Research Reports 1997

Research Institute for Pig Husbandry

Address
P.O. Box 83
5240 AB Rosmalen
Netherlands
Phone: + 31 73 528 65 55
Fax: + 31 73 521 82 14

Report P 5.5
March 1998
ISSN 1385 - 5883

PREFACE

At the Research Institute for Pig Husbandry, an organization with 65 employees, applied research has been carried out in order to find practical solutions for actual and future problems and to stimulate desirable developments in pig husbandry.
In total 1200 sows and 3000 growing-finishing pigs at three experiment farms in Raalte, Rosmalen and Sterksel are available. The experiments are often multi-disciplinair but also displinairy practica1 aspects of pig farming are investigated. This means that several different aspects of pig production are in study. The experiments are funded by the Ministry of Agriculture, Nature Management and Fisheries, Product Boards, farmers organizations and private companies. The results are published in reports and articles. This report gives a review of the published data in 1997.
The main research topics in 1997 were:

- Strategic reactions to politica1 decisions concerning the structure of the pig industry in the Netherlands.
- Quality improvement in the production chain of pig industry, based on data exchange.
- Improvement of health status on pig farms.
- Improvement of the competitive position of the Dutch pig industry.
- Development of sustainable pig farming systems, with special attention to environment, animal welfare and energy use.
- The efficient use of cereals and byproducts from the food processing industry as feed for pigs.
- Improvement of the working conditions for the employees ons pig farms.

When you have any question or remark concerning our research programm do not hesitate to contact us. You can reach us by
voice: +31 73 528 65 55 or
fax: +31 73 521 82 14.

Jan A.M. Voermans,
director

CONTENTS

FEEDING
Spray-dried blood plasma and spray-dried blood cells in diets of weaned piglets 5
Feeding starter diet to weaning piglets at a body weight of above 18 kg 6
Feeding hammermilled wheat to weaned piglets 8
Feeding hammermilled and crushed wheat to growing and finishing pigs 9
Feeding wheat treated by crusher or structure mill to growing/finishing pigs 10
Spray-dried porcine and bovine plasma and animal and plant protein in diets of weaned piglets 11
Feeding byproducts through the drinking nipple at weaned piglets and growing/finishing pigs 12
By-products related to performance and environmental characteristics at growing/finishing pigs 13
By-products for growing/finishing pigs: the influence of feed level and amino acid content 14
Optimalisation of *STAR-concept with regard to performance and health of growing/finishing pigs 15
The addition of the enzymes β-glucanase and xylanase to the diets of weaned piglets 16
Individual feed restriction of group-housed growing-finishing barrows 17

ENVIRONMENT
Ammonia emission and costs of a few housing systems 18
Euralclar slurry flushing and slurry treatment system 20
Effect of multi phase feeding on the ammonia emission of growing-finishing pig facilities 22
Reducing the ammonia emission with a chemical airscrubber 23
Effects of measures to reduce the mineral excretion by pigs in the NUBL area 24
Design of biological nitrogen removal systems for pig slurry 27
Urinary pH, ammonia emission and performance of fattening pigs, after the addition of a mixture of organic acids, mainly benzoic acid, to the feed 29
Microbiological acidification of fattening pig manure by the addition of potato starch 31
Sloped plates in the slurry channel in a fattening pig pen 32
Lowering ammonia emission by cooling down the manure of weaned piglets 33

HOUSING AND WELFARE
Housing pigs in one pen from birth to slaughter 34
Comparison of four housing systems for non-lactating sows 35
A raised soft farrowing mat during lactation 41
Strategies for stocking weaned piglets and fattening pigs 42
Welfare of pigs: from management regulations towards management measures 43

CLIMATE
Comparison between underground airtubes and groundwater exchanger for finishing pigs 45 ▶

HEALTH
Effects of an additional iron injection on the growth and humoral immunity of weaning pigs 46
Supplying a chelated iron via drinking water to suckling piglets 47

QUALITY
Prediction and assessment of ultimate meat quality for groups of slaughter pigs 49
Practica1 value of ear tags for identification & registration of pigs 51
Effects of two sire lines on growth performance, carcass- and meat quality 53

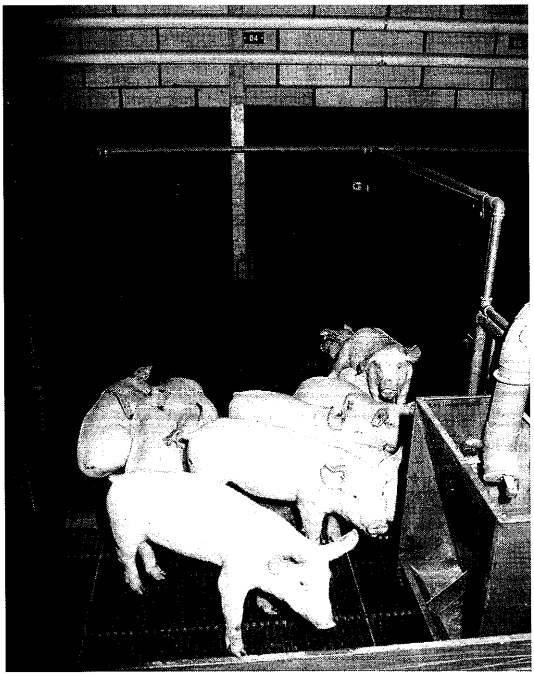
ECONOMICS
Comparison of the cost price of pork in some selected EU membership countries (EuroporC) 54
Marketing Dutch bacon in the United Kingdom after January 1st 1999 56

PUBLISHED RESEARCH REPORTS 57

SPRAY-DRIED BLOOD PLASMA AND SPRAY-DRIED BLOOD CELLS IN DIETS OF WEANED PIGLETS

ir. C.M. C. van der Peet-Schwering, ing. G.P. Binnendijk

In a 33-day *2 x 2* factorial study, 720 crossbred weaned piglets (7.6 kg) were used to examine whether spray-dried blood plasma (= SDBP) in a prestarter diet (first 8 days after weaning) affects the performance of the piglets and the occurrence of post-weaning diarrhoea. Moreover, the performance of piglets was studied after replacing high quality fish meal with granulated spray-dried blood cells (= SDBC) in a starter diet (day 9 - day 33).



Four experimental treatments were tested:

1 from day 1 to 8 a prestarter diet without SDBP and from day 9 to 33 a starter diet without SDBC;

2 from day 1 to 8 a prestarter diet without SDBP and from day 9 to 33 a starter diet with 2.5% SDBC replacing 4% fish meal;

3 from day 1 to 8 a prestarter diet with 5% SDBP replacing 5% fish meal and from day 9 to 33 a starter diet without SDBC;

4 from day 1 to 8 a prestarter diet with 5% SDBP replacing 5% fish meal and from day 9 to 33 a starter diet with 2.5% SDBC replacing 4% fish meal.

The diets were provided ad libitum.

The most important results and conclusions are given below:

- From day 1 to 8, the piglets fed the diet with SDBP performed better than the piglets fed the diet without SDBP. From day 1 to 33, the piglets fed the diet with SDBP tended to have a higher growth rate and a better feed conversion ratio.
- The health of the piglets and the financial results per delivered piglet were not effected by the presence of SDBP in the diet. The occurence of post-weaning diarrhoea was low in all experimental treatments.
- Piglets fed a starter diet containing 2.5% SDBC had a similar performance and financial results as piglets fed a starter diet containing 4% fish meal. ■

Report Pl. 168

FEEDING STARTER DIET TO WEANING PIGLETS AT A BODY WEIGHT OF ABOVE 18 KG

ing. D. J.P. H. van de Loo, ing. M. P. Beurskens-Voermans, ing. A. I. J. Hoofs

Between September 1992 and 1994 research was carried out into the environmental and economical effects of feeding weaning piglets above a weight of 18 kg a starter diet. This was carried out at the Experiment Farm for Pig Husbandry in Sterksel. Two experiments were carried out, one during the nursery period and the other during the growing-finishing period.
The used diets are shown in the table.

Nursery period

The following two treatments were given:
1 A prestarter diet during the whole nursery period.
2 A prestarter diet followed by a starter diet at 18 kg live weight.

The technical results in the nursery up until a body weight of 18 kg were similar. In the period from 18 kg until transfering to the growing-finishing pig stable, the growth and the feed conversion were worse in the second group. Overlooking the whole nursery period, the feed conversion of the piglets given a starter diet from a body weight of 18 kg was worse than that of the piglets on a prestarter diet. This first group also required more veterinary treatment. The mortality rate in both groups was the same.
The costs of piglets on the prestarter diet during the whole nursery period were Dfl 0.11 lower than the costs of the second group.
The nitrogen excretion of pigs which were offered a starter diet at 18 kg live weight was 10.3% higher and the phosphorus excretion was 14.9% lower.

Growing-finishing period

The following two treatments were given:
1 A starter diet from the beginning of the growing-finishing period for piglets that were offered a prestarter diet during the nursery period.
2 A starter diet from the beginning of the growing-finishing period for piglets on a starter diet from 18 kg live weight in the nursery period.

The technical results of the finishing pigs which were given a starter diet from a body weight of 18 kg were worse, especially the feed-intake and the feed conversion. These pigs also required more veterinairy treatment, although the mortality rate was similar in both groups.

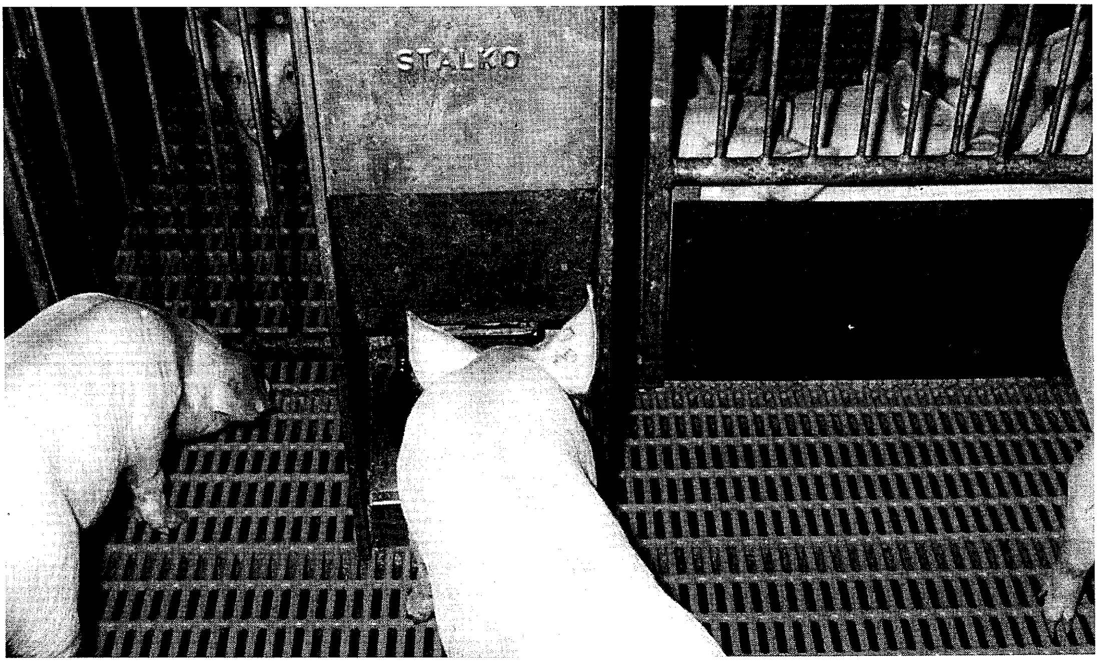
Table: Used diets

	energy (MJ ME)	crude protein (g/kg)	crude fat (g/kg)	crude fiber (g/kg)	digest. lysine (g/kg)	digest. phosphorus (g/kg)
prestarter diet, medicated (oxytetracycline 400 ppm, from weaning until 7 days later)	14.06	169	49	36	9.9	4.2
prestarter diet (7 days after weaning until 28 days after weaning)	13.55	166	41	40	9.9	4.0
starter diet small (28 days after weaning until the transfer to the growing-finishing pigstable)	13.30	170	36	46	8.2	3.0
starter diet (from the start of the growing-finishing period until 4 weeks later)	13.30	172	36	50	8.2	3.1
growing-finishing feed (from 4 weeks after the start until the end of the growing-finishing period)	12.93	161	32	58	6.7	2.0

The costs of the pigs receiving the starter diet from the start of the growing-finishing period were Dfl 1.98 less than the costs of the second group.
The nitrogen and the phosphorus excretion of pigs that were on a starter diet from 18 kg live weight was higher (4.1% and 3.7%).

In conclusion: it is better to offer a starter diet from the beginning of the growing-finishing period for technical, economical en environmental reasons. ■

Report Pl. 174



FEEDING HAMMERMILLED WHEAT TO WEANED PIGLETS

ir. R.H.J. Scholten, ing. G.P. Binnendijk

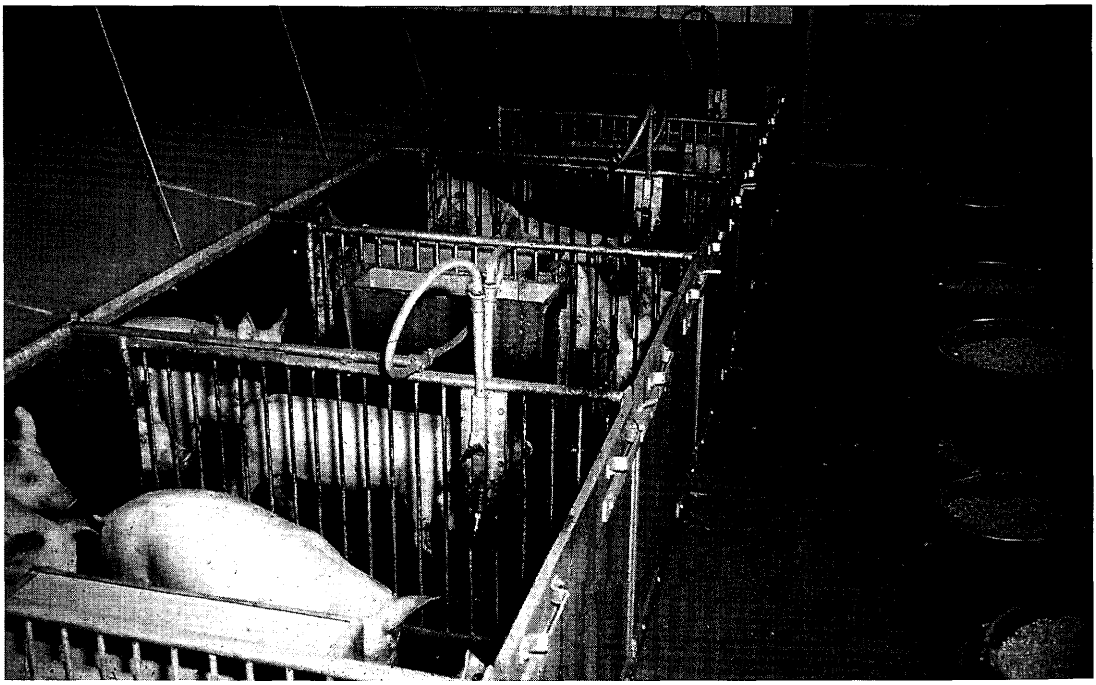
It is possible to reduce feed costs by replacing a part of the compound feed ration with wheat. Between November 1995 and July 1996 research was carried out on the possibilities of feeding milled wheat to weaned piglets on the pig farm of the Research Institute for Pig Husbandry in Rosmalen. Research was focused on how much compound feed can be replaced by hammermilled wheat (in combination with a complementary compound feed) and what the effects are on performance and health. The following three treatments were compared with each other:

1 Complete compound feed;
2 Diet of *75%* complementary compound feed and *25%* hammermilled wheat;
3 Diet of 50% complementary compound feed and 50% hammermilled wheat.

The piglets receiving a diet containing 25% hammermilled wheat and 75% complementary compound feed had the same performance as piglets receiving standard compound feed. Increasing the content of wheat to 50% decreased the rate of growth and health of the piglets. The performance and health was especially negatively influenced by feeding 50% hammermilled wheat during the first 14 days after weaning.

If 25% or 50% hammermilled wheat is fed during the whole rearing period, this leads to a profit of 0.75 and 0.64 Dutch guilders respectively per delivered piglet, compared with the costs of feeding standard compound feed. It is necessary to make a calculation for each pig farm to see if it is interesting to feed wheat and to store and treat wheat. ■

Report Pl. 175



Feeding wheat to weaned piglets

FEEDING HAMMERMILLED AND CRUSHED WHEAT TO GROWING AND FINISHING PIGS

ir. C.M. *C. van der Peet-Schwering, ing. J. G. Plagge, ir. R.H. J. Scholten*

During the last few years an increasing interest is being shown in replacing part of the compound feed by wheat. Because wheat grain cannot be digested by the pig, wheat should be treated with a hammer mill, a crusher or a structure mill. At the Experiment Farm for Pig Husbandry at Raalte, a study was conducted to examine the effect of hammer milled and crushed wheat on the performance and health of individually housed growing and finishing pigs.
From day 1 to 30 all the pigs were fed the same starter diet. Then four experimental treatments were randomly assigned:

1 *Control*: pigs were fed a standard growing/finishing diet.
2 *Hammer milled 40%:* pigs were fed a ration including 40% hammer milled wheat and 60% complementary growing/finishing diet.
3 *Hammer milled 10%:* pigs were fed a ration including 10% hammer milled wheat and 90% standard growingfinishing diet.
4 *Crushed 10%:* pigs were fed a ration including 10% crushed wheat and 90% standard growingfinishing diet.

All pigs were fed twice a day. Sows and barrows were fed different amounts of feed. The pigs were given free access to water.

The most important results and conclusions are given below:

- Replacement of 10% of the standard growing/finishing diet with 10% hammer milled or crushed wheat had no effect on the performance of growing/finishing pigs. However, the pigs fed 10% crushed wheat had a tendency to an improved feed conversion ratio.
- Pigs that were fed 40% hammer milled wheat grew less and had a worse feed conversion ratio from 70 kg live weight to delivery. This is probably due to wastage of the hammer milled wheat. Feeding 40% hammer milled wheat had no effect on the slaughter quality of the pigs.
- Pigs that were fed 10% crushed wheat grew faster and had a better feed conversion ratio than pigs that were fed 40% hammer milled wheat.
- Pigs that were fed 10% or 40% hammer milled wheat had more severe oesophagogastric lesions than pigs that were fed no wheat or crushed wheat.
- Pigs that were fed 10% cruhsed wheat had the best economic results per delivered pig. Pigs that were fed 40% hammer milled wheat had the worst economic results per delivered pig. ■

Report Pl. 177

Source: Misset/Boerderij
10% Crushed wheat and 90% standard diet

FEEDING WHEAT TREATED BY CRUSHER OR STRUCTURE MILL TO GROWING/FINISHING PIGS

ir. R. H. J. Scholten, ing. J. G. Plagge, ir. C.M. C. van der Peet-Schwering

Wheat is the cereal most often fed on pig farms feeding cereals. The use of barley is increasing. Before these cereals can be fed to the pigs, the particle size of grains must be reduced. The hammer mill is mainly used for this purpose. Depending on the sieve diameter and rotation speed, the hammer mill produces a fine cereal. Several articles (Elbers et al., 1995; Borggreve et al., 1996) and experimental results from our Experiment Farm for Pig Husbandry at Raalte (Scholten et al., 1996; Van der Peet-Schwering et al., 1997) have demonstrated that fine grinding of feedstuffs has a negative effect on the number of pigs with oesophagogastric lesions. The provision of compound feed including coarse components or the seperate feeding of coarse wheat can be preventative with respect to oesophagogastric lesions. Because of this other ways of preparing grains are being developed. An example of another method is the crusher and structure mill. Pig farmers feeding cereals, or planning to make the necessary investments to make this possible, require experimental results on the different possibilities of preparing cereals. In both the Netherlands and other countries there is no available research comparing the separate feeding of wheat prepared using a crusher and structure mill. Therefore an experiment to compare the effect of crushed wheat and structured wheat on the performance, slaughter quality and oesophagogastric lesions of growing/finishing pigs was carried out. The experiment compared three treatments:

1 Standard compound feed (control);
2 Diets including 25% and 50% crushed wheat in the starter and finisher diet respectively. (crusher);
3 Diets including 25% and 50% structured wheat in the starter and finisher diet respectively. (structure mill).

