in the gestation unit. The risk of developing shoulder sores depends on the body condition of the sow, floor type, temperament and activity around farrowing. Sows that lie down a lot and restless sows are predisposed to shoulder sores. It is thus important that the sow can stand up and lie down without any problems in the farrowing pen. The floor must be non-skid and the sides of the farrowing crate must only be closed for a few days in connection with farrowing. After that, the farrowing crate must be re-opened so that both the sow and the piglets have more space.

Slippery floors with small level differences to improve the non-skid quality of the floor are inappropriate in relation to shoulder sores. Furthermore, a humid, dirty and rugged concrete floor may increase the risk of shoulder sores. A worn concrete floor with sharp rocks must be given surface treatment as it may otherwise wear out and put great strain on the shoulders of the sow.

Hospital pens

If the sow has signs of deep sores, it must immediately be moved to a well-bedded hospital pen were she can move. The majority of the shoulder sores will then heal during a couple of weeks. If the sow has piglets, it may be necessary to wean them or transfer them to a nursing sow.

Spread of respiratory disorders

Commercial herds

In the period from May 1996 to May 2001, data were analysed from 3,055 herds free from Antinobacillus pleuropneumoniae (Ap) serotype 2 and from 931 herds free from Mycoplasma hyopneumoniae (Myc). An average of 2.6 % Ap-free herds and 11.9% Myc-free herds were infected per year. Based on the Geographic Information System (GIS), a risk index was made for each herd describing the density of pigs (number of pigs/distance to neighbouring buildings) within 3 km of each herd. Furthermore, data from the Danish Meteorological Institute were analysed for correlation between climatic conditions and infection risk.

It was found that the density of pigs was of essential importance to both diseases. When the risk index was doubled, the risk of infection increased by 50%. The size of the herd was also of importance. When the number of finishers on the premise was doubled, the risk of infection of Ap or Myc increased by 12-13%.

The climate was also of some importance as high temperatures reduced the risk. It was also found that rain had a reducing effect on the risk probably because the infectious particles to a certain extent were "washed out" of the atmosphere.

Breeding and multiplication herds

Antinobacillus pleuropneumoniae serotype 2

The risk index was also of great importance in the breeding and multiplication herds as a doubling of the risk index almost corresponded to a doubling of the infection risk. Furthermore, the number of sows was of significant importance as herds with more than 500 sows had a risk that was approx. three times as high as the risk in herds with less than 500 sows.

Mycoplasma hyopneumoniae

The infection risk was increased by 60% when the risk index was doubled. Herds with a large production of finishers/growers (more than 800 a year) had an infection risk that was 2.5 times higher than that of herds with less than 800 produced finishers/growers per year. A previous Danish study also found an effect of purchased animals. This effect was not seen in this study, possibly because the purchase patterns have changed since the 1980s and the blood sampling systems for identification of infected herds have improved.

Neither Ap nor Myc were affected by the number of visits (vet/advisors/other persons), or whether there was any staff besides the owner or by the type of feeding strategy (mixed on-farm/purchased, liquid/dry).

PRRS

As in previous studies, a strong effect was found of risk index as herds with a high index had a risk of infection that was 3.8 times higher than herds with a low index.

Herds in Southern Jutland had a risk that was six times higher than for herds in Zealand, while the risk for herds in Central and Eastern Jutland was 4.6 times higher than for herds in Zealand. Herds with many finishers/growers (more than 800 per year) had a risk that was twice that of smaller herds. Furthermore, SPF herds had the smallest risk, while MS herds had a risk that was three times as high and conventional herds a risk that was five times as high.

Based on these calculations, GIS will be updated with new equations so that the risk indices for all three respiratory disorders are considered when planning a health strategy.

Pain relief

Pain-relieving drugs are rarely used for pigs. It was not until 2001 that a pain-reliever was registered for use in pigs. According to the present legislation, this drug can only be used for certain types of arthritis and can be dispensed for a five-day cure.

The National Committee for Pig Production has initiated studies to elucidate the effect of using pain-relievers in pigs. If the results of these studies are promising, they may contribute to increasing the possibilities of using pain-relievers in pigs.

Why pain relief?

Improved welfare

Treatment with pain-relieving drugs serves several purposes. Pain relief will improve the welfare of the animals in cases of painful diseases and during surgery.