Growing/finishing pigs given treatment 2 or 3 were fed a specially produced concentrate along with the wheat. The combination of concentrate and wheat contained the same amount of nutrients as the control group. Pigs were fed using dry feed hoppers. Barrows and gilts were housed seperately and fed using different feeding schemes.

Most important results and conclusions of the experiment:

- There was no significant difference in the growth rate, feed and energy intake, feed and energy conversion of animals fed crushed wheat or structured wheat. This was valid for the whole period (25 - 108 kg) as well as for the different growth periods (25 - 44 kg; 44 - 70 kg; 70 - 108 kg).
- Animals fed structured wheat had a significantly higher lean meat percentage than animals fed crushed wheat. There was no difference between animals fed structured wheat and animals fed the control diet.
- Animals fed crushed wheat or structured wheat had fewer oesophagogastric lesions than animals fed the control diet.
- Animals fed the control diet had a better feed and energy conversion than animals fed crushed wheat and animals fed structured wheat. ■

Report P1. 179

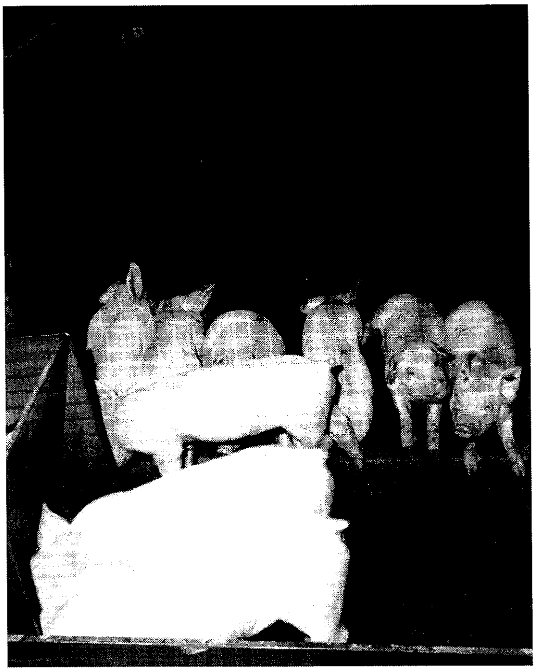
SPRAY-DRIED PORCINE AND BOVINE PLASMA AND ANIMAL AND PLANT PROTEIN IN DIETS OF WEANED PIGLETS

ir. C.M.C. van der Peet-Schwering, ing. G.P. Binnendijk

In a 33-day study, 960 crossbred weaned piglets (body weight 7.5 kg) were used to examine whether the protein source of prestarter diets affects the performance and occurrence of post-weaning diarrhoea in piglets. Moreover, the inclusion level of spray-dried porcine plasma in a prestarter diet was evaluated.

Six experimental treatments were tested:

1 *Plant protein:* a prestarter diet with mainly plant protein and no animal plasma;
2 *Porcine plasma:* a prestarter diet with 5% spray-dried porcine plasma replacing part of the plant protein;
3 *2/3 porcine plasma + 1/3 animal protein:* a prestarter diet with 5% of a combination of spray-dried porcine plasma (2/3) and animal protein (1/3) replacing part of the plant protein;
4 *1/3 porcine plasma + 2/3 animal protein:* a prestarter diet with 5% of a combination of spray-dried porcine plasma (1/3) and animal protein (2/3) replacing part of the plant protein;
5 *Animal protein:* a prestarter diet with 5% animal protein replacing part of the plant protein;
6 *Bovine plasma:* a prestarter diet with 5% spray-dried bovine plasma replacing part of the plant protein.



The experimental diets were provided ad libitum for two weeks. Thereafter, all pigs were given free access to a commercial starter diet.

The most important results and conclusions are given below:

- From day 1 to 14, the piglets fed the diets with 5% porcine plasma and 5% bovine plasma ate more and had a higher growth rate than those that were fed diets with animal or plant protein. There were no differences in feed conversion ratio. From day 1 to 33, the piglets fed the diets with 5% blood plasma tended to have a higher growth rate.
- The health of the piglets and the financial results per delivered piglet were not effected by the presence of blood plasma (porcine plasma and bovine plasma) in the diet. The occurrence of post-weaning diarrhoea, however, was low in all experimental treatments.
- From day 1 to 14, there were no differences in performance between the piglets fed the diet with spray-dried porcine plasma and piglets fed the diet with spray-dried bovine plasma.
- From day 1 to 14, the growth rate and feed intake increased linearly as spray-dried porcine plasma increased in the diet. The growth rate and feed intake were highest for the diet with 5% spray-dried porcine plasma. ■

Report PI. 185

FEEDING BYPRODUCTS THROUGH THE DRINKING NIPPLE AT WEANED PIGLETS AND GROWING/FINISHING PIGS

ing. D. J.P. H. van de Loo, ir. R. H. J. Scholten

Two experiments were carried out on the Experiment Farm for Pig Husbandry "South- and West-Netherlands" in Sterksel in the period between January 1996 and February 1997. These experiments examined the possibilities of feeding byproducts to weaned piglets and growing finishing pigs using a drinking nipple. The investment costs of this feeding system are low compared with a liquid feeding system. The investment costs of a drinking nipple system are Dfl 185.70 per finishing pig place for 1,080 growing finishing pig places. The investment costs for a dry feed installation are Dfl 109.44 per finishing pig place for the same number of pigs. The extra investment costs for a drinking nipple system are Dfl 76.26 per finishing pig place for 1,080 growing finishing pig places. The annual costs of the investment are (including a dry feed installation) Dfl 27,871.- for 1,080 finishing pig places for a drinking nipple installation (Van Brakel et al., 1996).

In the first experiment the effect on the performance of weaned piglets was examined. Two treatments were compared:

1 water through the drinking nipple and commercial pelleted feed through the dry/wetfeeder;
2 byproducts (wheat starch and whey) through the drinking nipple and complementary compound feed through the dry/wetfeeder; 28% of the dry matter was replaced by byproducts.

Weaned piglets fed with byproducts had a lower growth, a lower feed and energy intake and a tendency to a better feed conversion, but not a better energy conversion. Their health was also better because oedema disease was less prevalent. This resulted in a profit of Dfl 1.82 per delivered piglet (tendency).

In the second experiment the effect on the performance of growing finishing pigs was examined. Two treatments were compared:

1. water through the drinking nipple and commercial pelleted feed through the dry/wetfeeder;
2. byproducts (wheat starch and whey) through the drinking nipple and complementary compound feed through the dry/wetfeeder; 40% of the dry matter was replaced by byproducts.

There were no differences in the technical results of both treatments. The lean meat percentage of the pigs which have been fed byproducts was lower. The growing finishing pigs fed byproducts required fewer veterinary treatments, because oedema disease was less prevalent. This resulted in a cost reduction of Dfl II.66 per delivered finishing pig (tendency). The profit per pig per year was Dfl 35.78 (tendency).

In conclusion:

- Weaned piglets fed byproducts (max. 2.5 liters/piglet/day) have a lower growth and feed and energy-intake, lower mortality, require fewer veterinary treatments (especially to treat oedema disease) and there is a tendency towards a better feed-conversion.
- Weaned piglets fed byproducts with complementary compound feed have better economical results (tendency).
- Growing finishing pigs fed byproducts have comparable technical results, a lower lean meat percentage, a worse classification and require fewer veterinary treatments.
- Growing finishing pigs fed byproducts with complementing compound feed have better economical results (tendency). ■

Report Pl. 186

BY-PRODUCTS RELATED TO PERFORMANCE AND ENVIRONMENTAL CHARACTERISTICS AT GROWING/FINISHING PIGS

ir. R. H. J. Scholten, ing. A.I. J. Hoofs, ir. N. Verdoes

There is an increased use of by-products from the human food industry in the Dutch pig feeding industry. In both national and international literature, little information is available on the effect of diets using liquid by-products with regard to performance, slaughter quality and environmental characteristics. In most cases the relevant literature deals with digestibility trials using only one by-product. Data on the performance of pigs fed a diet with by-products is often based on information from datasets (Siva, 1997). These datasets compare pig farms using compound feed with pig farms using liquid diets with by-products. There are drawbacks to this information because of several disrupting factors such as management, feeding system (dry versus wet) and the definition of a by-produet-farm. Experiments studying the influence of diets including by-products on ammonia emission, manure quantity and manure composition are not available. The policies of the Dutch government concerning ammonia and minerals/manure have led to an increased need for information on the environmental effects of feeding by-products. Therefore, a study was conducted to examine the effect of a diet containing the most frequently used by-products on the performance, slaughter quality and environmental characteristics of growing/ finishing pigs at the Experiment Farm for Pig Husbandry at Sterksel.

Three experimental treatments were tested:

1. Wet feed without by-products (CONTR);
2. Wet feed with three common by-products and a feeding regime identical to treatment 1 (BIJPR);
3. Wet feed with three common by-products and a feeding regime reduced beyond 75 kg (BIJPR_A).

The liquid feed of the control group included "standard" compound feed mixed with water in a water : feed ratio of 2.3 : 1. The liquid feed of treatment 2 and 3 contained three common by-products (wheat starch, potato steem peels and whey) and a special concentrate. The by-products replaced 35% and 55% of the compound feed measured as dry matter in the growing and finishing phase respectively. The water : feed ratio was 2.6 : 1. All animals were fed three times a day in a trough using a wet feed installation. Barrows and sows were housed in separate pens and were fed different amounts of feed.

The most important results and conclusions are as follows:

- Both groups of pigs fed by-products realized a better daily growth and a better energy efficiency than the pigs in the control group.
- The group given by-products and a reduced feeding regime had a significantly better energy efficiency than the group given by-products and an increasing feeding regime.
- Growing and finishing pigs fed by-products had a significantly lower lean meat percentage than the pigs given wet feed without by-products. Both diets included 7.0 gram ileal digestible lysine per kilogram in the growing period.
- The ammonia volatilization did not differ significantly in the treatments with or without wet by-products.
- The volume of the manure increased by 5.9 and 5.1% respectively in the by-product groups with an increasing or decreasing feeding regime. When the manure production is expressed per kg growth, it increased by 2.4% in the groups given by-products compared with the group not given by-products. The dry matter percentage of the manure in the groups given by-products was lower: respectively 1.5% and 1.2% compared with the wet feeding group not given by-products.
- The gross margin per delivered pig was Dfl 38.68, Dfl 55.33 and Dfl 58.47 for the control, by-product and by-product with a decreasing feeding regime treatments. ■

Report Pl. 187

BY-PRODUCTS FOR GROWING/FINISHING PIGS: THE INFLUENCE OF FEED LEVEL AND AMINO ACID CONTENT

ir. R. H. J. Scholten, ing. A. I. J. Hoofs, ing. M.P. Beurskens-Voermans

Results from an experiment by Scholten et al. (1997) show that growing/finishing pigs fed with a liquid feed diet with liquid by-products have a better energy conversion rate than growing/finishing pigs fed liquid feed without liquid by-products. However the lean meat percentage is unfavourable when by-products are fed, which is in contrast with the positive effect on energy conversion. Both diets had comparable calculated contents of ileal digestible amino acids and an identical feeding regime (Scholten et al., 1997). At the same experimental pig farm an experiment has been carried out with growing/finishing pigs fed liquid by-products using a nipple compared to growing/finishing pigs fed water using a nipple. In that experiment liquid by-products were found to have a positive effect on energy conversion and a negative effect on lean meat percentage (Van de Loo & Schotten, 1997). These aspects were the reason why experiments at the Experiment Farm "South- and West-Netherlands" at Sterksel were started to examine the effect of the feeding scheme and the amount of ileal digestible amino acids (lysine, methionine, cystine, treonine) on the lean meat percentage. These two experiments are included in this report.

Experiment 1 examines the effect of feeding level from 70 kilogram live weight on the performance and slaughter quality of growing/finishing pigs fed a diet that contained wet by-products. Experiment 2 examines the effect of the ileal digestible amino acid content of diets with wet by-products on the performance and slaughter quality of growing/finishing pigs.
In the first experiment two treatments are compared:

1 Feeding scheme 1: from week 13 to delivery a maximum EW-level of 2.84 and 2.86 per animal per day for sows and barrows respectively;
2 Feeding scheme 2: from week 10 to delivery a maximum EW-level of 2.59 and 2.64 per animal per day for sows and barrows respectively. From week 0 to 10 the EW-level is the same as that in treatment 1.

It appears that growing/finishing pigs fed following scheme 2 had a tendency towards a lower growth (17 gram per day; p = 0.068) than the growing/finishing pigs whose feed ration was increased conform scheme 1. Energy conversion and lean meat percentage were improved when the pigs were fed conform scheme 2, but the differences were not significant (p = 0.15 and p = 0.26 respectively). The balance per delivered pig was Dfl 58.80 and Dfl 61.02 for treatment 1 and treatment 2 respectively.

In experiment 2 the effect of increasing the calculated content of ileal digestible amino acid of the diets with by-products was examined. Three treatments are compared:

1 Diet with 8.2 and 7.0 gram ileal digestible lysine/kg in the starter diet and finisher diet respectively (control);
2 Diet with 8.5 and 7.3 gram ileal digestible lysine/kg in the starter diet and finisher diet respectively (high amino acids);
3 Diet with 8.8 and 7.6 gram ileal digestible lysine/kg in the starter diet and finisher diet respectively (extra high amino acids).

In the diets of the three treatments the percentage of ileal digestible lysine compared with the other essential amino acids (methionine, cystine, threonine, tryptophan) was kept as stable as possible.

It appears that growing/finishing pigs fed a diet with the high digestible amino acid content had a significantly higher lean meat percentage than the growing/finishing pigs being given the other two treatments. ■

Report Pl. 188

OPTIMALISATION OF *STAR-CONCEPT WITHREGARD TO PERFORMANCE AND HEALTH OF GROWING/FINISHING PIGS

ir. R. H. J. Scholten, ing. J.G. Plagge

The Research Institute for Pig Husbandry together with feed company ABC Lochem, carried out two experiments on the effects of adding fibre to compound feed on the performance and health of growingfinishing pigs. The materials used were wheat and non-soluble straw pellets, both treated according the ABC-process (*STAR-concept). In the first experiment, adding 10% or 40% wheat and 5% non-soluble straw pellets was studied (Scholten et al., 1996). Adding 10% wheat or adding 5% non-soluble straw pellets gave promising results. To gain more insight into the optimal percentage of wheat or straw pellets added to the diets of growingfinishing pigs, a second experiment was carried out (see this report).

An experiment with four treatments was carried out at the Experiment Farm for Pig Husbandry "North- and East-Netherlands" in collaboration with ABC:
1 compound feed with 10% wheat following the ABC-process (control);
2 compound feed with 5% wheat following the ABC-process;
3 compound feed with 5% non-soluble straw pellets following the ABC-process;
4 compound feed with 2.5% non-soluble straw pellets following the ABC-process.

The treatments were compared on the growing and finishing feed. Growing feeds had an energy content of 13.56 MJ ME; finishing feeds had an energy content of 13.43 MJ ME. All animals were fed twice a day. Pigs were housed individually. Performance, slaughter quality, health, manure constitution and oesophagogastric lesions were measured.

The most important results and conclusions of the research are:
- There were no significant differences in growth, feed intake, energy intake, feed conversion and energy conversion between groups with 10% wheat, 5% wheat and 2.5% non-soluble straw pellets in both the growing and finishing phase.
- Compound feed with 5% non-soluble straw pellets showed a tendency to lower growth and a worse feed and energy conversion compared to compound feed with 2.5% non-soluble straw pellets and 10% wheat. The difference was found in the growing phase from 25 to 42 kilogrammes.
- No significant differences in performance were observed in the phase from 42 kg to 73 kg. Neither were significant differences in growth, feed and energy conversion observed in the phase from 73 kg to delivering.
- Compound feed with 5% wheat gave more oesophagogastric lesions than compound feed with 10% wheat or 5% non-soluble straw pellets. Reducing the percentage of wheat or straw pellets treated following the ABC-process in compound feed gave more oesophagogastric lesions and the appearance and severity of diarrhoea seemed to increase. ■

Report Pl. 195

THE ADDITION OF THE ENZYMES B-GLUCANASE AND XYLANASE TO THE DIETS OF WEANED PIGLETS

ir. R.H.J. Scholten, ing. G.P. Binnendijk

Between November 1995 and February 1996 research was carried out on the experiment farm of the Research Institute for Pig Husbandry in Rosmalen. This research was focused on the possibilities of adding ß-glucanase and xylanase (Porzyme-81 00®) to the diets of weaned piglets. This enzyme product is produced by Finnfeeds International Ltd.. This product contains 250 units ß-glucanase and 400 units xylanase, and has been developed to improve the digestibility of diets with a minimum of 30% barley and a maximum of 20% wheat(byproducts). The objective of the experiment was to examine the effect of the addition of the enzyme to the diet on the performance and health of weaned piglets. Two treatments were carried out:

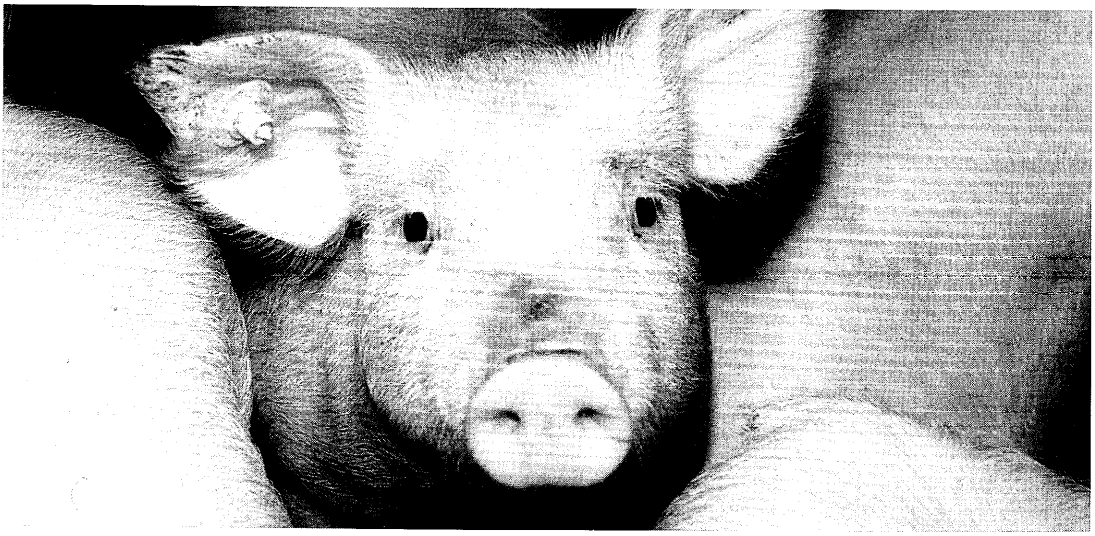
1 diet without enzyme;
2 diet with enzyme.

From day 1 to day 15 after weaning the piglets were given a prestarter diet (energy content of 9.84 MJ NE and ileal digestible lysine of 9.9 g/kg). From day 15 to day 34 the piglets were given a starter diet (energy content of 9.67 MJ NE and ileal digestible lysine of 9.3 g/kg). All feeds included 30% barley and 15% wheat(middlings). The enzyme contained at least 250 units ß-glucanase and 400 units xylanase per gram enzyme. One kilogram enzyme was given per 1,000 kilogram feed.

The most important results and conclusions of the research are:

- Adding ß-glucanase and xylanase (Porzyme-81 00®) to a prestarter and a starter diet containing 30% barley and 15% wheat(middlings) had no effect on the performance of the weaning piglets in this experiment.
- Adding ß-glucanase and xylanase (Porzyme-81 00®) to prestarter and starter diets with 30% barley and 15% wheat(middlings) had no effect on mortality and the number of veterinairy treated piglets in this experiment. In the third week after weaning the addition of enzymes led to a slight reduction of diarrhoea. ■

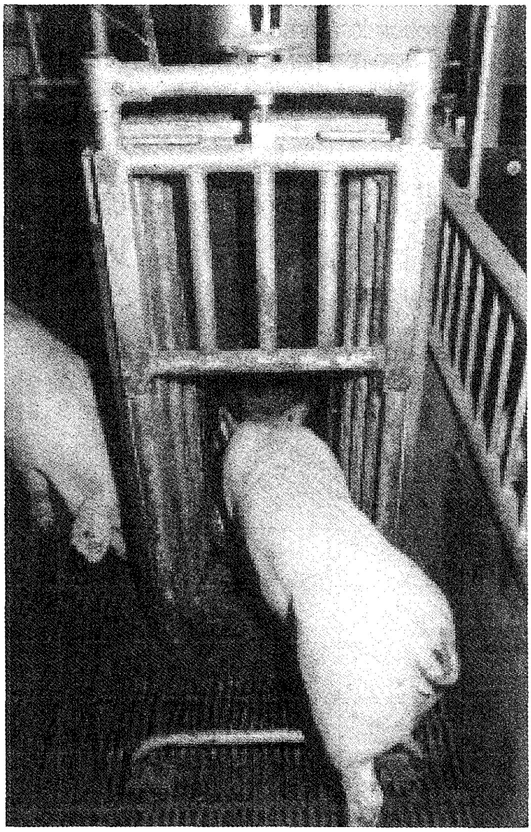
Report P4.20



INDIVIDUAL FEED RESTRICTION OF GROUP-HOUSED GROWING-FINISHING BARROWS

dr. ir. P.J. L. Ramaekers, ing. J.H. Huiskes, dr. ir. J. W.G. M. Swinkels, ir. C. M.C. van der Peet-Schwering, prof. dr. ir. M. W.A. Verstegen[1]

In total *48* crossbred barrows and 12 gilts were used to examine the effectiveness of a pair-gain feeding strategy for individually fed group-housed barrows. In a pair-gain feeding strategy, barrows are individually restricted to a feeding level at which their growth is similar to the mean growth of ad libitum fed gilts. The aims of this feeding strategy are to have barrows and gilts reach slaughter weight at the same time, and to improve carcass traits of the barrows. At 29.8 ± 0.4 kg BW, barrows were assigned to either the pair-gain treatment or the ad libitum treatment. All pigs had free access to feed up to 60 kg BW. The experimental period was from 60 to 110 kg BW. The twelve group fed gilts and 24 individually fed barrows (12 per pen) were also given free access to feed throughout the experimental period. The remaining 24 barrows (12 per pen) were put on a pair-gain feeding strategy. In the pair-gain feeding strategy, the feed allowance of each individual barrow was dependent of it's BW, energy conversion rate and the mean growth rate of the gilts.



Feeding station with electronic identification and forelegs weighing system in front of a feeder

The barrows in the pair-gain treatment had a similar growth to the gilts. The ad libitum fed barrows had a better ($p < 0.05$) growth and a worse energy conversion ratio than the barrows in the pair-gain treatment. The total energy conversion ratio, backfat thickness and lean meat percentage were similar ($p > 0.10$) in the two treatments. In conclusion, the pair-gain individual feeding strategy for barrows starting at 60 kg proved to be effective in achieving similar growth in barrows and gilts. The total energy conversion ratio and carcass traits of the individual restricted fed barrows, however, were not improved in this experiment. It appears that individual feed restriction should be directed at the barrows with the highest feed intake that do not realise a concomitant comparable high weight gain, and not on the pigs with the highest growth rate. ■

Report P4.24

[1] Wageningen Agricultural University

AMMONIA EMISSION AND COSTS OF A FEW HOUSING SYSTEMS

ing. G.M. den Brok, ing. M.G. M. Vrielink, ing. M.P. Beurskens, ir. C. E.P. van Brakel

In 1993 the Dutch Government introduced regulations to encourage the development and implementation of low ammonia emission techniques, the so-called Green Label systems. A system is given a Green Label certificate if the emission level is lower than a specific threshold (40 - 60% reduction compared with the emission level of traditional systems). Farmers investing in a Green Label system are given a special depreciation rate (lower level) of income tax and the guarantee that new governmental regulations will not require them to rebuild their barn within 15 years. The implementation of a new technique on a practical scale is dependent on the reliability of the system and on the investment costs and annual costs. In the Netherlands much current environmental research is based on the development of simple, reliable and cheap Green Label systems.
At the Research Institute for Pig Husbandry in the Netherlands research has been conducted to determine the effect of (a combination of) low emission techniques on the total ammonia emission in four categories of pigs: farrowing sows, weaned piglets and grower/finishing pigs. The investment costs and annual costs were kept as low as possible.

Farrowing sows

Two rooms with a fully slatted floor and a small manure canal at the back were tested; in one room the manure canal under the slatted floor was combined with a sloping plate in front and in the second room the manure canal was combined with a water canal (figure 1). In a third room, the pit was provided with a laminated cooling system, floating in the top layer of the manure.
The average ammonia emission in the room with the combination of a sloping plate and a small manure canal was 4.6 kg per sow place per year. The extra annual costs were Dfl 34.51 per farrowing place, or Dfl 9.33 per kg reduction in ammonia emission.
The average ammonia emission in the room with the combination of a water and manure canal was 4.0 kg per sow place per year, equal to the standard for Green Label (the standard for a tradional system is 8.3 kg per place per year). The extra annual costs were Dfl 24.10 per farrowing place, or Dfl 5.60 per kg reduction in ammonia emission.
The average ammonia emission in the room with the manure cooling system was 2.4 kg per sow place per year. The average manure temperature was 14.0°C. The extra annual costs per farrowing place were Dfl 90.68, or Dfl 15.37 per kg reduction in ammonia emission.

Weaned piglets

The research was conducted in a room with 0.15 m^2 solid floor per pig, metal try-bar slats and a plastic tray, hanging between the

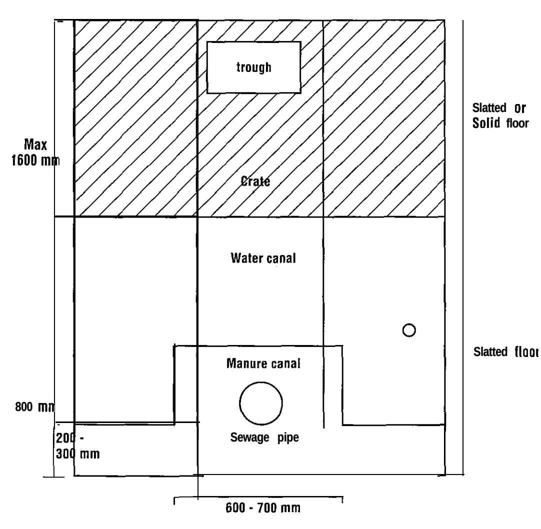


Figure 1: New pen design for lactating sows

pit walls (reference), and in three other, almost similar rooms. In one of these rooms the deep manure pit at the back of the pen was provided with a sloped wall to lower the total manure surface area. Another room was provided with a larger surface area per pig place; 0.17 instead of 0.15 m^2. In the last room the plastic tray in the manure pit at the back of the pen was provided with an overflow system in combination with a cooling system (using ground water) (figure 2).

In the reference room the average ammonia emission was 285 gr per place per year (standard for Green Label is 300 gr per place per year). The extra annual costs, compared to a traditional room with fully slatted floors and deep pits, were Dfl 2.76 per pig place.
In the room with a sloped pit wall, the average ammonia emission was 330 gr per place per year, higher than the Green Label standard. The extra annual costs were Dfl 3.36 per pig place.
The average ammonia emission in the room with a larger solid floor was 270 gr per place per year. The extra annual costs were Dfl 2.54 per pig place, comparable with the extra costs of the reference room. The larger area of solid floor did not result in more pen fouling.
The room with the cooling system showed the best results for ammonia emission; 240 gr per place per year. However the extra annual costs were Dfl 8.47 per pig place.

Growing/finishing pigs

Research in a room for fattening pigs with an optimal pen design (tiled convex floor, metal try-bar slats and a slit of 10 cm for a better manure throughput) resulted in a reduction in ammonia emission of almost 30%, compared to the standard norm of 2.5 kg per place per year (Ter Elst en Den Brok, 1996). Extra measures were necessary to reduce the emission under the Green Label norm of 2.5 kg per place per year. In this study we attemped to achieve more reduction by combining the water- and manure canals under the slatted floor at the back of the pen and by changing the fences between two pens.
The result was that the ammonium concentration in the "water" canal was only lower in the first month of the fattening period. The ammonia emission will possibly only be reduced during this period. The ammonia emission is normally low in the beginning of a fattening period. The effect of the combination of a water and manure canal on the total ammonia emission during the fattening period is expected to be very low.
The extra investments and annual costs were Dfl 58.40 and Dfl 10.77 respectively. Extra measures to achieve the Green Label standard will lead to higher costs. ■

Report Pl. 169

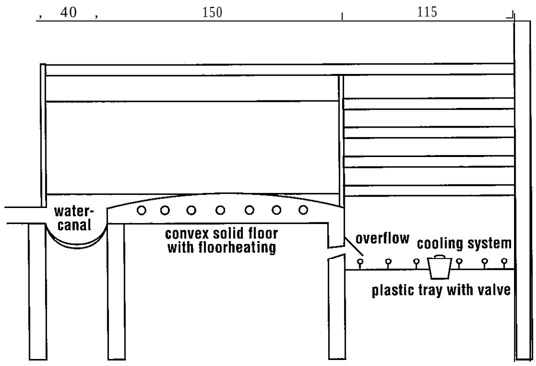


Figure 2: Cross section of a pen for weaned piglets provided with a simplified cooling system

EURALCLAR SLURRY FLUSHING AND SLURRY TREATMENT SYSTEM

ing. J.P.B.F. van Gastel, ir. N. Verdoes, ing. M.P. Beurskens-Voermans

From late 1993 to mid 1995, the Research Institute for Pig Husbandry investigated the possibilities of technical and economical optimalization of the Euraclar manure flushing system and the feasability of applying the Alclar process as a post-treatment step after the flushing system. The research was part of the "Euraclar"-project; an international co-operation project between businesses and research institutions in France, Belgium and The Netherlands in the field of manure treatment, in which the different application possibilities of the Alclar process were closely studied. In this report the Dutch contribution to this project is described. This was performed at the Experiment Farm for Pig Husbandry South- and West-Netherlands in Sterksel.
In earlier research, Hoeksma et al. (1993) studied the use of the manure flushing system, with the aim of reducing the ammonia emission from growing-finishing pig houses. Despite the positive effect with respect to emission reduction, the system is little used in practice due to the high costs and insufficient technical reliability. A more reliable and cheaper process may be achieved if the pre-separation of manure is improved, the application is changed or the distribution of the flushing liquid is improved. Two pre-separation methods were researched: separation by sedimentation followed by filtering the settled thick fraction through a sieve, and separation by centrifuging. Part of the thin fraction was aerated to allow oxidation of ammonia to nitrate. The mixture of the aerated and non-aerated thin fraction was re-used as a flushing liquid.
The Alclar process was applied to improve the possibilities for marketing and re-use of the flushing liquid. The principle of the Alclar process is based on the binding and deposition of negatively charged particles using calcium aluminates and lime. After a reaction time of several hours, the deposited products are separated from the liquid by sedimentation.

The flushing process was applied to 3 finishing pig rooms, each with 80 places, a nursery room with 70 places, a farrowing room with 12 places and a room for pregnant and dry sows with 28 individual pens and 5 group pens, each with 5 sows. The ammonia emission from each room was compared with a reference room in which the flushing system was not applied. A 10 cm layer of flushing liquid was added to the manure pits of the flushing rooms. After 24 hours, the flushing liquid and manure produced in 1 day were collected and treated by separation and aeration to obtain an ammonia free flushing liquid.

The following aspects were studied:
- the influence of the solid retention time in the aeration tank on the stability of the nitrification process;
- the influence of improved pre-separation and application of the Alclar process on the manure distribution costs;
- the proportion of minerals in the thick and thin manure fraction;
- the reduction in ammonia emission obtained by flushing systems in each pig category;
- the energy profit due to the reduced transport costs of manure distribution;
- the additional emission reduction by lowering the crude protein content in the feed of growing-finishing pigs;
- the spreading of pathogens through the flushing liquid by sampling various places in the flushing system.

The main results and conclusions of the research are:
- The nitrification process required to prepare the flushing liquid, can function steadily without supervison. The average solid retention time of 4 days at a tempera-

ture of 23 - 25°C is sufficient to maintain a stable population of nitrifying bacteria in the aeration system.

- The level of evaporation in the flushing system was 22 - 25%. This results in a higher total solid content of the distributed manure. The total solid content of the transported manure amounted to 20 - 23%. The thick manure contained approximately 20% of the produced amount of nitrogen and over 70% of the produced amount of phosphate.
- Flushing the rooms with aerated flushing liquid markedly reduced the ammonia emission. The ammonia emission in kg per animal place per year is shown in the table. The relatively high standard deviations are mainly due to changes in the procedure. The ammonia emission in the growing-finishing pigs and piglet rooms was also reduced due to improved pen design.
- The influence of a reduced crude protein content in the feed on the ammonia emission in fattening houses could not be established when using the flushing system.
- Although 20% of the manure vaporizes in the flushing system and large quantities of the effluent liquid fraction can be spread on nearby land, energy usage was not reduced. The energy requirement for treating manure in the flushing system was 206 MJ/m³, whereas the energy requirement for transport over 150 km was estimated at about 117 MJ/m³.
- The extra annual costs of the flushing system for a pig farm with 3,000 growing-finishing pigs amounts to Dfl. 27.- per pig place when using sedimentation and sieving as a separation technique and Dfl. 35.- when a centrifuge is used for separation. Dependent on the chosen separation technique, the extra annual costs of the flushing system for a pig farm with 400 sows amounts to respectively Dfl. 145.- and Dfl. 186.- per pig place.
- The above mentioned annual costs can be reduced by Dfl. 8.- per fattening pig place and Dfl. 34.- per sow place by reduced manure distribution costs, when the flushing liquid contains less than 200 mg N/l. At higher N-concentrations in the flushing liquid which are less than 2,500 mg N/l, the maximum saving is Dfl. 5.- per growing-finishing pig place and Dfl. 20.- per sow place.
- Pathogens can enter the pig rooms by means of the flushing liquid. This did not lead to more animal sickness during this study. The most probable reason for this is the fact that no direct contact between the animals and flushing liquid is possible.
- At the moment, the prospects of the manure flushing system are limited, since there are cheaper alternatives on the market to reduce ammonia emission. The prospects of the manure flushing system will improve, if the regional manure distribution costs increase whilst at the same time the obtainable saving on the manure distribution costs for the pig farmer increase.
- The prospects for the Alclar process for the treatment of the flushing liquid are limited, because the slight improvement of the effluent quality does not lead to improved distribution possibilities compared with the flushing liquid that contains low levels of phosphate and nitrogen. ■

Report Pl. 172

Table: Ammonia emission in kg NH, per pig place per year in the research period.

Room	Average per period	Standard deviation	Reduction compared to standard (Anonymous, 1994)
Growing-finishing pigs	1.57	0.42	37%
Lactating sows	5.22	2.16	37%
Piglets	0.25	0.07	58%
Dry and pregnant sows	1.75[1]		58%

[1] measuring period: 3 succesive months

EFFECT OF MULTI PHASE FEEDING ON THE AMMONIA EMISSION OF GROWING-FINISHING PIG FACILITIES

ir. C.M. C. van der Peet-Schwering, ing. M. P. Beurskens-Voermans, ir. N. Verdoes

Dutch central government aims to reduce the emission of ammonia caused by agriculture by 50% in the year *2000* and *70%* by the year *2005.* The year 1980 is used as a reference year. In the few last years, emphasis has been placed on the reduction of ammonia emission from animal housing. Today housing systems are available that make it possible to reduce the ammonia emission by 60 to 65%. These housing systems, however, are very expensive. It may be possible to achieve a reduction in ammonia emission of about 60% by applying a combination of feeding and low cost housing measures.

Therefore, a study was conducted to examine the effect of low protein diets in combination with simple housing measures on the ammonia emission and performance of growing and finishing pigs at the Experiment Farm for Pig Husbandry in Sterksel. The study included two experiments. In the first experiment (report PI .145) the effect of low protein diets on the ammonia emission in traditional and optimal housing was studied. There was a restricted water supply. In the second experiment the effect of low protein diets on the ammonia emission was studied in combination with an ad libitum water supply. The experiment was conducted in an optimal housing system.

Two experimental treatments, using in total 320 pigs, were tested:

1 two phase feeding, optimal housing;
2 multi phase feeding, optimal housing.

All the pigs were fed two times a day. Water was supplied ad libitum. Multi phase feeding involves a feed with a high content of nitrogen and minerals (NMR-feed) being mixed with a feed with a low content of nitrogen and minerals (NMA-feed) in different ratios each week. The calculated amount of protein and ileal digestible lysine in the growing/finishing feed, NMR-feed and NMA-feed was, respectively, 16.0% and 0.71%, 16.5% and 0.80% and 13.5% and 0.60%.