Faster recovery

Previous studies indicate that pain may delay the cure of injuries and reduce the ability to fight inflammation. It is therefore likely that treatment with pain-relievers will speed up the recovery from certain diseases. Furthermore, pain relief will often have a positive effect on the appetite of the animal, which in turn promotes recovery and improves welfare and productivity.

Reduction of the use of antibiotics

A number of disorders that are often treated with antibiotics can probably be treated with pain-relievers instead. Because of possible problems with antibiotics resistance this is desirable.

When is pain relief relevant?

Alleviation of pain is particularly appropriate in cases of painful diseases and when it results in a faster cure and/or a reduction in the consumption of antibiotics.

It is important to emphasise that the use of pain relievers cannot replace the use of hospital pens or a required improvement of a poor housing system or management. In some cases, pain relief will have to be combined with the use of antibiotics.

Pain relief could be beneficial in the treatment of the following diseases:

- MMA
- Certain types of arthritis
- Blows or strains
- Gastro-intestinal diseases
- Pneumonia
- Urinary tract infections
- General infections, such as influenza
- Meningitis
- Tail bites and other injuries
- Surgery

Current studies

Current studies will elucidate the effect of pain relief on certain types of lameness in finishers and MMA sows.

Lameness and MMA account for a significant part of the antibiotics consumption in Danish pig production. Recent studies have showed that lameness is the most frequent reason for antibiotic treatment by injection in finishers.

The aim of the studies is to clarify whether pain relief results in a faster cure of the animals. Furthermore, it is studied if pain relief has a positive effect on welfare.

New studies elucidate the effect of pain relief on MMA

Salmonella

Salmonella in slurry

Survival of Salmonella in slurry after spreading on the field was studied in a pig herd infected with Salmonella DT 104. The slurry was spread with a slurry spreader (three fields) or with a slurry injector (one field). Two of the fields using slurry spreaders were harrowed or ploughed in and harrowed, respectively, after spreading of slurry.

The prevalence of Salmonella in soil samples was significantly reduced during the first week after spreading. Salmonella could not be detected in soil after ploughing in. On the other fields, the number of positive samples of soil or plants varied from 13 to 50% when measured two hours after spreading, while only one positive soil sample (after slurry injection) was found a week later. Salmonella was not found 2, 3 or 4 weeks after spreading.

Furthermore, measurements of the number of coliform bacteria and faecal enterococci, which were included as indicator bacteria in this study, showed a reduction of more than 95% during the first week after spreading.

Infection dynamics

The prevalence and transmission of Salmonella in pigs was studied over time. In three farrow-to-finish herds, cohorts of pigs from several litters were followed individually from weaning to slaughter with respect to excretion of Salmonella and antibody response.

Table 1. Effect of the feed's form and of addition of the enzyme Porzyme 9300 (from Danisco Animal Nutrition) for finishers measured on productivity and relative risk of a pig being salmonella-positive

Meal/pellets	Pellets	Pellets	Meal	Meal	Effect of treatment Feed's form	Enzyme
Screen in Hammermill	2.5 mm	2.5 mm	4.0 mm	4.0 mm		
Porzyme 9300, 1 kg/t	No	Yes	No	Yes		
% positive	30.6	24.1	17.6	13.0	p=0.02	p=0.27
Relative risk*	1	0.69	0.45	0.30	Meal: 1 Pellets: 2.25	Enzyme -: 1 Enzyme +: 0.69
Productivity, GM/place unit/year, index	100	106	66	72	p<0.01	p=0.05

** Relative risk denotes how many times higher or lower the risk is of a pig being positive when a certain type of feed is used. The relative risk is always stated compared with a reference group (pelleted feed with no enzyme).*

The results showed that Salmonella excretion increased dramatically after weaning, peaking in the weaner unit, while the excretion declined in the finisher period when only few pigs excreted Salmonella at slaughter. However, serum antibodies were found in almost two thirds of the animals at some point during the finisher period.

There were considerable differences between litters, cohorts and herds in terms of prevalence, time of infection and degree of excretion. The correlation over time between excretion and antibody response was rather poor when assessed using individual animals. Bacteriological studies of herd Salmonella status should therefore be based on samples from several age groups.