The most important results and conclusions are:

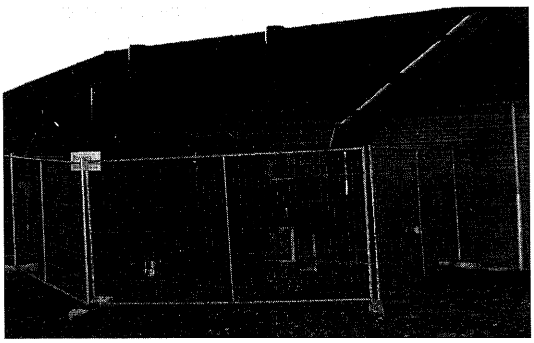
- Multi phase feeding reduces the ammonia emission by 10.8% and the nitrogen excretion in the urine by 12.7%.
- The pigs fed with multi phase feeding eat less and have a lower growth rate than the pigs fed with two phase feeding. This is probably caused by health problems. There are no differences in feed conversion ratio and slaughter quality between the pigs fed two and multi phase feeding.
- In batch 1, 2 and 3 the reduction in protein intake reduced the water intake. In batch 4, however, the opposite was found.
- Multi phase feeding leads to a shift from column C to F in MiAR (Mineral Supply Registration System). This means a reduction in phosphate excretion of 32.4% in relation to the fixed standard.
- Multi phase feeding gives an ammonia emission of 1.56 kg ammonia per fattening place per year. ■

Report Pl. 176

REDUCING THE AMMONIA EMISSION WITH A CHEMICAL AIRSCRUBBER

ing. M.G. M. Vrielink, ir. N. Verdoes, ing. J.P.B.F. van Gastel

The Research Institute for Pig Husbandry investigated the chemical scrubber as a means of reducing ammonia-emission from fattening pig sheds commissioned by Bovema inc.. The scrubber is supposed to absorb ammonia from the ventilation air into a sulphuric acid solution. The acid fluid is sprayed onto a plastic filter medium, that is placed in the ventilationstream of the shed. The main aim of this research was to determine the reduction in ammonia emission from the fattening pig shed when applying this airwashing technique. Furthermore, the sensitivity to technical breakdown was examined, the acid and energy consumption was measured, and a tost-analysis was performed. Indicative measurements with respect to the reduction of odour emission and the increase in hydrogen sulphide concentration in the shed as a result of the with



The chemical airscrubber on the Experiment Farm for Pig Husbandry at Raalte

drawal of sulphate rich drainage water from the manure pit were also performed. The research was performed at the Experiment Farm for Pig Husbandry at Raalte from September 20 1996 until January 15 1997. Ventilation air from a fattening pig room containing 66 animals was treated with the scrubber. The functioning of the scrubber was practically flawless. The average ammonia emission from the fattening pig shed was reduced by 90.7%, at a mean washing water pH of 3.6. Improvement of the drip catcher needs further attention, in order to prevent the drainage water from leaving the installation as a spray. The detection of a white (saline) deposit on the ventilation shaft and a shortage in the nitrogen balance are indications that drainage water may disappear as a spray. On average 41.5 liters of drainage water with an ammonium-nitrogen content of 4.84 g/l were flushed into the manure pit per fattening pig per year. An increase in the hydrogen sulphide concentration in the room as a result of the additon of drainage water containing sulphate to the manure pit was not proven. The odour emission seemed to decrease by 27 - 66%. Further quantification of the odour emission reduction is recommended. The extra annual costs for the application of the chemical scrubber in combination with a central exhaustion unit are calculated to be *ƒ* 32.-, of which *ƒ* 9.84 are the extra electricity costs. ■

Report P1. 178

EFFECTS OF MEASURES TO REDUCE THE MINERAL EXCRETION BY PIGS IN THE NUBL AREA

drs. C.P.A. van Wagenberg, dr. ir. G. B. C. Backus

Project assignment

The Research Institute for Pig Husbandry (PV) investigated the possibilities of reducing mineral excretion by pigs in the NUBL area for the Project Office NUBL and the Product Board for Animal Feed (PVV). The aim of the study was to investigate the extent to which phosphate and nitrogen excretion on pig farms could be reduced and the measures required to do so. This was achieved by looking at whether and how pig farms could realize a phosphate excretion of 4.2 kg per fattening pig per year and 14.0 kg per sow per year (including piglets up until weaning) and a nitrogen/phosphate excretion ratio of respectively 2.9 and 2.0. The present mineral excretion was calculated for several scenarios. For each scenario the possible measures, the effect of the measures on the minerale excretion and the costs and benefits of the measures were determined, using data from pig farms.

Situation at onset

In order to gain insight into the types of pig farm present in the NUBL area, the farms were classified according to high and low feed consumption, high and low production

Table 1: Expected effects of the measures on the phosphate and nitrogen excretion and on the economic performance of an individual growing-finishing pig farm in the situation at onset[1]

measure	phosphate (kg/pig/year)	nitrogen (kg/pig/year)	econ. performance (gld/pig/year)
Management:			
Optimizing feeding schedule	-0.12 to -0.10	-0.28 to -0.25	+4.70 to +4.74
Reducing spillage	-0.20 to -0.17	-0.46 to -0.42	+2.39 to +7.90
Delivering fewer too heavy fattening pigs	-0.07 to -0.05	-0.15 to -0.13	+4.05 to +4.27
Optimizing grouping strategy at start	-0.09 to -0.07	-0.24 to -0.20	+7.37 to +7.48
Lowering initial life weight	-0.18 to -0.12	-0.41 to -0.32	-3.28 to +7.83
Ration composition:			
Lowering mineral content in the feed	-0.69 to -0.62	-1.22 to -1.08	-1.96 to -1.76
Three phase feeding	-0.19 to -0.02	-0.65 to -0.30	-8.03 to +0.53
Number of pigs on the farm:			
Buying manure production rights[2]	-1.21 to 0.00	-3.10 to 0.00	-18.44 to 0.00
Lowering sty occupancy[2]	-1.22 to 0.00	-3.11 to 0.00	-416.56 to 0.00[3]

[1] The effects of optimizing the climate, fattening boars, choice of genotype, optimizing the water supply and switching from fattening pigs to sows are not calculated because these measures are only realizable in the long run, are not realizable due to external circumstances or because almost every farm has already implemented them.

[2] to reach a phosphate excretion of 4.2 kg and a nitrogen excretion of 12.2 kg per fattening pig per year

[3] in Dutch guilders per fattening place per year

(growth per day and number of raised piglets), small, middle and large farms and (for 1996/1997) normal and low mineral contents in the ration.
In the situation at onset the calculated phosphate excretion varied from 3.99 to 5.41 kg per fattening pig per year and from 11.02 to 14.74 per sow per year. The nitrogen excretion varied from 10.84 to 13.86 kg per fattening pig per year and from 26.20 to 35.92 per sow per year.

Measures and effects

Fourteen measures to reduce the mineral excretion were evaluated with respect to slaughter pig production. These measures were categorised according to management, ration composition and number of pigs on the farm. In table 1 the expected effects of the measures on the phosphate and nitrogen excretion and on the economic performance for the slaughter pig production are given. It was foreseen that some measures would not be effective and so their effects were not calculated in this study.

Eleven measures to reduce the mineral excretion on sow farms were evaluated. These measures were categorised according to management, ration composition and number of pigs on the farm. In table 2 the expected effects of the measures on the phosphate and nitrogen excretion and on the economic performance for sow farming are given.

Management measures may lead to an increase in the economic performance per pig per year on some farms. This will only take place when the farmer takes the correct measures. Management measures mainly influence the mean feed consumption. Examples of possible management measures are optimizing the feeding schedule, reducing spillage, optimizing the initial live weight and delivery weight, climate control and optimizing the grouping strategy at the onset. Some farms will only be able to take such measures after having invested in new systems in the sty. The positive effects of the measure on the economic performance are (largely) nullified by the necessary invest- ▶

Table 2: Expected effects of the measures on the phosphate and nitrogen excretion and on the economic performance of an individual sow farm in the situation at onset[1]

measure	phosphate (kg/sow/year)	nitrogen (kg/sow/year)	econ. performance (gld/sow/year)
Management:			
Optimizing feeding schedule	-0.51 to -0.45	-1.18 to -1 .00	+22.19 to +23.97
Reducing spillage	-0.51 to -0.45	-1.18 to -1 .00	+22.19 to +23.97
Heating sty for pregnant sows	-0.32 to -0.28	-0.72 to -0.64	-42.91 to -39.15
Lowering delivery weight of the piglets	-0.93 to -0.80	-2.48 to -1.90	-85.00 to -68.13
Ration composition:			
Lowering mineral content in the feed	-1.33 to -1.21	-4.29 to -3.75	-18.71 to -15.93
Number of pigs on the farm:			
Lowering occupancy sty for rearing sows[2]	-1.20 to 0.00	-2.93 to 0.00	-43.08 to 0.00
Buying manure production rights[2]	-3.25 to 0.00	-7.92 to 0.00	-68.64 to 0.00

[1] The effects of lowering the number of non-productive days, lowering replacement percentage, choice of genotype and optimizing water supply were not calculated because these measures are only realizable in the long run, are not realizable due to external circumstances or because most farms have already taken the measure.
[2] to reach a phosphate excretion of 14.0 kg and a nitrogen excretion of 28.0 kg per sow per year

ment costs. Before management measures can be taken, the pig farmer must gain an insight into the possibilities on his farm. This process can be supported by counseling. Furthermore pig farmers can reduce the mineral content in the ration. This can be done by reducing the mineral content in the feeds used, which implies an increase in the feed price and the feeding costs (the technical results do not change). Another possiblity is to switch to three phase feeding which in some cases will require an investment in an extra feed silo and/or a new feeding system. The effect of three phase feeding is dependent of the mineral content in the feeds usually used. The lower the content, the smaller the effect of three phase feeding and the higher the increase in feeding costs. Finally, measures regarding numbers of pigs on the farm can be taken. A lower occupancy of the sty or buying manure production rights tend to have a strong negative impact on the economic performance (including investment costs). Only a reduced occupancy of the sty for rearing sows, realised by buying the sows at *110* kg instead of at 25 kg, has little effect on the economic performance. However, many farms already buy their rearing gilts at *110* kg. Measures regarding numbers of pigs on the farm shall only be a solution for a small number of farms.

Feasibility of the proposed standards

Most fattening pig farms with normal mineral content in the feed cannot meet the proposed phosphate excretion standard of 4.2 kg per fattening pig per year only without adjusting their management. By using feeds with a low mineral content in combination with management measures, most farms with fattening pigs wil have a phosphate excretion of between 4.0 and 4.5 kg per fattening pig per year. A number of farms will have to cut the feed consumption through a combination of measures: reducing spillage, split-sex-feeding of barrows and sows and optimization of the feeding schedule. These measures may lead to a better economic performance per fattening place. However, the necessary adjustments are not easy, will take time and will not be possible on all farms. Farms with sows with normal mineral content in the feed will only be able to meet the proposed nitrogen standard of 28.0 kg per sow per year with additional management measures. These farms will also have to reduce the mineral content in the feed. Most farms with sows will meet the proposed phosphate standard of 14.0 kg per sow per year if the feed used has a low mineral content. The proposed nitrogen/phosphate excretion ratio of 2.0 : 1 will remain a problem for a number of farms with sows. These farms will only be able to meet the proposed standard if they can reduce the feed consumption drastically by reducing spillage and by optimization of the feeding schedule. For some farms with sows heating of the sty of pregnant sows may be a solution. Most of the measures in sow farming will require extra investments so the economic performance (including investment costs) will decrease.

Conclusion

The possibilities of reducing the mineral excretion are mainly dependent on the situation at onset. In many cases lowering of the mineral content in the feed alone will not be sufficient. Farms with a mean or high feed consumption will have to adjust their management. There are possiblities for reducing the mineral excretion level but it takes time to implement the suitable measures and they are not feasible for all farms. The proposed standards of 4.2 kg phosphate excretion per fattening pig per year and of 14.0 kg per sow per year and a nitrogen/phosphate excretion ratio of respectively 2.9 and 2.0 can be met by most pig farms. This will not be easy and will take some time. On a number of farms the measures are not sufficient to meet the proposed standards. ■

Report Pl. 191

DESIGN OF BIOLOGICAL NITROGEN REMOVAL SYSTEMS FOR PIG SLURRY

ir. C. C. R. van der Kaa, ing. J. PB. F. van Gastel

Nitrogen removal by means of biological treatment of manure leads to a reduction in the ammonia emission during storage and while spreading the manure on the fields. It is also possible to reduce the ammonia emission from pig houses if the effluent of the biological slurry treatment is used to flush the slurry pits. In early 1997 the legislation in the Netherlands concerning the application of manure became less stringent concerning slurry effluent with a low nitrogen content. The spreading of effluent with a nitrogen content lower than 200 mg/l is no longer restricted by volume norms and the use of low-emission spreading techniques is not obliged. Considering the possibility of reducing ammonia emissions and increasing the applicable slurry volume on arable land, the Research Institute for Pig Husbandry in the Netherlands has drafted a handbook for the design of biological nitrogen removal systems on a farm scale.

By using this handbook the reactor volume and the oxygenation capacity needed for the biological process can be calculated for every scale of farm. Two types of processes are described: the slurry flushing system and the sequentia1 batch reactor (SBR) system. Besides the reactor and aeration design the energy balance of the biological reactors is discussed in order to determine the minimum and maximum process temperature. The procedure to start up the biological process is also highlighted.

The biological removal of nitrogen consists of two processes: nitrification and denitrification. The nitrification process is carried out by bacteria that oxidize ammonium to nitrate with the intermediate formation of nitrite. An oxygen supply is required. Denitrification involves the microbial reduction of nitrate and nitrite to nitrogen gas. This proces commonly occurs in the absence of molecular oxygen. Most denitrifying bacteria are able to oxidize organic substances (COD) under aerobic conditions.

The aim of the slurry flushing system is both to treat the slurry and reduce the level of ammonia emission from pig houses. The slurry from the pig houses is separated and aerated. The effluent of the aeration process contains little ammonia and high concentrations of nitrate. This effluent is pumped back into the slurry pits to dilute the freshly produced manure whereby the ammonia emission is reduced. Under the anoxic conditions in the slurry pit the nitrates are denitrified to nitrogen gas.
In this handbook the design of the reactor size of the slurry flushing system is based on the sludge retention time approach. At a minimum process temperature of 10˚C, an oxygen concentration of 1,5 mg/l and pH 8, a minimum sludge retention time of 10 days is required to maintain nitrifying bacteria in the aeration tank. Due to the relatively high dry matter content of the mixture of sludge and effluent the performance of a settlement tank to return the sludge to the aeration tank is poor, as shown in earlier research. Without a settlement tank and sludge return, the solids retention time equals the hydraulic retention time. This leads to relatively large reactor sizes, especially in the case of slurry flushing systems that treat diluted slurry. A farm with 2,500 growing-finishing places requires an aeration tank of 1,068 m^3. The oxygen demand of the process amounts to 315 kg oxygen per day. Considering the maximum reactor temperature of 27°C in summer and the infuence of the slurry on the oxygen transfer, the (standard) oxygenation capacity of the aerator has to be at least 564 kg oxygen per day. In winter the minimum process temperature of 10°C can not be guaranteed if an open concrete tank is used. ▶

The aeration tank should at least be roofed. Additional measures to maintain higher process temperatures in winter are the installation of heating equipment and lowering the flushing frequency and/or ventilation of the head-space under the roof of the aeration tank with warm air from the pig houses.

The Sequentia1 Batch Reactor (SBR) system is characterised by a repetative sequence of processes in a single tank. The number and order of the processes may vary. The SBR process described in this handbook consists of 3 phases: (1) filling and mixing, anoxic phase (2) aeration (3) effluent withdrawal. A sedimentation phase is not included, considering the poor sedimention performance of activated sludge from a biological slurry treatment. During the first phase slurry is pumped into the tank. The nitrate formed during the previous aeration phase is reduced to nitrogen gas under anoxic conditions. During the aeration phase nitrifying bacteria oxidize ammonia to nitrate. After aeration the mixture of sludge and effluent is discharged.

The design of the SBR process in this handbook is based on the ammonium oxidation rate approach. The ammonium oxidation rate of Nitrosmonas is about 0,67 kg NH_4-N per kg Nitrosomonas per day at a minimum process temperature of 10°C, an oxygen concentration of 1,5 mg/l and pH 8. The ammonium oxidation rate that can be measured in the SBR depents on the percentage of Nitrosomonas in the microbial sludge. The fraction of nitrifiers can be estimated from the knowledge of the biological yields of the autotrophic and heterotrophic populations and the amount of N and COD that will be removed.
The ratio between the nitrification and denitrification rate determines the needed ratio between the duration of the aerobic and anoxic phase. Earlier research on nitrogen removal in slurry has shown that the aeration phase should be about 4 times longer than the anoxic phase.

The SBR size can be calculated if the added amount of nitrogen is known as well as the ammonium oxidation rate, the aeration time and the sludge concentration in the tank.

A farm with 2,500 growing-finishing places requires SBR of 89 m^3 (wet volume). The oxygen demand of the process amounts to 326 kg oxygen per day. Considering the maximum reactor temperature of about 39°C in the summer and the infuence of the slurry on the oxygen transfer, the (standard) oxygenation capacity of the aerator must be at least 595 kg oxygen per day. When concentrated slurry is treated in a roofed reactor the temperature may rise above the maximum of 40°C in summer. The temperature can easily be brought down by widening the ventilation opening in the roof or by a temporary decrease in slurry addition.

An additional carbon source may be needed for complete denitrification, depending on the type of (pre-)separation, the type of biological treatment and the fraction of biodegradable carbon in the influent. As the COD/N ratio drops below 8,3, the need for an external carbon scource becomes more likely. It is presumed that an additional carbon source is not needed when simple filtration machines are used for pre-separation.

Lowering the nitrogen contents of the slurry below the limit of 200 mg/l N for unrestrained application by means of biological treatment is neither possible for sow slurry nor for slurry from growing and finishing pigs. This means that inspite of the low ammonia contents of the biological effluent low emission techniques are required for application on agricultural land. Application of 50 m^3 effluent per hectare arable land and 100 m^3 effluent per hectare grass land is allowed.

The models for the design of the slurry flushing system and the SBR system suggested in this handbook have not been verified. ■

Report Pl. 192

URINARY PH, AMMONIA EMISSION AND PERFORMANCE OF FATTENING PIGS, AFTER THE ADDITION OF A MIXTURE OF ORGANIC ACIDS, MAINLY BENZOIC ACID, TO THE FEED

ing. G.M. den Brok, ir. J.G. L. Hendriks, ing. M.G. M. Vrielink, ir. C. M.C. van der Pee t-Sch wering

Reducing ammonia emission from animal housing is possible using technical solutions (scraper systems, flushing systems) or by improving the pen design. This improved pen design is based on reducing the slurry surface area in the slurry pit and reducing the surface area covered in slurry in the pen. At the moment, more research is being carried out on the possibilities of using feeding measures, possibly in combination with housing measures, to reduce ammonia emission. A promising feeding measure is adding acidic salts to the feed in order to lower the pH of the urine and slurry. Initial research on this subject resulted in a 30 - 54% reduction of the ammonia emission.
Therefore, a study was conducted at the Experiment Farm for Pig Husbandry at Raalte to examine the effect of an improved pen design in combination with adding a mixture of several organic acids to the feed of fattening pigs on the pH of the urine and slurry, the ammonia emission and the performance of the pigs.
The research was conducted in three rooms and during three fattening periods. Each room had six pens containing 66 animals. In the first two identical rooms the pigs were fed with either control feed or acidified (experimental) feed. After each period the treatments were changed over. The improved pen design in the two rooms consisted of a narrow slurry channel (50 cm) with concrete slats at the front of the pen, a convex solid floor (185 cm) and a broad slurry channel with tri-bar metal slats and a sewage pipe system underneath at the back of the pen (160 cm, including a slurry slit). In these two rooms the pH of the urine and slurry and the ammonia emission were measured.
In the third room pigs in three pens were fed the control feed and pigs in another three pens were fed the experimental feed. In this room the effect of the experimental feed on performance and meat quality was examined. All pigs were fed using a dry-wet feeder and were fed with a starter feed during the first four weeks. After this period, the starter feed was replaced by a growing and finishing feed over a period of five days. The experimental starter feed and growing finishing feed contained no $CaCO_3$, but did contain a mixture of acid salts comprising 1% and 2% of the feed, respectively. The mixture consisted of 70% benzoic acid, 16.5% calcium salts, 6.5% formic acid and 7.0% propionic acid (experimental starter feed and growing finishing feed consisted of 0.7 and 1.4% benzoic acid, respectively). The ME and crude protein content of the control feed and experimental feed were equal.

The most important results and conclusions are:

- The average pH of the urine of fattening pigs fed with control- and acidified starter feed was 7.50 and 5.69, respectively (difference is 1.81). For fattening pigs fed on growing and finishing feed the pH of the urine was 7.48 and 5.02, respectively (difference is 2.46).
- The average pH of the top layer of the slurry of fattening pigs fed with control- and acidified starter feed was 7.76 and 7.28, respectively (difference is 0.48). For fattening pigs fed on growing and finishing feed the pH of the top layer was 7.82 and 7.04, respectively (difference is 0.78) (figure 1).
- The improved pen design in this study resulted in an ammonia emission of 2.04 kg per pig area per year (2.5 kg per pig area per year is standard for traditional pen design). The combination of improved ▶

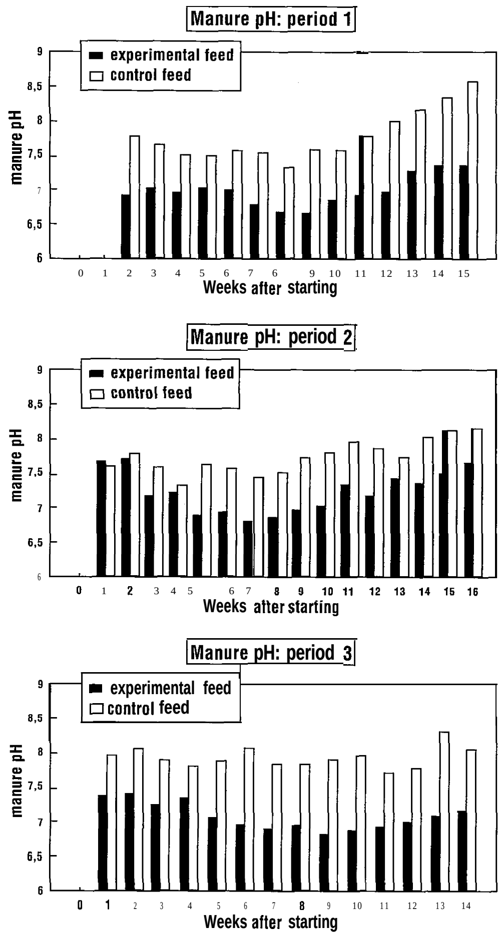


Figure 1: Development of pH of manure, produced by fattening pigs fed with control feed and acidified feed

pen design and acidified feed resulted in an ammonia emission of 1.22 kg per pig area per year, a reduction of 40%. The calculated ammonia emission rate was not corrected for the ammonia concentration of surrounding air (in similar reasearch the corrected ammonia emission is about 0 - 5% lower than the not corrected emission).

- Feeding acidified feed to fattening pigs in this research did not influence the meat quality.
- Feeding acidified feed to fattening pigs in this research improved the feed ME-conversion ratio by 0.09 (2.83 instead of 2.92). There was no influence on mortality rate.
- The additional feeding costs for the use of acidified feed in this research was calculated to be Dfl 16.65 per pig area per year. Because of a better ME-conversion, the gross profit margin in this research decreased by only Dfl 5.66 per pig area per year. Together with the extra annual costs of Dfl 9.90 per pig area for the improved pen design compared to a traditional housing system, the total extra annual costs were Dfl 5.66 + Dfl 9.90 = Dfl 15.56 per pig area (see table 1). ■

Report Pl. 194

Table 1: Extra annual costs for the improved pen design compared to a traditional housing system, with or without the use of acidified feed

	ammonia emission (kg/ppl/y)	extra investment costs (Dfl/ppl)[1]	extra annual costs (Dfl/ppl/y)
traditional housing (concrete slats)	2.52		
improved pen design (metal slats)	2.0	42.00	9.90
improved pen design and acidified feed	1.2	42.00	15.56

[1] Dfl/ppl = Dutch guilders per pig place

[2] 2.5 kg/ppl/y = ammonia emission norm for a traditional housing system for fattening pigs with a partly slatted floor and concrete slats

MICROBIOLOGICALACIDIFICATIONOF FATTENING PIG MANURE BY THE ADDITION OF POTATO STARCH

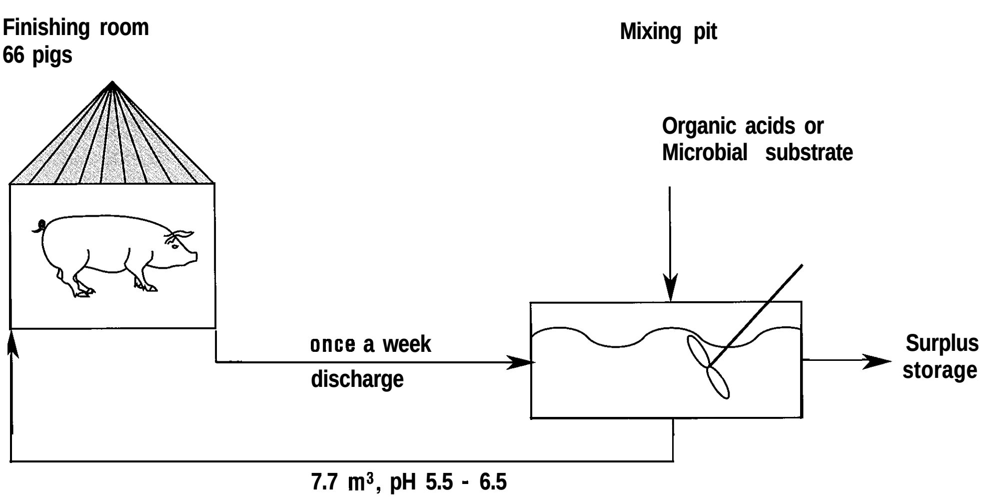
ir. J.G. L. Hendriks, ing. M.G. M. Vrielink

The Dutch government has set the aim of reducing the ammonia emission of Dutch agricultural activities. Research has demonstrated that the ammonia emission of fattening pig houses can be reduced to 1.32 kg ammonia per pig place per year by the microbiological acidification of manure. Milled wheat was mixed with the manure to activate micro-organisms. The average pH of the acidified manure during two fattening periods was 6.12. The extra annual costs are calculated at between ƒ 40.- and ƒ 42.- per fattening pig place, depending on construction of the pig house, when milled wheat is used. During this study the use of heated potato starch instead of milled wheat was examined.

The research was carried out at the Experiment Farm at Raalte during one fattening period between June and October 1996. The manure channel beneath the metal slatted floor was filled with 7.7 m^3 fresh non-acidified fattening pig manure before the start of the trial. This manure was acidified using citric acid to a pH of 5.5 and inoculated with lactic acid micro-organisms (Lactobacillus plantarum). The acidified manure was pumped into the manure Channel. Heated potato starch was mixed with the manure during the weekly mixing process in a central mixing facility.

The average pH, measured weekly after the intensive mixing process, was 6.04. The ammonia emission was 1.49 kg ammonia per pig place per year. Approximately 80 kg dry matter heated potato starch was used each week, which is equivalent to 1.2 kg per animal per week. The extra annual costs of the microbiological acidification system decreased by 45% (from ƒ 40.- till ƒ 23.- per pig place) by replacing the milled wheat with heated potato starch. The conclusion of the study is that heated potato starch can be used for the microbiological acidification system as well as milled wheat. ■

Report P4.19



Flowscheme of manure with microbiological acidification

SLOPED PLATES IN THE SLURRY CHANNEL IN A FATTENING PIG PEN

ing. A.J.A.M. van Zeeland

Reducing the emitting surface is a simple way of reducing the ammonia emmision. Therefore the Experiment Farm for Pig Husbandry in Sterksel carried out an experiment to the effect of reducing the emitting surface, by means of sloped plates in the slurry channel in a fattening pig pen. The starting point was a special design of pen used for fattening pigs with a narrow water Channel, a convex solid floor and a broad manure channel which had a removal point every two meters for the sewer system. Both manure and water channels had triangular metal slats.
Research into this pen design has showed that this seems to be an easy way of reducing the ammonia emission drastically.
By assembling sloping plates in the slurry pit and decreasing the level of slurry to 20 centimeters frequently by means of the sewer system, it is possible to reduce the emitting surface even more. The sloped plates are used in the slurry channel as well as in the water channels. By assembling two sloped plates in the water channel at an angle of 60°, the water wastage is reduced. A small layer of cleaning water of 5 to 10 cm in the water channel is sufficient to dilute the small amount of manure that falls in it. In the broad manure channel two plastic plates are assembled. The plastic plate against the solid floor is assembled under a 50" angle, the plastic plate behind the wall under a 60" angle. The lowest 10 cm of both plates are standing perpendicular up the pit floor. The surface of the manure channel depends on the manure level. The surface of the broad manure channel consequently can be reduced from 0.29 m^2 to 0.11 m^2 per animal place.

During two successive fattening periods the ventilation flow and ammonia concentration has been measured between 19-06-1996 and 9-10-1996 and between 29-10-1996 and 14-02-1997. In the first and second fattening period, the average ventilation flow and ammonia concentration were 2,019 and 915 m^3/uur, 2.87 and 5.68 mg NH_3/m^3 respectively. The calculated ammonia emission for the first and second fattening period respectively were 1.02 and 0.99 kg NH_3 per animal place per year. The average ammonia emission was 1 .01 kg NH_3 per animal place per year.

Dirtiness in both the pen and on the sloping plates in the manure pit effect the ammonia emission. This is why the dirtiness of the sloping plates in the broad manure channel is monitored. Since manure tends to build up along the back of the pen more manure and urine from this plate remains in the manuring pit. Because of the regular urine flow there is very little accumulation of manure. Soon after starting a layer of dust and hairs accumulates on the sloping floor against the solid floor. There is very little accumulation of manure in this area.

The manure level in the broad manure channel is also relevant with respect to the emmiting surface per animal place. In this research the maximum emitting surface in the broad slurry channel was 0.18 m^2 per animal place.

In a cost calculation a newly built system is compared with a standard pig shed with 1,840 places and compartments for 80 fattening pigs using a partly slatted floor, a complete manure pit (1.75 m deep) and concrete slats. The extra investment and annual costs per animal for this system are Dfl 44.08 and Dfl 10.31 per animal place, exclusive VAT (Van Brakel et.al., 1997). The extra investments are mainly incurred by the sewer system, trough in the water Channel, triangular metal slats and manure storage. These amounts are a rough indication. The total investments depend on the point of departure of each individual case. ■

Report P4.22

LOWERING AMMONIA EMISSION BY COOLING DOWN THE MANURE OF WEANED PIGLETS

ing. M. P. Beurskens-Voermans, ir. C. C. R. van der Kaa

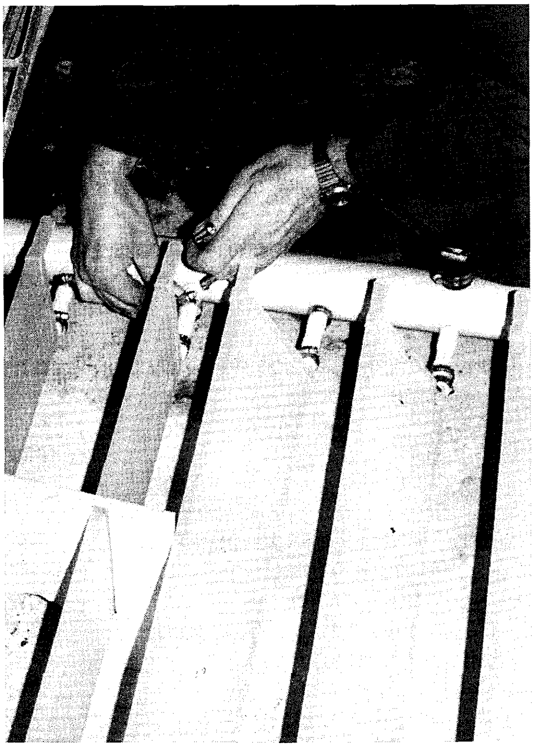
Between April and June of 1996, an experiment on the effect of cooling down the top layer of slurry of weaned piglets on the ammonia emission was carried out on the Experiment Farm for Pig Husbandry at Sterksel. The weaned piglets were housed on a full slatted floor.

Cooling down the top layer of the slurry took place using a plastic laminated frame through which ground water flowed. The ground water was pumped from a 30 metre deep pit. This water had an average temperature of 105°C. Because the specific gravity of the plastic elements filled with water is lower than the specific gravity of the slurry, the elements float in the slurry. For this reason only the top layer of the slurry cooled down. In this experiment the average temperature of the top layer of the manure was 15°C. By cooling down the temperature of the manure, the ammonia emission reduced to 0.15 kg NH_3 per animal place per year (corrected for the outside concentration), during two rounds. The ammonia emission is lower than the emission in a traditional housing system for weaned piglets (0.6 kg NH_3 per animal place per year) and also lower than the Green Label requirement (0.3 kg NH_3 per animal place per year). The average ammonia concentration in the outlet ventilation air is 3.21 mg NH, per m^3, the average ventilation rate 591 m^3 per hour and the average temperature in the compartment 24.5˚C.

The average temperature 10 and 50 cm above the slatted floor is 25.3˚C and 25.7˚C respectively. It can be presumed that cooling down the top layer of the slurry had no influence on the surrounding temperature at piglet level.

The extra environmental investment and annual costs per piglet for the cooling system are estimated as respectively DFL 59.01 and DFL 9.39 (including energy costs), or DFL 2.35 per kg ammonia emission reduction. The reference was a pig shed, housing 452 sows, in which the R&R cooling system was applied for all 1,263 weaning piglets places. In this case a maximum volume of 10 m^3 groundwater per hour is withdrawn without requiring permission, which brings extra investment costs. The investment costs can be reduced by also applying the cooling system in rooms of other animals, so that the costs of digging and ground water wells are reduced per animal category. ■

Report P4.23



Source R&R Systems
Installation of the cooling system

HOUSING PIGS IN ONE PEN FROM BIRTH TO SLAUGHTER

ir. H.M. Vermeer, ing. J. G. Plagge, ing. G. t? Binnendijk, dr. ir. G.B. C. Backus

Elimination of the stress factors which pigs are subjected to from birth to slaughter can result in improved technical performance. Examples of such stress factors are relocation and mixing of animals. On the Experiment Farm for Pig Husbandry in Raalte two experimental treatments were compared: in one treatment the group remained in one pen from birth to slaughter and in the other treatment the group was relocated twice and mixed once.
The aim of the experiment was to examine the perspectives of keeping pigs together in one group and one pen for their life time compared to the more common system of relocations and mixing at 24 kg.

In the relocation treatment the animals were relocated at weaning (4 weeks) and at the start of the growing-finishing period (24 kg) and mixing took place at 24 kg. The pens of the treatment in which relocations and mixing did not occur were enlarged at 24 kg bodyweight to achieve the same stocking density as in the other treatment. In the following table the results are summarized.

The total daily weight gain from birth to slaughter was higher for the pigs not relocated than for the relocated pigs. This difference results from differences in the rearing period after the first relocation and in the first part of the growing-finishing period after the second relocation and mixing. No difference in weight gain was found in the lactation period and in the second part of the growing finishing period. Feed intake of the not relocated pigs was higher in the first part of the growing-finishing period but not in the other periods. No differences were found in feed conversion, mortality and slaughter quality.

The technical performance of the not relocated pigs in this experiment was better than that of the relocated pigs. On the other hand the housing costs are higher when the pigs are kept in one pen for their lifetime.
According to model calculations the system of not relocating pigs is financially only attractive when the difference in daily weight gain is 33 g/d or more. This difference was not achieved in this experiment. It is possible that a system without mixing pigs, but with relocations to specific pens per category, offers better perspectives. ■

Report Pl. 170

Table: Weight gain, age and daily gain from birth to slaughter for pigs not relocated and relocated twice

Treatment	not relocated	relocated at weaning and 24 kg	Significance
Number of slaughtered animals	193	195	
Weight gain (kg)	103.3	102.6	
Age at slaughter (d)	175	180	
Daily gain from 1 to 105 kg (g/d)	590	573	**
Daily gain 1 - 8 kg (g/d)	226	224	n.s.
Daily gain 8 - 24 kg (g/d)	418	393	#
Daily gain 24 - 40 kg (g/d)	736	655	**
Daily gain 40 -105 kg (g/d)	753	755	n.s.

n.s. = **not significant; ** = P < 0.01; # = P < 0.10.**

COMPARISON OF FOUR HOUSING SYSTEMS FOR NON-LACTATING SOWS

dr. ir. G.B. C. Backus (ed.), ir. H.M. Vermeer, ing. P.F.M. M. Roelofs, drs. P. C. Vesseur, ing. J. H.A. N. Adams, ing. G.P. Binnendijk, ing. J. J. J. Smeets, ir. C.M. C. van der Peet-Schwering, ir. F.J. van der Wilt

Introduction

In the late eighties, a comparative study of different housing systems for pregnant sows, including the electronic sow feeding system (ESF), was conducted at the Rosmalen Institute. One of the main conclusions of the study was that the ESF system needed to be further developed, before practica1 use could be stimulated. Moreover, it was expressed that recent developed group housing systems should also be evaluated.
As a follow-up of this study, the Rosmalen Institute was asked to install and compare three operational group housing systems for non-lactating sows with the commonly used individual stall system.
In 1991 and 1992, the three group housing systems were planned, construction took place and management protocols were developed for each of the four housing systems. The mechanics and the management protocol of each of the four housing systems were tested and optimised in 1993. From January 1994 to March 1996, a comparative study was conducted to determine whether group housing of dry sows can be advised as an alternative for individual housing. In the study three group housing systems (free access stalls, trickle feeding and the electronic sow feeding) and one individual housing system (stalls) were considered.

Material and methods

Animals, Housing and Feeding

In 1993 the (closed) Rosmalen sow herd was split up in four herds of each 90 sows. The present sows were allocated to one of the four housing systems based on parity, previous housing system (tethers, individual stalls or ESF) and breed origin. At Rosmalen a rotation cross-breeding program is used with the breeds Dutch Land Race (NL), Finnish Land Race (F), and Great Yorkshire sow line (Vz). Sows that could not be maintained within the system were culled.
Voluntary replacement of sows was standardised across the four housing systems using a replacement index that expressed the expected replacement value.
During the study, a surplus pool of replacement gilts was maintained. Replacement gilts were randomly allocated to one of the four systems to stay there either until the end of the study or culling.
Each system had it's own room for dry sows. The separate rooms had partially slatted floors without bedding. In the individual stall system, the available area per crate was 2.00 x 0.65 m, of which 0.6 m^2 concrete solid floor and 0.7 m^2 slatted floor. In the free access stall system, the available area per crate was *2.05 x 0.65* m, of which 0.9 m^2 concrete solid floor and 0.4 m^2 slatted floor. Furthermore, two walking areas of 2.60 x 13.28 m, each between two rows of 20 crates, were available for 74 sows. In the trickle feeding system, a floor area of 18.00 x 13.28 m was divided in 14 different size pens with 84 feeding places. The room with the ESF system contained two small and two large pens. In the small pens, replacement gilts and early pregnant sows were housed. At mid-pregnancy the gilts and sows were moved to the large pen and mixed with a similar size group of longer pregnant sows.
The four housing systems were mechanically ventilated. During the farrowing period, all sows were housed individually in conventional crates. The sows were weaned at 4 weeks after farrowing. At weaning, a special constructed outside outlet was used to allow for group formation. Group size was 10 - 14 in the free access stall, 13 - 26 in the ESF system, and 6 - 8 in the trickle feeding sys- ▶

tem. The sows were kept together from weaning until farrowing in stable groups, except in the ESF system in which two groups of similar size were mixed after 6 - 9 weeks in gestation. To enable working with stable groups, a three weekly production system was applied. The systems were managed by the same animal care takers and health management was the same for all four systems.
In the systems with simultaneous feeding (stalls, free access stalls, and trickle feeding systems) sows were fed twice a day at 7.30 and 14.30 h. In the ESF system, the sows had access to feed at 15.30 h. The sows were free to consume their daily portion at once, or to split up their ration over several visits to the station. Sows in stalls had limited access to water twice a day for one hour immediately after feeding. In addition to a limited water amount from the nipple above the through, all group housed sows had free access to water from a drinking reservoir.