Worms and Salmonella

It was studied whether there is any association between the prevalence of worms and of Salmonella in finisher herds. Meat inspection data (% white spots in the liver) and Salmonella data (% positive meat juice samples) from four slaughterhouses and their supplier herds were compared. Possible effects of slaughterhouse and season were accounted for in the data analysis.

At herd level there was a significant association between recording of salmonella-positive meat juice samples and recording of worm spots in the livers of finishers. However, a significant association between the degree of infection (number of positive animals) with Salmonella or worms could not be demonstrated, neither at individual level nor at herd level. The results indicate that there might be an association between herd and management factors and the prevalence of Salmonella and worms.

Commercial products

It was studied whether addition of the enzy-

Spreading of slurry with slurry spreader.

Salmonella

me Porzyme 9300 to finisher feed affected the productivity and the prevalence of Salmonella (Report no. 558).

Addition of Porzyme 9300 did not have a significant influence on the prevalence of Salmonella or the microbial ecosystem in the gastro-intestinal tract, but it did improve productivity, cf. table 1.

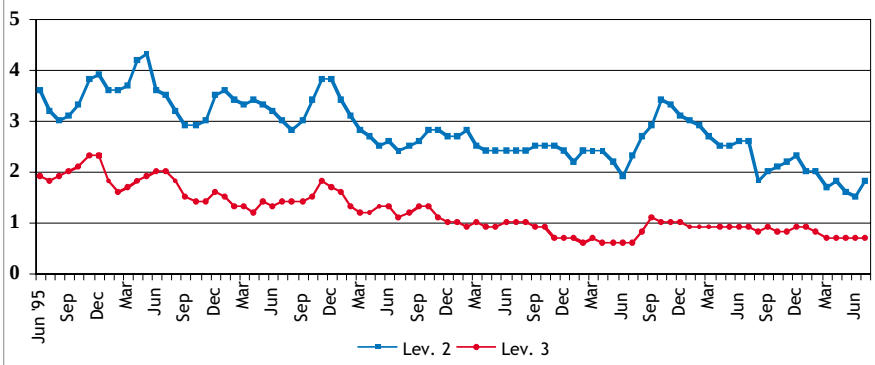
Coarsely ground meal feed reduced the prevalence of Salmonella compared with finely ground, pelleted feed. Furthermore, coarsely ground meal feed improved the microbial balance in the gastro-intestinal tract compared with finely ground, pelleted feed, but resulted also in a distinctly poorer productivity primarily due to a reduced feed conversion.

Addition of a plant extract from "den lokale andel" consisting of polysaccharides extracted from sea and terrestrial plants did not affect the productivity or the prevalence of Salmonella in finishers. However, it did seem that meal feed and the plant extract affected the microbial ecosystem in the caecum in the same direction.

New Salmonella surveillance plan

On January 1, 2002, the new surveillance plan III on Salmonella, administrated by the industry, replaced the old Salmonella surveillance plan. The aim of the plan is to reduce the prevalence of Salmonella by 25% measured on carcasses. The industry is obliged to pay all costs except the running of the Danish Zoonosis Register. Furthermore, the administration of the plan has been transferred to the industry under the Department of Zoonosis Management.

Thus, as of May 1, 2002, the DANISH BACON AND MEAT COUNCIL also handles the mapping of herds delivering pork to the unions Danske Håndværksslagtere and Danske Slagtermestres Landsforening.
As a new element in the plan, the requirements to the individual slaughterhouse



The distribution of levels 2 and 3 herds in per cent of all herds in the period June 1995 - July 2002.

were tightened on May 1, 2002. If a slaughterhouse has more than 2.3% salmonella-positive samples in the fresh meat surveillance for four consecutive months, the slaughterhouse must increase their salmonella-control. The slaughterhouse must then in the next six months prove that the prevalence of Salmonella can be maintained stable below 2.3%. If the slaughterhouse still has a too high prevalence of Salmonella, the Danish Veterinary and Food Administration can make tangible requirements to improvement of the hygiene.

Status on Salmonella surveillance plan

In June 2002, the distribution of finisher herds in levels 1, 2 and 3 was 97.5%, 1.8% and 0.7%, respectively, which is acceptable. The figure illustrates the distribution of levels 2 and 3 since 1995.

The average prevalence of Salmonella in fresh carcasses in 2001 was 1.5%. The prevalence in the first six months of 2002 was largely unchanged compared to 2001.