Measurements
The four systems were compared on different aspects: i.e. animal behaviour, reproduction and replacement, health, feeding, labour and control, and economics. The following measurements were agreed among a group of experts: oral activities as a measure for stereotypies, cortisol rhithmic, skin lesions, hoof lesions, reproductive traits, veterinary treatments, usage of feed and water, dust concentrations, noise exposure levels, physical and mental work load, and working time for specific animal care taking activities.
During three 24 h periods in March, July and November 1994, sow behaviour was determined by personal observation. From October 1994 to January 1996, monthly

The individual stall system

The free access stall system

The trickle feeding system

The electronic sow feeding system

observations of individual dry sow behaviour were registrated: in the three systems with simultaneous feeding (stalls, free access stalls, and trickle feeding) during 1.5 h after afternoon feeding, and in the ESF system from 17.00 to 20.00 h. From December 1994 to March 1995, saliva cortisol rhithmic of all empty and pregnant sows was determined. Of all sows, saliva samples were taken twice a day, between 12.30 and 13.30 h and between 15.30 and 16.30 h.
Veterinairy treatments and reproductive traits of individual sows were registrated routinely. Feed and water usage were registrated per room. All sows were inspected for skin lesions at weaning and at 4 days and 12 weeks after weaning, and classified on a scale ranging from 0 (no lesions) to 5 (severe lesions). The hooves of individual sows were inspected for lesions at 4 days and 12 weeks after weaning, and classified on a scale ranging from 0 (no lesions) to 4 (severe lesions). Both respirable and inspirable dust concentrations (mg dust per m^3 air) were calculated as monthly averages, based on 24-hour average dust concentrations per room. Noise levels were measured in the winter period after shutting of the room fans. Based on the required time per work activity and the associated noise level, noise exposure levels per day and per week were determined for each system. Physical work load, safety aspects, flexibility and controlability were subjectively determined based on a questionnaire answered by the animal care takers. Required time for system related work activities was determined by both direct observation and time studies. The data were statistically analysed using variance analysis, Chi square test, and the Friedman test (SAS Institute Inc., 1989). The sow or group of sows was considered the experimental unit.

Results and discussion

An overview of the results with respect to behaviour, health, reproductive traits, feed and water intake, animal weights, controllability, labour and labour circumstances, investment costs, and an economic evaluation is presented in table 1.

Behaviour

Compared with the free access stall system, sows spent more time on oral activities in the stall system and the trickle feeding system, and less in the electronic sow feeding system. However, this behavioural trait is closely related to the feeding regime; i.e. once a day in the electronic sow feeding system and twice a day in the three other systems. No differences were observed in saliva cortisol rhithmic among the four systems.

Health

The percentage of sows with hoof lesions at 12 weeks after weaning was low in stalls and free access stalls, compared with the ESF and trickle feeding systems. It is noteworthy, however, that the number of sows with hoof lesions in the present ESF system was only two-thirds of the number observed in the first comparative study.
At 12 weeks after weaning, the percentage of sows with skin lesions (forehand) was high in the trickle feeding and especially in the ESF system, compared with the stall and the free access stall system. The high percentage of sows with skin lesions in the ESF system was partly due to the mixing of two groups during pregnancy. The groups were mixed to obtain a sufficient number of sows per group, and is, therefore, farm size related but not system related. The high percentage in the trickle feeding system was partly due to agressive interactions around feeding.

Productivity

The interval weaning - first insemination was, especially in 1994, highest in the trickle feeding system and in the ESF system. In the ESF system, also a high loss of backfat thickness during the farrowing period was found. In 1995 both the interval weaning - first insemination and the percentage non-returns in the trickle feeding system and the ESF system were markedly improved. This suggests that sows require time to adjust to the new housing system.
The average number of live-born pigs per litter only showed a numerical variation from 10.7 for the stall and trickle feeding system, 10.9 for the free access stall system, and 11 .O for the ESF system. Also the realised ▶

Table 1: Summary of results

	Stalls	Free access stalls	ESF	Trickle feeder
Average present sows (1994 - 1995)”	86	85	89	88
Reproductive performance				
Number of cycli	377	373	395	401
Interval weaning-insemination (days)	6.6^{a}	6.2^{a}	7.3^{b}	7.3^{b}
Percentage non-return	88.9	87.6	87.4	88.7
Live born piglets per litter	10.7	10.9	11.0	10.7
Weaned piglets per sow per year	22.1	22.5	22.1	22.2
Birth weight live born piglets (kg)	1.45^{a}	1.44^{a}	1.40^{b}	1.45^{a}
Piglet growth: day 1-28 (g/day)	221^{a}	221^{a}	227^{b}	227^{b}
Animal characteristics				
Weight of the sow: end of pregnancy (kg)	222^{a}	226^{b}	219^{a}	221^{a}
Backfat thickness of the sow; end of pregnancy (mm)	18.0^{a}	19.3^{b}	20.8^{c}	18.9”
Behaviour				
Oral activity 1st pregnancy after feeding (%time)	32.4^{a}	20.4^{b}	9.4^{c}	26.7^{ab}
Health				
Sows with locomotion disorders (%)	8.4^{a}	10.4^{a}	19.5^{b}	17.8^{b}
Sows with forehand skin lesions 12 wks pregnancy (%)	0^{a}	6^{b}	33^{c}	19^{d}
Feed and water usage				
Feed level (kg/day)				
- primiparous	2.5^{a}	2.7^{b}	2.5^{a}	2.7^{b}
- multiparous	2.8^{a}	2.8^{a}	2.7^{b}	2.8^{a}
Water usage (ltr/sow/day)	10.2	11.8	8.4	8.7
Labour and control				
Labour time room for 170 pregnant sows (hrs/yr)	287^{a}	285^{a}	207^{b}	293^{a}
Labour time whole farm with 210 sows**	$3,050^{a}$	$3,048^{a}$	$2,970^{b}$	$3,056^{a}$
Respirable dust (mg/m^3)	0.16^{a}	0.19^{a}	0.44^{c}	0.28^{b}
Noise exposure level whole farm (dB(A))	88.5	88.5	88.6	88.5
Physical load score (ranking)**	1.0	2.2	3.3	3.5
Controllability score (ranking)**	1.0	2.2	3.7	3.2
Distortion score (ranking)**	1.0	2.4	3.3	3.4
Observed sows with locomotion disorders***	20.0	26.7	11.1	38.1
Economic aspects				
Investment room for 170 pregnant sows (Dfl/sow)****	1,535	1,976	1,503	1,601
Economic evaluation (Dfl/sow/year compared with stalls)		-30.51	+47.83	+5.81

* The average number of present sows includes lactating sows. A sow is defined as a sow from the first insemination on the farm until the (registrated) departure from the farm

** 1 = favourable; 4 = unfavourable

*** % of all sows with locomotion disorders

**** 1 USD = 1.70 Dfl.

a,b,c,d Data in a row with a different superscript differ significantly ($p < 0.05$)

percentages of non-returns did not differ significantly. The live-born pigs from group housed sows with an electronic feeder station had the lowest average weight at birth. However, the piglet weight at weaning was highest in the electronic sow feeding system and in the trickle feeding system. Overall productivity level was satisfactory in all four housing systems: over 22 weaned piglets per sow per year.

Feed and water usage

The mean feed intake of young sows (first pregnancy) was higher in the free access stall and trickle feeding system than in the individual stall and electronic sow feeding system. All sows were restrictively fed with the same feeding scheme. However, in free access stalls and trickle feeding systems sows were not fed individually but as a group. Therefore, young sows and multiparous sows were fed on the same feeding scheme.
At the end of pregnancy, the weight of the young sows was highest in the free access stalls. But in the trickle feeding system, where the young sows were on the same feeding scheme, sows weighed less compared to sows in free access stalls.
Backfat thickness of multiparous sows in group housing was higher than of sows in the individual stalls. The high backfat thickness of sows in the ESF system is not related to realised room temperatures or levels of feed intake. In the ESF system, sows were fed consequential with a frequency of once a day (or more often depending on the individual feed intake pattern). To which extent the feeding regime plays a role can not be determined from this research.
The level of water usage was lowest in the ESF and trickle feeding systems. Despite limited water supply, the water usage of sows was highest in stalls. Since January 1996, the drinking time via the through nipple in free access stalls was reduced from 2 x 60 minutes per day to 2 x 20 minutes per day, the same time period as in the trickle feeder system. After the change, the daily water intake per sow in the three group housing systems varied from 8.4 to 8.7 litre. This is 1.5 - 1.8 litre water per sow per day less than the water usage of individual housed sows.

Controllability

Total controllability and the overview on feed intake and health were perceived by the animal care takers as best in the stall system, except for the control of hoof lesions. The latter was perceived as best in the free access stall system.
During intensive control by the researcher, the highest percentage of cripple sows were observed in the electronic sow feeding system and the trickle feeding system. During the routinely daily control by the care taker, the largest fraction of these cripple sows was registrated to be cripple in the trickle feeding system and the lowest fraction in the electronic sow feeding system. In the trickle feeding system, the stall system and the free access stall system, all sows are aroused during feeding. This makes observation of cripple animals easier. Furthermore, sows have more freedom to move in group housing systems, which makes it easier to observe them from different sides. However, other health parameters are more difficult to relate to individual sows in group housing systems.

Labour and labour conditions

Working time in the ESF system was shorter than in the three other systems. Expressed in total working time, this difference accounted for only 3%, because working times in rooms for dry sows contribute to less than 10% of total working time on sow farms.
Measured noise exposure levels in the four housing systems differed hardly, but were too high. Ear protective devices are recommended in all four systems. Concentrations of respirable dust in the trickle feeding system, and especially in the ESF system, were higher than in the stall system and the free access stall system. Subjective evaluation by the animal care takers of both the physical and mental work load was ranked from more to less favourable for the stall system, the free access stall system, and finally both the trickle feeding system and the electronic sow feeding system. Group housing requires ▶

changes in work methods and routines. A condition therefore is that the sow farmer is able to make this change.

I nvestment

For both small and large farms, (annual) investment costs are highest for the free access stall system. Investments for the trickle feeding system are somewhat higher than for the stall system, but the annual costs are lower. This is due to the relative small fraction of equipment in total investment for the trickle feeding system. With increasing farm size, annual investment costs decrease. This procentual decrease is highest for the ESF system due to the decrease in the required floor space per sow. For the three other systems, the decrease in investment cost is similar with increasing farm size.

Economie evaluation

In the economic evaluation of the four housing systems, the following aspects were quantified: feed usage, water usage and associated manure disposal costs, energy usage, interval weaning-insemination, required labour, and required investment. The economic performance of the electronic sow feeding system and the trickle feeding system were respectively 47.83 and 5.81 Dutch guilders per sow per year higher than in the stall system. In contrast, the annual economic performance per sow in the free access stall system was 30.51 Dutch guilders lower than in the stall system.

The economic evaluation did not cover all aspects. For example the investment costs to meet Dutch environmental standards for ammonia emission and the impact of the different housing systems on the marketing perspectives of meat could not be quantified. The number of weaned piglets per litter was not taken into account in the economic evaluation because the trait was not significantly different among the four housing systems. Lastly, the replacement rate of the sows was not analysed because the trait could not be assessed within the experimental period.

Conclusion

The technical performance of group housed dry sows was similar to individual housed sows. Stereotypic behaviour was more frequent in the trickle feeding system and in the stall system. The percentage of sows with locomotion disorders was higher in the trickle feeding system and in the electronic sow feeding system. Labour requirements were similar among the housing systems, but both the physical and mental work load in group housing systems were perceived as more strenuous than in the individual housing system. Except the free access stalls, group housing systems were favoured over the individual housing system in the economic evaluation. In conclusion, group housing of non-lactating sows is feasible in practice, but will require more of the management of the farmer, compared to individual housing. ■

Report PI. 171

A RAISED SOFT FARROWING MAT DURING LACTATION

ing. G.P. Binnendijk, ir. H.M. Vermeer

The effect which a raised, soft farrowing mat in the farrowing pen had on the technical results and health of sows and piglets was examined in 108 litters. A raised area beneath the sow can improve the accessability of the udder for the piglets, resulting in an improved weight gain. The soft back part of the mat provides the sow with more grip for the hind legs and can lead to fewer piglets being crushed.

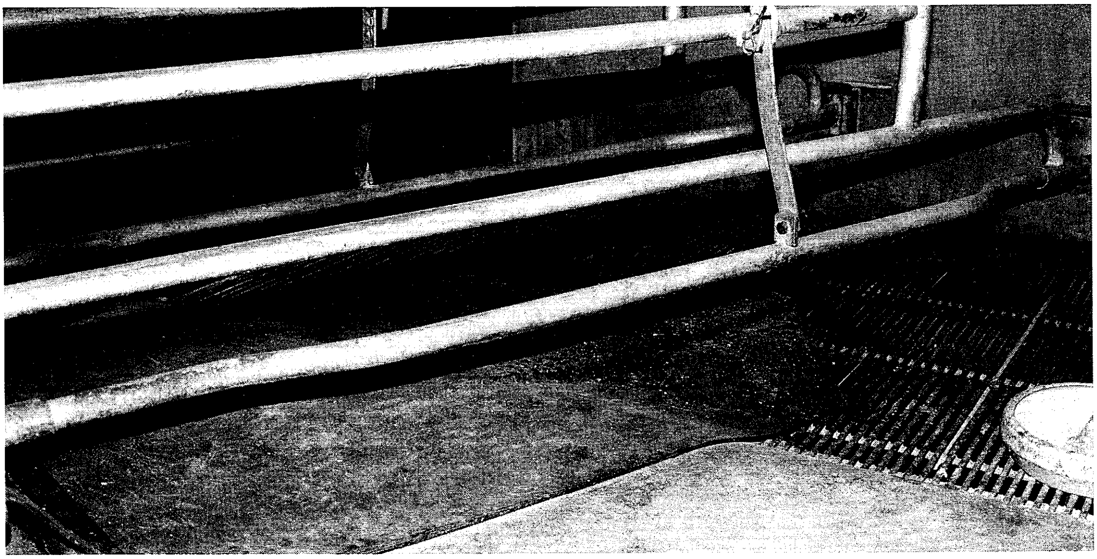
The experiment was carried out in two farrowing rooms, each containing six pens. The sows and litters were housed on a partly slatted tribar floor with a diagonally placed farrowing crate. A raised, soft farrowing mat (Productive Comfort) was installed in half of the pens, combined with a piglet mat. Results were collected from 52 farrowing mat litters and 56 control litters.

There was no difference in the daily weight gain of the piglets in the control and the farrowing mat treatment (respectively 220 and 219 g/d, ns). Mortality of liveborn piglets was higher in the control treatment than in the farrowing mat treatment, mainly caused by a reduction in crushing (mortality respectively 12.4 and 8.0%, $P < 0.05$; crushing 5.0 and 2.4%, $P < 0.05$). Less injuries were caused to the udders and teats of the sows in the farrowing mat group than the control group. There was no difference in the number of piglets with injuries to the front legs, although more piglets had joint infections in the control treatment than in the farrowing mat treatment.

In conclusion the mat on a metal tribar floor has benefits which are seen as a higher survival rate of the piglets caused by less crushing and less injuries to the udder of the sow and less joint infections in the piglets.

The farrowing mat should be attached to the floor in such a way that dirt and moisture cannot accumulate on or under the mat. The durability of the mat could not be assessed because of the short length of the experiment. ■

Report Pl. 190



The raised soft farrowing mat Productive Comfort from Pemarsa S.A.; the front part has a solid coating, while the soft and raised back part supports udder and hind legs

STRATEGIES FOR STOCKING WEANED PIGLETS AND FATTENING PIGS

ing. D. J. P.H. van cie Loo, ing. A. I. J. Hoofs, dr. ir. J. W. G. M. Swinkels

In the Dutch pig industry, pigs are stocked and mixed several times. The litters are mixed particularly when the pigs are moved to the fattening barn. This study at the Experiment Farm for Pig Husbandry "South- and West-Netherlands" at Sterksel dealt with several ways to group pigs. With the weaned piglets a comparison was made between keeping the litter together after weaning and mixing the piglets and putting groups of piglets with a small weight difference together in one pen. With the fattening pigs a comparison was conducted between four strategies where in all cases the groups were mixed. The pigs were grouped based on weight and/or age. The purpose of both studies was to see what effect these strategies had on technical and economic performance and health.

Weaned piglets

There were two treatments:

1 The litters were kept together after weaning and moving from the farrowing unit into the nursery.
2 The piglets were mixed and grouped based on body weight by replacing them in the nursery. The difference in weight within one pen was kept as small as possible.

The growth and feed-intake of the pigs which were kept together as a litter was the highest. The feed-conversion and health were the same for both groups. The profit gained from keeping litters together after weaning was Dfl 1.51 per piglet more than mixing the litters up and grouping them according to weight.

Fattening pigs

There were four treatments:

1 A small difference in body weight (≤ 4½ kg) and a small difference in age (≤ 7 days) between pigs in one pen.
2 A large difference in body weight (≥ 9 kg) and a small difference in age (≤ 7 days) between pigs in one pen.
3 A small difference in body weight (≤ 4½ kg) and a large difference in age (≥ 14 days) between pigs in one pen.
4 A large difference in body weight (≥ 9 kg) and a large difference in age (≥ 14 days) between pigs in one pen.

There was no interaction between a difference in age or weight. Pigs which were kept in a pen with a small difference in weight had a higher growth, a better feed- and energy-conversion and a lower number of veterinary treatments than pigs kept in a pen with a large difference in weight. With a small difference in age the piglets grew more and had a higher feed-intake than piglets in pens with a large difference in age. The lean meat percentage and other slaughter qualifications were the same for all treatments. The profit gained from a small difference in weight was DFL 3.96 per finishing pig compared to a large difference in weight between pigs in one pen. The profit gained from a large difference in age was very small (DFL 0.12) per finishing pig, compared to a large difference in age.

In conclusion:

- It is better to keep litters together after weaning for technical results and for economic reasons.
- When litters have to be mixed by moving them to the fattening pig barn, they can best be grouped based on a small difference in weight between pigs in one pen. In comparison to grouping them on the basis of a difference in weight, the profit gained from grouping them by age is negligible. ■

Report Pl. 193

WELFARE OF PIGS: FROM MANAGEMENT REGULATIONS TOWARDS MANAGEMENT MEASURES

ir. H.M. Vermeer, dr. ir. E.D. Ekkel[1], ing. J.S. M. de Groot[2], dr. ir. C. E. van 't Kloosters, ir. G.F.V. van der Peet[4], dr. ir. J. W.G. M. Swinkels

In 1991, the European Union published regulations on housing and management requirements to protect the welfare of pigs. The Dutch Welfare Regulations for Pigs of 1994 were drawn up to implement the European regulations with more detail being paid to some of the housing and management requirements. In contrast to the housing regulations, management regulations are mainly concerned with the day to day relationship between farm workers and livestock animals. Therefore, the aims of a management regulation need to be translated into one or more management measures that can be implemented at a farm-level. The objective of this study was to make an inventory of management measures that can be used for implementing the management regulations, described in the Dutch and European welfare regulations, on pig farms. A further objective was to clarify whether available and new management measures ▶

Table 1: Number of closed herds (from a total of 32) complying with the management regulations. The management regulations of the Dutch and European welfare regulations are divided into three groups: "already implemented", "need advice" and "need research".

	number of herds complying with the regulations (total 32)
Already implemented	
Daily inspection	32 (100%)
Castration before four weeks of age	32 (100%)
Weaning after three weeks of age	30 (94%)
Need to be adressed in advice	
Light (> 12 lux, 9.00 - 17.00 h)	24 (75%)
Isolation of criminals, victims and sick animals	25 (78%)
Stable groups soon after weaning	24 (75%)
Bedding materials for sucking piglets	24 (75%)
Teeth clipping not as a routine	17 (53%)
Need to be adressed in research	
Distraction material for piglets and finishers	10 (31%)
Tail docking not as a routine	(0%)
Roughage for dry sows	4 (13%)
Nesting material for farrowing sows	0 (0%)

[1] DLO Institute for Animal Science and Health
[2] Agricultural Extension Service
[3] DLO Institute of Agricultural and Environmental Engineering
[4] National Reference Centre Agriculture

need to be propagated and developed, respectively, in practice.
An inventory of all available management measures that can be used at a farm-level was made for each management regulation in the Dutch and European welfare regulations (table 1). The suitability of these measures was assessed by the authors, the Animal Protection Movement and a group of 32 pig farmers. The authors determined the suitability of the measures based on the criteria animal welfare, health, performance, labour demand, labour conditions, economics and environmental aspects. The Animal Protection Movement was asked to determine whether the management measure was in accordance with the aim of the associated management regulation. The opinion of the pig farmers with regard to the suitability of the management measures was determined by means of an inquiry. In the inquiry, each farmer was asked whether he or she was committed to implementing the management measures on the farm.

In table 1 the management regulations are divided into three groups: "already implemented", "need advice" and "need research". The inquiry among the farmers showed that some of the management measures are common in practice and that some of the management measures need to be propagated in practice. In contrast to the "already implemented" measures, the "need advice" measures need to be addressed in special advisory programmes and supported by applied research. All of these measures were considered suitable in practice by both the authors and the Animal Protection Movement.
The assessment by the authors and the farmers demonstrated that available management measures are inadequate to implement the "need research" management regulations on the farm. This conclusion has been accepted by the Animal Protection Movement, but they have clearly stated that suitable management measures have to be developed for each of these regulations.
According to the authors and the Animal Protection Movement, the highest priority should be given to the development of suitable distraction materials for piglets and pigs and their relation to tail biting, and the feeding of roughage to dry sows. This research should be performed in close cooperation with advisors and pig farmers.
Providing nesting material in the farrowing unit requires a total redesign of the commonly used pens. This management measure can be implemented during the development of loose housing for lactating sows.

It can be concluded that appropiate management measures are available for most of the management regulations. However, the application of some of these measures needs to be propagated in practice. This can be achieved by starting advisory programmes and stimulating the exchange of information among farmers. Furthermore, applied research results may be carried out in support of the advisory programme.
New measures need to be developed for a limited number of management regulations. The implementation of distraction material, tail biting and roughage for dry sows should be given the highest priority, because these aspects can easily be implemented in the present environmentally friendly housing systems. A new and innovative pen design will have to be constructed for the implementation of nesting material in the farrowing pen. It is recommended that the development of the new measures is carried out in close cooperation between research institutes, advisory agencies and farmers. ■

Report Pl. 173

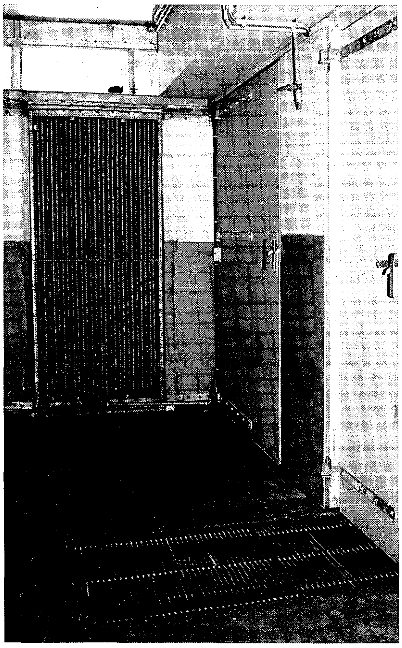
COMPARISON BETWEEN UNDERGROUND AIRTUBES AND GROUNDWATER EXCHANGER FOR FINISHING PIGS

ing. J. J.H. Huijben, ing. A.I.J. Hoofs

In this study underground airtubes were compared with a groundwater exchanger in order to determine the effect of cooling and heating the ventilation air and to estimate the energy consumption in houses for finishing pigs. An economic analysis of the difference in investments- and annual costs in both systems was also made.

The research was carried out in two identical compartments for finishing pigs on the Experiment Farm for Pig Husbandry "South- and West-Netherlands" at Sterksel between June 1994 and September 1995.

In one compartment the air inlet was comprised of underground airtubes, in the other compartment it was a groundwater exchanger. In both compartments the air inlet was an air channel under the central path covered with metal tri-bar slats.



Groundwater exchanger placed in the doorway with air inlet channel to the compartment

It was possible to measure the cooling down and heating up of the inlet air in both systems, especially at extremely hot or cold temperatures outside. The air could be cooled by 4 to 8°C on a hot summer day. On a cold winter day the air could be heated by 4 to 10°C. Both systems stabilise the climate inside. Both differences between the seasons as between day and night are strongly reduced. The heat exchange occurring with the groundwater exchanger was a little higher than that using the airtubes. This could have been because the maximum capacity of the groundwater exchanger used was higher than necessary for the number of pigs in the compartment.

The thermic climate in the compartment with airtubes was more stable than that in the compartment with the groundwater exchanger.

Air inlet by airtubes or by a groundwater exchanger did not lead to a difference in pen dirtiness with respect to manure and urine.

The total energy costs for ventilation and heating in the compartment with airtubes were Dfl.10.58. In the compartment with groundwater exchanger they were Dfl. 11.60 per pig place per year. The energy costs per finishing pig place per year of only the pump of the groundwater exchanger were Dfl. 0.56.

The extra investment costs per pig place when airtubes are used were Dfl. 160.-. When the groundwater exchanger was used they were Dfl. 136.-. Because the airtubes must be renewed every 20 years and the groundwater heat exchanger every 10 years, the annual costs per pig place for the system with airtubes are Dfl. 5.25 lower than for the system with the groundwater exchanger.

The total energy costs and extra annual costs in a heat exchanging system, are Dfl. 6.83 per pig place lower for the system with airtubes than for the system with the groundwater exchanger. ■

Report Pl. 180

EFFECTS OF AN ADDITIONAL IRON INJECTION ON THE GROWTH AND HUMORAL IMMUNITY OF WEANING PIGS

ir. E.M.A. M. Bruininx, K. Jetten[1], dr. ir. J. W. Schrama[2], dr. ir. H. K. Parmentier[2], dr. ir. J. W.G. M. Swinkels

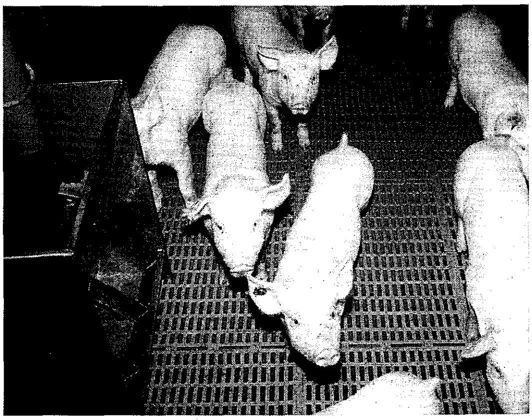
In a 5-week study, 120 4-week old crossbred weaning pigs were used to examine the effects of an additional Fe-injection and immunization moment on the growth and humoral immune response. Pigs were allotted to one of eight treatments based on bodyweight and litter origin. Factors included:

1 single injection (day 3 after birth) versus double injection (day 3 and day 21 after birth) of 200 mg Fe;
2 antigen challenge (KLH and OA versus placebo);
3 immunization moment (d -1 versus d 1 after weaning).

All pigs had free access to prestarter diets supplemented with 80 mg per kg Fe as $FeSO_4$. Pigs were housed in a room consisting of 12 pens (10 pigs per pen). During the experiment, blood Hb-levels and body weight were determined weekly and total lg, IgG and IgM titers to KLH and OA twice a week. At day 6 after weaning, the blood Hb-levels of double injected pigs were higher ($P < 0.01$) than that of those that had received a single Fe-injection. Prior to day 6 and thereafter, blood Hb-levels were similar for both single and double injected groups. Throughout the experiment, the additional Fe-injection had no effect ($P > 0.1$) on the growth and immune response. Neither was growth affected ($P > 0.1$) by an antigen challenge or immunization moment. The overall mean total lg response to KLH and OA was not affected by an additional Fe-injection nor by the immunization moment ($P > 0.1$). However, an interaction ($P < 0.05$) was observed between the immunization moment and the kinetics of the response of the total lg to KLH and OA. In general the results suggested that the response of the piglets which were immunized one day after weaning was slower than that of the piglets which were immunized one day before weaning. Furthermore it became clear that the kinetics of a humoral immune response are affected by genotype.

In conclusion, an additional injection of Fe one week prior to weaning does not affect body growth, and does not enhance or suppress the humoral immunity to a T-cell dependent antigen. Furthermore, the suppressing effect of weaning on humoral immunity was not affected by additional Fe. However this suppressing effect suggests that a combination of exposure to a stressor (such as weaning) and challenging the immune system with an antigen (vaccination) should be avoided. Further research on the relationship between genotype and immunity is desirable. ■

Report Pl. 182

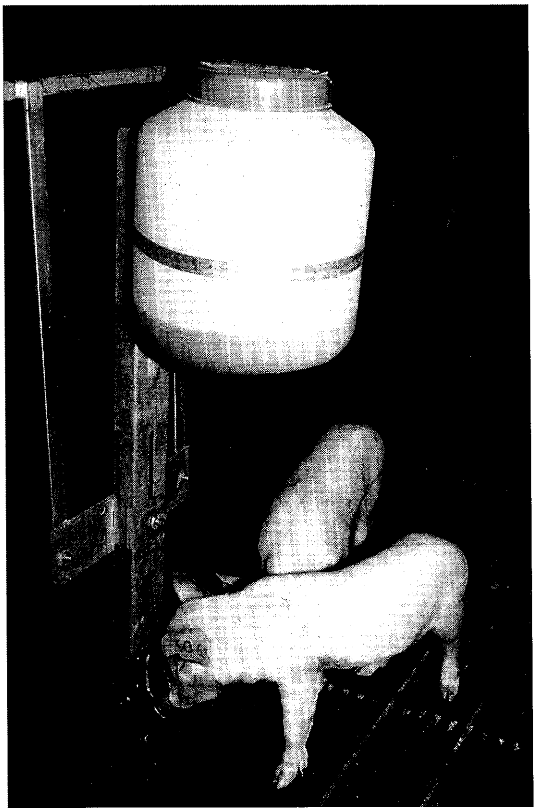


[1] Student, Wageningen Agricultural University
[2] Wageningen, Institute of Animal Science (WIAS)

SUPPLYING A CHELATED IRON VIA DRINKING WATER TO SUCKLING PIGLETS

ir. E.M.A. M. Bruininx, dr.ir. J. W. G. M. Swinkels, ing. G.P. Binnendijk, ing. E. J.A. J. Broekman, A. van der Straaten, ir. C.M. C. van der Peet-Schwering

In 1993, research was started to examine the possibility of supplying a synthetic chelated iron via drinking water to sucking piglets as an alternative for the subcutaneous injection with iron-dextran. The research was conducted at the Research Institute for Pig Husbandry. Alternatives for the iron injection are of interest, because it contributes to the animal welfare of piglets and reduces the number of routinely administered veterinary treatments on pigfarms. In the study, blood hemoglobin concentrations were used as indicator for iron status.



A chelated iron via drinking water

The study consisted of three experiments using 120 litters of crossbred pigs. In experiment I, a 2 x 2 factorial approach was used. In 6 rounds, 24 litters were administered either an iron injection on day 3 or given free access to a synthetic chelated iron A via drinking water (1 g iron per liter) throughout the 4-week lactation period. Furthermore, the pigs were given no or free access to a creep feed starting on day 10 of the lactation period.

The results of experiment I showed that the synthetic chelated iron A was well solvable in drinking water and that it can be used as an iron-source for suckling piglets. Additionally, it was found that creep feed stimulated water intake of the piglets. However, the intake of the synthetic chelated iron A via drinking water was too low to maintain an iron-status similar to that of piglets injected with iron-dextran. The piglets that were given free access to the synthetic chelated iron A via drinking water tended to grow slower over the entire suckling period than those that received an iron-dextran injection.

In a follow-up of experiment I, experiment II and III were conducted. Each experiment consisted of 12 rounds or 48 litters (4 litters per round). In these experiments, the effectiveness of adding sweeteners to the synthetic chelated iron A via drinking water was examined. Moreover, the concentration of the synthetic chelate A was doubled in the first two weeks of the experiment (2 g iron per liter). During week 3 and 4, the normal concentration (1 g iron per liter) was maintained. Furthermore, a synthetic chelated iron B (1.82 g iron per liter in week 1 and 2, and 0.91 g iron per liter in week 3 and 4) was tested. All piglets were given free access to creep feed starting on day 10 after farrowing.
The results of experiment II showed that ▶

adding sweeteners (Talin or vanilla) to the chelated iron A in water solution did not improve the water intake of the piglets. On day 13, the iron-status of the piglets that had received an iron injection tended to be higher than that of piglets that were given either a pure or sweetened chelated iron A via drinking water. On the day of weaning, the iron status was similar for all treatments. However, mortality was highest within the three groups of piglets that were given chelated iron A via drinking water. In contrast to experiment I, growth of the piglets was similar among the four treatment groups.
The results of experiment III showed that piglets were not able to maintain the iron-status when doubling the concentration of chelated iron A (with or without apple sweetener) or of chelated iron B via drinking water during the first two weeks of the suckling period. Like in experiment II, the mortality among piglets that received chelated iron A or B in water solutions was higher than that of the piglets that had received an iron injection. An exception was the mortality rate among the piglets that where given an iron chelated solution A flavoured with apple sweetener. Growth of piglets was similar for all treatments.
In all three experiments, mean blood hemoglobin concentrations were all above the minimum (5 mMol or 8 g/dL) below which piglets are considered anemic.

In conclusion, synthetic chelated iron in drinking water provides biological available iron to suckling piglets, thereby preventing blood anemia. However, the intake of chelated iron A or B solutions by suckling piglets was too low to maintain an iron-status similar to that of piglets that were injected with an iron-dextran solution. Of the performance, only the mortality rate was higher in piglets that were given chelated iron A or B in drinking water. ■

Report PI. 196

PREDICTION AND ASSESSMENT OF ULTIMATE MEAT QUALITY FOR GROUPS OF SLAUGHTER PIGS

ir. J. B. van der Fels, ing. J.H. Huiskes, dr. ir. E. Kanis[1], dr. ir. P. Walstra[2], ing. B. Hulsegge[2]

The ultimate pH (pH measured at 24 hours *post mortem* (p.m.)), capacity to bind water and colour are important meat quality properties for processing and marketing pig meat. In order to control meat quality it is important to gain a clear understanding of the factors influencing these quality properties at different stages of the production process. From earlier studies it is known that the ability to predict ultimate meat quality of individual carcasses on the slaughter line (45 minutes p.m.) is limited. This study was conducted in order to examine the possibilities of predicting and assessing ultimate meat quality of groups of slaughter pigs by using meat quality properties on the slaughter line. The following research problem was defined:

- To what extent can the meat quality (24 hours p.m.) of groups of slaughter pigs be predicted and assessed by light reflection measurement (HGP-pse) and/or pH measurement on the slaughter line (45 minutes p.m.)?

The meat quality properties of 1,378 slaughter pigs, divided into 96 groups and 6 days of slaughter, were measured at 4.5 minutes p.m. and 24 hours p.m. Feed withdrawal before slaughter (16 hours versus 0 hours) and a resting period before slaughter (2 hours versus 0 hours) were used in order to create variation in meat quality between groups of slaughter pigs. Feed withdrawal only took place for slaughter pigs from the Research Institute of Pig Husbandry at Rosmalen. The other 72 groups of slaughter pigs came from external farms. Creating contrasts by resting before slaughter took place in all the 96 groups of slaughter pigs.

Meat quality properties measured at the slaughter line (45 minutes p.m.) were light reflection of the *musculus longissimus thoracis* (LT) and pH of the *musculus longissimus lumborum* (LL). Meat quality properties measured after 24 hours p.m. at the LL were: filter paper wetness score; pH; Minolta L*, a* and b* colour values; FOP and Japanese colour standard score. In order to examine possible differences between muscles, the pH of the *adductor femoris* (AF) and the *musculus semimembranosus* (SM) was also measured. To compare the relationship between meat quality properties at 45 minutes p.m. and 24 hours p.m. analysis took place on the individual slaughter pig level as well as on the group of slaughter pigs level. The analysis concerned Principal Component Analysis (PCA) and quality groups. These quality groups were based on ultimate pH and a combination of filter paper wetness score with Minolta L*. This combination resulted in PSE-DFD quality groups.

The most important results and conclusions are:

- In groups of slaughter pigs, the correlations between meat quality properties at 45 minutes p.m and 24 hours p.m. were much stronger then those for individual slaughter pigs. From the meat quality properties at 45 minutes p.m., pH showed the highest correlations with the meat quality properties at 24 hours p.m.
- Compared to LL and SM, AF showed on average a higher final pH and more dispersion.
- For research purposes it was appropriate to use Principal Component Analysis to ▶

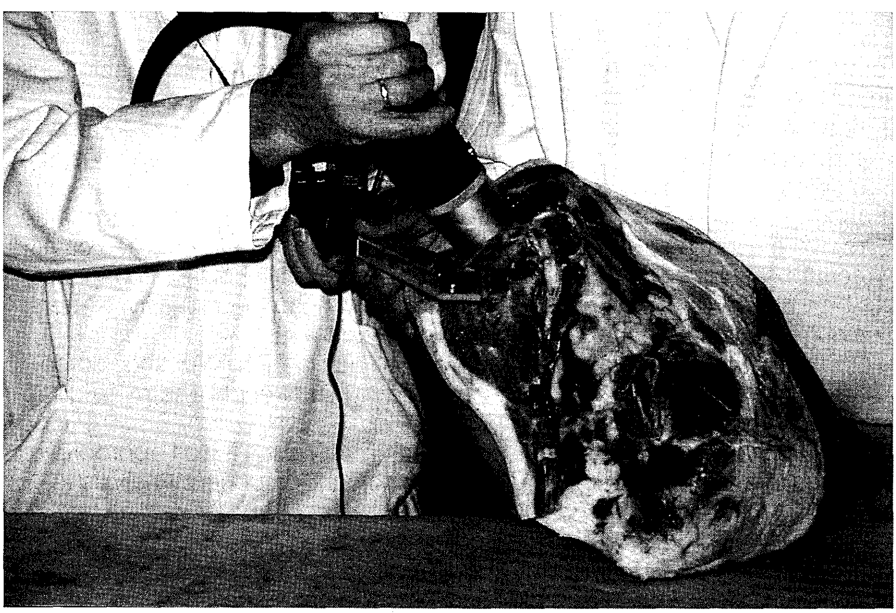
[1] Wageningen Agricultural University, Department of Animal Breeding and Genetics
[2] DLO Institute for Animal Science and Health, Lelystad

combine different meat quality properties at 24 hours p.m. into one factor. The highest proportion of variance in final meat quality was explained by factor 1 (PI). PI is indicative of PSE and DFD meat because of its strong correlations with colour, ultimate pH and water binding.