According to the annual report of Danish Zoonosis Centre, Danish pork accounted for approx. 160 cases of Salmonella in humans in 2001, which must be considered very low seen in the light of the approx. 800-1,000 annual cases prior to the Salmonella surveillance plan in 1995.

Salmonella Typhimurium DT104

This past year, the number of herds infected with DT104 has for the first time more than halved compared with last year. The number of pigs requiring special slaughter has also halved, and most sow herds are no longer under zoonosis surveillance. Thus in September 2002, 100 weaners had to be put down weekly. The co-operation with the Regional Veterinary and Food Control Authorities on the zoonosis surveillance has been good and constructive.

Scientific studies show that there is very little risk of Danish consumers becoming infected by DT104 form Danish pork. Besides, if humans become infected by DT104, it is no worse than becoming infected by other types of Salmonella.

The National Committee for Pig Production therefore works on changing the circular/order on Salmonella in cattle and pig herds, so that the special precautions – the zoonosis surveillance – on handling herds where Salmonella Typhimurium has been established are removed.

PMWS - experiences with the disease

PMWS

Post-weaning Multisystemic Wasting Syndrome (PMWS) was first described in 1991 from Canada and now the disease has been diagnosed in most pig-producing countries. PMWS affects pigs post-weaning starting 3-4 weeks post-weaning. The symptoms are variable but include unthriftiness, increased mortality and dyspnoea.

Pig suffering from PMWS

Cause

Porcine Circovirus type 2 (PCV2) is causally associated with the development of PMWS. PCV2 is found in most Danish pig herds indicating that other factors are involved in the development of the disease. These factors have not yet been identified, but it seems that factors stressing the pigs could be involved.

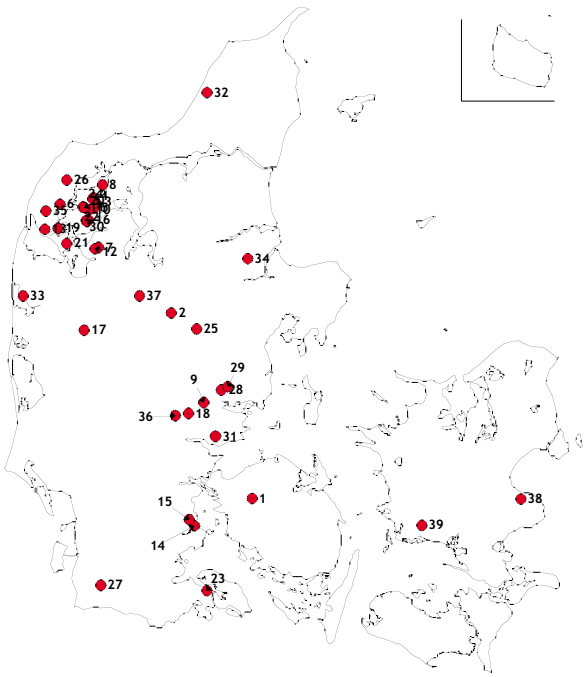
PMWS in Denmark

As of July 31, 2002, PMWS has been diagnosed in 39 herds in Denmark cf. the figure below. In affected Danish herds the mortality among the piglets varies between 5% and 30%. PMWS occurs in high health herds as well as in conventional herds.

The reason why some herds develop PMWS while others do not is still unknown, and which factor triggers the development of PMWS is under intense research in many countries. There are indications that the sum of stress on the pig is determining to whether PMWS is developed or not. The trigging factor may be a small and apparently insignificant stress on the pig that - combined with other factors - triggers PMWS.

Control measures

Experience shows that establishment of all in-all out production in a herd with PMWS often controls the disease. Table 1 outlines some useful control measures. Partial depopulation of the piglets seems to help controlling the disease and thereby reducing the losses due to PMWS in the herd. It is also important to control other infections in the herd e.g. trough vaccination. The National Committee for Pig Production has given some recommendations on how to control the disease in the herds. This has been forwarded to all vets and can also be found on the website www.lu.dk.



Diagnosed PMWS herds as of July 31, 2002, in Denmark.

Studies

In ongoing studies, the National Committee for Pig Production is investigating whether PMWS affects pigs of some particular sows. Furthermore, the effect of specific serum against PCV2 will be examined in co-operation with the Danish Veterinary Institute. The National Committee for Pig Production is also working on obtaining permission to test auto serum.

The future

If PMWS is diagnosed in a herd, the management routines should be carefully examined. Routines should be tightened where necessary, e.g. establishing all in-all out, removing sick animals to a hospital pen as soon as possible, and conducting a partial depopulation in the weaning section. In many cases, these measures are likely to reduce the losses caused by PMWS.

Table 1. Control measures

Farrowing unit	All in-all out, good hygiene, cross fostering before < 24 h of birth
Weaner unit	Small pens
	Al in-all out, good hygiene, disinfection
	Stocking density max. three pigs per m2
	Space by the feeder for all pigs
	Good air quality
	Temperature appropriate and constant
	No mixing of piglets
Grower and finisher units	Small pens
	All in-all out, disinfection, good hygiene
	No mixing of pigs
	No overcrowding
	Optimum air quality
	Optimum temperature
Other	Appropriate vaccination programme
	Strict hygiene procedures during castration
	Early removal of sick pigs to hospital pens

Antibiotics for finishers

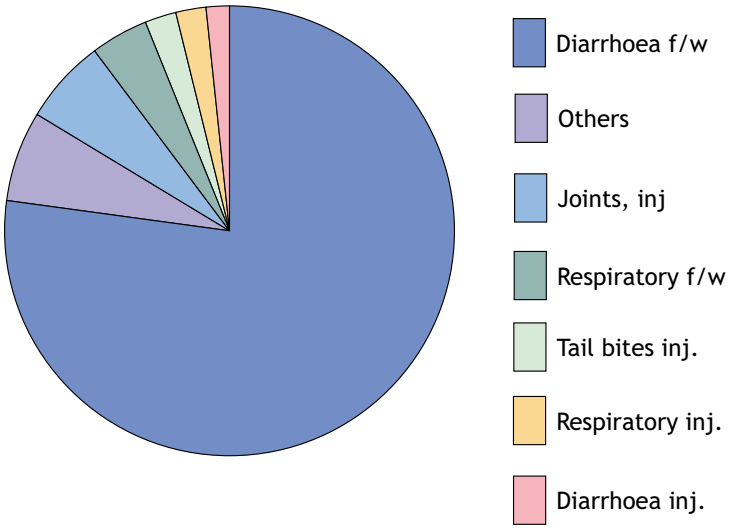
The number of treatments with antibiotics was investigated in 96 herds. The producers recorded the treatments over a period of two months in 2000. The number of treatments varied from no treatments to 23.8 treatments per produced finisher. On average there were 1.9 treatments per produced finisher, but 79% of the herds used less than one treatment with antibiotics.

Operation and management factors

The frequency rate was correlated with the operation and management factors in the herds. Antibiotics given via feed or water represented 85.7% of all treatments in the study. There were significantly more treatments via feed/water for diarrhoea in housing units where the pens were never cleaned (relative risk = 4.8). Only few treatments (14.3%) were injected individually to sick animals.

A large number of the treatments could be related to three of the studied factors. Housing units with young finishers (below 50 kg averagely), highly sectioned housing units, and housing units with high health status had a frequency rate that was up to three times higher. The size of the herd, change of boots and clothes upon entry to the herd, participation in courses or work groups or the producers' awareness of possible resistance was not of significant importance to the use of antibiotics. In relation to animal welfare, it cannot be established whether there was under-treatment or over-treatment in the individual herds. The study was carried out in cooperation with the Research Centre for the Management of Animal Production and Health (CEP-13).

Figure 1



Causes of treatment with antibiotics of finishers in 96 herds (Antibiotics given: f/w = feed/water; inj=injection).

Information and reported results - September 2001 - September 2002

Reports

No. 20: Enzymes added to pig feed
No. 21: Lactic products for weaners
No. 22: Costs in international pig production – 2000
Manual: PMWS manual 1st version August 2002 – Postweaning Multisystemic Wasting Syndrome

Experiences

No. 0107: Flush system in finisher units
No. 0108: Frost-proof water system for outdoor production
No. 0109: Measurement of back fat and assessment of body condition of sows
No. 0201: Gestating sows' use of feeding stalls in systems with one feeding and resting stall per sow
No. 0202: Eradication of pneomonia and pleuropneumonia on removal of seropositive sows
No. 0203: Test of feeding and insemination stalls for group-housed sows in service units
No. 0204: Test of feeding and resting stalls for group-housed sows, gestating sows
No. 0205: Water temperature and consumption in farrowing paddocks outdoors
No. 0206: Economy in WTF production systems
No. 0207: Service units with insemination pens established in Denmark
No. 0208: Health and production conditions in Danish pig herds in 2000
No. 0209: Gastro-intestinal health in salmonella-level 1 and 3 herds
No. 0210: Economic incentives to reduce Salmonella
No. 0211: Health and production conditions in Danish sow units in 2000

Trial reports

No. 528 Effect of meal feed, potato protein concentrate, a commercial mix, sugar beet pulp and zinc gluconate on preva-lence of Salmonella, gastro-intestinal health and productivity in finishers
No. 529 Continuous management with all in-all out management at property level
No. 530 Evaluation of technical performance of tube feeders for WTF
No. 531 Fermented maize for weaners
No. 532 Effect of human stimulation of sows on oxytocin in the blood during artificial insemination
No. 533 Dimensions of slatted floor in pens with group-housed, gestating sows
No. 534 Effect of meal feed, coarse grinding of pelleted feed and Bacona FormiVækst on Salmonella, gastro-intestinal health and productivity of finishers
No. 535 Productivity and meat quality in offspring from Halothane gene-free Pietrain, Duroc and HD boars
No. 536 Respiratory disorders in pig herds – serology as a tool for disease surveillance
No. 537 SoftAcid II for weaners
No. 538 RT-PCR for detection of porcine reproduction and respiratory disorder virus (PRRSV) in boar semen
No. 539 Solving problems after withdrawing antibiotic growth promoters from weaner feed (3)
No. 540 Solving problems after withdrawing antibiotic growth promoters from weaner feed (4)
No. 541 Operation and management in Danish multisite systems
No. 542 Reduced phosphorus standard for gestating sows
No. 543 Weaner feed that reduces Salmonella – the effect of the form of the feed and of addition of lactic acid on the prevalence of Salmonella, Lawsonia, gastro-intestinal health, and productivity
No. 544 Commercial products for weaners – test of the acid product Gustor
No. 545 Glutamic acid and threonine for weaners
No. 546 Extra calcium and phosphorus in feed for gilts weighing 7-130 kg
No. 547 Fermented grain in liquid feed for heavy pigs
No. 548 Comparison of 11 or 12 piglets in the litter
No. 549 Threonine for weaners
No. 550 Importance of group size during trickle feeding
No. 551 Options for increasing weaning weight
No. 552 Semen produced on-farm versus purchased semen
No. 553 Two DLG mixes for weaners
No. 554 Test of BIOMIN P.E.P. for weaners
No. 555 Commercial mixes for weaners – Southern Jutland, first quarter of 2002
No. 556 Prevention of umbilical hernia with iodine or antibiotics
No. 558 Effect of meal feed and Porzyme 9300 on Salmonella, gastro-intestinal health and productivity of finishers
No. 559 Floor design in service units with feeding and insemination stalls for group-housed sows
No. 560 Solving problems after withdrawing antibiotic growth promoters from weaner feed (5+6)
No. 561 Lupin Prima as protein source for organic finishers
No. 562 Test of Biogreen and BioMos for weaners
No. 563 Detection of Mycoplasma arthritis in pigs with a new serological method
No. 564 Determination of vitality of boar semen by flow cytometry
No. 565 Effect of meal feed and pelleted feed for sows and weaners on the prevalence of Salmonella, Lawsonia, productivity and gastric and intestinal health
No. 566 Fermented liquid feed for finishers – mixed on-farm with whey not containing formic acid
No. 567 Fermented liquid feed for finishers – pelleted feed
No. 568 Vaccination with Hyoresp ,Vet against pneumonia in finishers
No. 569 Serologic screening of finishers for Yersinia enterrocolitica serotype O:9
No. 570 Study of the Full Farmer concept for weaners
No. 571 Solving problems after withdrawing antibiotic growth promoters from weaner feed (7)
No. 572 Solving problems after withdrawing antibiotic growth promoters from weaner feed (8)

Information material

At http://www.lu.dk various information material can be downloaded as PDF files. Earlier information material, signs etc. can also be ordered on this address.

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Subject index of the annual report 2002

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ISBN 87-984721-3-5