- Besides ultimate pH and filter paper wetness score, the L* -value is indicative of meat quality. For groups of slaughter pigs as well as individual slaughter pigs, high correlations were found between these quality properties and P1.
- Of the meat quality properties at 45 minutes p.m. only pH could be used to explain the variance in final meat quality. This was true for both groups of slaughter pigs and individual slaughter pigs.
- For groups of slaughter pigs the proportion explained variance in ultimate meat quality was higher then the proportion explained for individual slaughter pigs. The origin of the slaughter pigs, (part of the) day of slaughter and the resting period before slaughter were found important in explaining the variance in final meat quality.
- Ultimate meat quality of individual slaughter pigs and groups of slaughter pigs cannot be predicted satisfactory by HGP-pse and pH at the slaughter line. Abnormal (groups of) carcasses with respect to the ultimate pH, colour and water binding, cannot be found by HGP-pse and pH measurements at the slaughter line. A reliable assessment based on these meat quality properties at 45 minutes p.m. is considered not to be possible.

Prediction and assessment of meat quality based on light reflection (HGP-pse) and pH at the slaughter line are considered to be unrealistic. Abnormal meat quality cannot be signaled satisfactorily by these meat quality properties at 45 minutes p.m. In order to select and evaluate meat quality it seems more important to apply ultimate meat quality properties. Subsequently these measurements can be linked to information about the herd of origin, transport and the conditions at slaughter. Earlier studies and the present study emphasize the importance of the ultimate pH and L* -value. Research about the implementation of these aspects as part of quality control is desirable. ■

Report Pl. 181



Measurement of meat quality on the slaughter line

PRACTICAL VALUE OF EAR TAGSFOR IDENTIFICATION& REGISTRATION OF PIGS

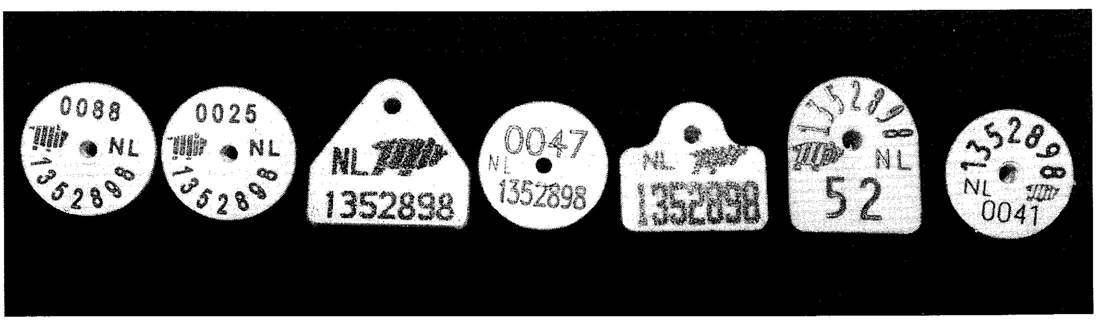
ir. E. R. ter Elst- Wahle, ing. P.F.M. M. Roelofs, ing. J. H.A. N. Adams

The Dutch Identification and Registration System (I&R) has been developed to control pig transportation in the Netherlands. This is mainly important when the health state of the animals is an issue. The I&R system is based on farm numbers, which are printed on ear tags. Every sow, pig or piglet in the Netherlands must be tagged, and farmers can only order ear tags with their own, unique farm number. Furthermore, there is a national institution that registers all pig transportations. Within 24 hours of each transportation farmers have to pass on the departures and arrivals of pigs by computerized phone (voice response).

When the study was started, farmers could choose out of seven types of ear tags that were accepted as I&R identification. To make a considered choice, they needed more information about the practica1 value of these ear tags. With financial support from the Produktschap Vee en Vlees (Meat Marketing Board) and with the cooperation of five commercial farmers the seven accepted ear tags were tested in 1996 and 1997. The seven types of tested ear tags are: Caisley, Herberholz, Hut with plastic pin, Hut with metal pin, Merko, Splitthoff and SWM.

On every commercial sow farm in this study, at least 120 samples of all seven types of ear tags were used by the same person. At least 50% were used before 4 weeks of age (castration or weaning) and the rest at about 10 weeks of age (from nursery to finishing barn). In total, between 460 and 518 samples of each type of ear tag have been tested. Data collection considered labour time for tagging, the number of ears damaged, the number of losses during the nursery and growing/finishing period and the costs. Finally the farmers opinion about the "quality" of the tags, their packing, the tagger and general remarks were noted.

The labour time needed for tagging was determined by time studies. Tagging piglets at 2 - 4 weeks is much easier and a little faster than tagging at 10 weeks of age. The difference is 38 seconds for 100 piglets ($p < 0.05$). Farmers need between 20'54" (20 minutes and 54 seconds, Merko) and 22'52" (Caisley) to tag 100 2 - 4 weeks old piglets. The difference (2'15") between Merko en Caisley is significant ($p < 0.01$), but of minor importance. On a farm with 210 sows the annual difference is less than two hours. Labour use for tagging 10 week old ▶

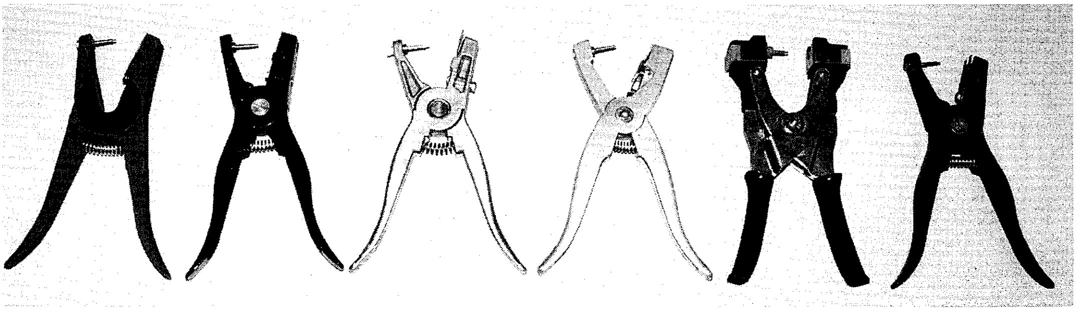


The seven I&R-ear tags. From the left to the right: Hut with metal pin, Hut with plastic pin, Herberholz, SWM, Splitthoff, Caisley and Merko

piglets differs ($p < 0.05$) between 20'10" (Merko) and 24'50" (Caisley).
Ear damage was recorded one, two and three weeks after tagging. One week after tagging, five pigs out of 1,281 had a visibly infected ear. A swollen ear around the tag hole was noticed in 5% of the pigs. After two weeks, swollen ears were registered in 3% and after three weeks in 1% of the pigs.
After one and two weeks, more pigs with a Herberholz or a Splitthoff ear tag than with other types of ear tags had a swollen ear ($p < 0.05$). However, it was noticed that swellings in ears with a Herberholz or a Splitthoff tag were easier to detect than swellings in ears using the other tags. The pins of these two ear tags are closer to the side of the tags than the pins of the other tags in which the pin is in the middle of the tag.
During nursery (8 - 25 kg) 0.15% of the ear tags were lost, during growing/finishing (25 - 110 kg) 0.68%. At this low level no significant differences between the types of ear tags could be found. There were differences between farms and even between pens within the same farm. Twelve out of 15 pigs that lost the tag were in two pens!
Farmers prefered round tags. As an option, they could order tags with a serial number, additional to the unique farm number. Since Januari 1st 1997 only tags with a serial number can be ordered. The only farmer that did so during the study judged that the serial numbers on the Caisley tags are easiest to read. In general the farmers prefered loose packing of the tags, with separate boxes or bags for the different parts of the tags. When serial numbers were used, the sequence of the numbered tags had to be logical. In that case it is better when the tags are fixed on a strip of paper or plastic. Farmers had different opinions about the quality of the taggers, but Splitthoff scored worst. This tagger required the most strength and one farmer said that it was too difficult to put the tags into the tagger.
The price of the ear tags depends on the order size, and therefore on the farm size. For each farm size, Merko is the cheapest type and Hut with metal pin the most expensive one. The annual difference for a farm with 210 sows is Dfl 464.- and for a farm with 500 sows it is Dfl 1,084.-.

In general the differences between the practical values of the seven accepted ear tags for I&R identification are so small that farmers prefer the cheapest type (Merko). If they use serial numbers on the tags they sometimes prefer Caisley ear tags. However, aspects such as delivery period and service are not included in this study. ■

Report Pi. 183



The taggers. From the left to the right: Hut, Herberholz, SWM, Splitthoff, Caisley and Merko

EFFECTS OF TWO SIRE LINES ON GROWTH PERFORMANCE, CARCASS- AND MEAT QUALITY

ing. J.H. Huiskes, ing. G.P. Binnendijk, ing. A. I. J. Hoofs, ing. H. Theissen

An important question pertaining to quality control and pork production is the effect of genotype on carcass and meat quality. Different sire lines can result in a different carcass and meat quality. A Great Yorkshire purebred sire line boar (GY-s) has been compared with the crossbred sire line boar DuGY-s (Du = Duroc) for the production of 3- or 4-breed crossbred slaughter pigs by F1 sows of the combination Great Yorkshire sow line x Dutch Landrace (YN). The single cross DuGY-s boar, later called “Krusta”, was developed from the Great Yorkshire sire line (GY-s) and Duroc sire line (Du) by Stamboek. All mentioned lines are Stamboek pigs. The aim was to create more heterosis, better vitality, a higher potential for growth, a better meat quality for commercial slaughter pigs and more libido for boars via a crossbred boar.

The objective of this experiment was to investigate differences in performance and carcass and meat quality between slaughter pig offspring from the sire lines Krusta and GY-s at ad libitum feeding conditions.

The experiment was carried out at the Experiment Farm for Pig Husbandry “South- and West-Netherlands” at Sterksel.
In total, 458 YN sows farrowed to supply piglets for this experiment. The experiment was mainly concentrated on the growing-finishing phase. Only birth weight, growth rate during the suckling period and mortality during the suckling and rearing periods are discussed for the piglet phase. The experiment comprised of 14 rounds with in total 768 slaughter pigs. Equal numbers of gilts and barrows of GY-s x YN and DuGY-s x YN were tested during growing-finishing from between 23 kg and 112 kg body weight.
The majority of the pigs (512 in total) were housed by gender and fed ad lib at a feed-hopper supplied with a drinker. The remaining 256 barrows and gilts were housed in mixed pens and fed liquid feed at a semi-ad lib schedule twice a day. Commercial starter feed (12.7 MJ ME per kg) was used during the first four weeks and, after a week of change, growing-finishing feed was subsequently given (13.1 MJ ME per kg).

Growth performance of progeny from Krusta boars was good and comparable with that of GY-s boars. There were also no clear differences in uniformity between the start and finishing weights and number of growing days, except that the age of the Krusta offspring varied somewhat at the start.
The carcass quality of the Krusta offspring was worse with a lower HGP meat percentage, a lower conformation score, thicker backfat and a comparable muscle thickness. There were no clear differences in the uniformity of the carcass parameters. The differences in carcass quality mainly resulted in a lower gross margin of well over Dfl 4.- per delivered pig and Dfl 14.- per pig per year. The cutting out yield of the Krusta offspring was better than expected from their carcass grading result.
By using Duroc in a sire line, a high content of intra-muscular fat (IMF) may be obtained. A positive difference in IMF when compared with GY-s offspring was, unlike the literature, not found in this experiment. In the experiments of Stamboek research farm there was a slight difference.
The other meat quality parameters pH, water holding capacity and colour did not differ between the Krusta and GY-s offspring.
During the piglet phase no significantly better results were found for birth weight, weaning weight and grow-th rate in the suckling period for the Krusta x YN piglets compared with the GY-s x YN piglets. This was also the case for the mortality during suckling and rearing. However, the numbers of veterinary treated pigs led to the impression that Krusta x YN pigs are somewhat stronger than GY-s x YN pigs. ■

Report Pl. 189

COMPARISON OF THE COST PRICE OF PORK IN SOME SELECTED EU MEMBERSHIP COUNTRIES (EUROPORC)

ir. M.A. H. Vaessen, dr. ir. G.B. C. Backus

Recently the European pig industry has increased in size particularly in Denmark, France (Brittany), Belgium and Spain (Catalonie). In the Netherlands the pig industry developed strongly between 1970 and 1990. Denmark and the Netherlands have the highest self-sufficiency rate in the European Union. The development of the self-sufficiency rate was clearly stronger in Denmark than in the Netherlands in 1995. Since 1994, France has a self-suff iciency rate of over 100 percent and has become a netto exporting country instead of a netto importing country. In some areas of the European Union the development of the pig industry is stronger than in other areas.

The aim of this research was to develop a calculation model, EuroporC, based on representative data from selected EU-membership countries using uniform data definitions and calculation rules to calculate the average cost price per kg carcass and to analyse the differences between countries. The development of the average cost price level of farms with pigs in the different EU-membership countries can influence the possible development in self-sufficiency rate of pig meat in the European Union.

The Dutch piglet price scheme and the French ITP model are used as a framework for the so-called cost price model EuroporC. The EuroporC model contains the following uniformly calculated costs items: labour, housing, interest, feed, mortality and miscellaneous costs.

In table 1 the main technical results are given for the five countries participating in EuroporC. France and Denmark have the highest number of weaned piglets. Daily gain is highest in Denmark, followed by the Netherlands and France. The daily gain of pigs in England and Italy are considerably lower than the daily gain of pigs in the other three countries, the growth traject of these countries is very different from the traject of the Netherlands, Denmark and France. The same is the case for the feed conversion. Because of the different growth trajects in England and Italy, these results are not comparable. The Netherlands has the lowest feed conversion, followed by Denmark. The cost price per kg carcass of each country is calculated based on these technical results.

In table 2 the results of the cost price calculation are given for the single costs items.

The major conclusion from table 2 is that labour costs are highest in the Netherlands. Housing costs are lowest in Italy, with England and France following very closely. Interest costs per kg carcass are highest in Italy. France has the lowest interest costs per kg carcass. Feeding costs per kg carcass

Table 1: Average production figures for selected EU membership states in 1995

	NL[1]	DK[2]	F[3]	UK[4]	I[5]
Weaned piglets per litter	9.60	9.70	9.70	9.57	8.95
Average interval between litters	155.1	154	152.8	160	159
Weaned piglets per sow per year	21.59	21.80	21.80	21.32	19.98
Growth per day (gr/day)	729	744	728	586	613
Feed conversion rate	2.79	2.80	2.90	2.58	3.58

[1] Netherlands, [2] Denmark, [3] France, [4] England, [5] Italy.

and costs of mortality are highest in Italy. Miscellaneous costs seemed to be the lowest in England. The integral cost prices per kg carcass for the Netherlands, Denmark, France, England and Italy are respectively Dfl 3.47, Dfl 3.47, Dfl 3.12, Dfl 3.18 and Dfl 3.58.

The main exporting countries in Europe, Denmark and the Netherlands, have an unfavourable meat price/cost price ratio per kg carcass compared to France and England. Italy has the highest cost price per kg carcass. Regional differences in social-economic factors, among which the benefits of the concentration of production, probably play an important part given the development of the pig industry in Brittany and in the south of the Netherlands. It can be concluded from the research that the technical results of most countries participating in EuroporC are quite similar. Differences in technical results between farms within countries are considerably higher than differences in technical results between countries. The cost price levels of the Netherlands and Denmark, two important exporting countries, are high. However there are large differences in the products produced and those that are exported between countries.

Developments in the pig industry in different countries not only depend on the cost price but also on the meatprice. The meatprice in exporting countries is lower than the meatprice in importing countries. ■

Report Pl. 184

Table 2: Cost price per kg carcass (in Dfl.)

	NL'	DK*	F3	UK4	I5
Labour	0.475	0.465	0.420	0.385	0.445
Housing	0.568	0.601	0.459	0.451	0.378
Interest	0.258	0.320	0.234	0.321	0.429
Feed	1.522	1.554	1.572	1.588	*1.737*
Mortality	0.089	0.074	0.070	0.057	0.146
Miscellaneous	0.558	0.454	0.369	0.380	0.444
Total	3.47	3.47	3.12	3.18	3.58

[1] Netherlands, [2] Denmark, [3] France, [4] England, [5] Italy.

MARKETING DUTCH BACON IN THE UNITED KINGDOM AFTER JANUARY 1ST 1999

ing. J.H. Huiskes, dr.ir. J. W. G. M. Swinkels, dr.ir. G.B.C. Backus

In this study, the relationship between the export of Dutch bacon to the United Kingdom and the required production volume on pig farms was quantatively assessed. The assessment was conducted in the light of the present developments with regard to group housing for dry sows on pig farms within the main bacon producing countries, i.e., United Kingdom, Denmark and The Netherlands. In the United Kingdom, group housing of dry sows will be enforced by law from 1st January 1999. At the present time, similar governemental regulations are not expected within Denmark or The Netherlands. To obtain a competitive advantange, pig producers, animal welfare and consumers organizations have put pressure on the British retailers to sell only bacon and other pig meat that is produced in production chains with group housing facilities for dry sows. The level of self-sufficiency is 46% in the United Kingdom (39% from Great Britain and 7% from Northern Ireland).

The remaining supply of bacon comes mainly from The Netherlands (22%) and Denmark (26%). In the Dutch pig industry, bacon represents 12.5% of the export value of pig meat.

In The Netherlands, there has been no development in the direction of group-housing for sows in the last years. Environmental aspects and requirements for new buildings and renovation, together with the problems associated with group-housing in the past, play an important role. Until now, renovating farms have chosen for the individual housing of dry sows.

In Denmark, about 10% of dry sows were group-housed in 1996. On renovating farms in 1996, individual housing systems of dry sows were still preferred. Of the sow places renovated, 40 to 50% were constructed in group-housing systems. It is estimated that about 20% of the dry sows will be group-housed by 1st January 1999. The development towards group-housing systems for dry sows is stimulated by the Danske Slagterier. Pig farmers that produce pigs in such a system can sign contracts with Danish slaughterhouses that pay an extra 20 øre (= Dfl 0,058) per kg pig carcass.

The United Kingdom is expected, within unchanged consumption patterns, not to become self-sufficient for bacon in the near future, because of the extra 16.4 million slaughter pigs required above the annual 14 million slaughter pigs during recent years. This implies that the presently required import volume of bacon will still be provided by exporting countries in the near future.

A total of 8 million slaughter pigs are required for the Dutch export of 94,000 metric tonnes of bacon products to the United Kingdom. These slaughter pigs represent the light weight class (40%) of the pigs delivered to the slaughterhouses. In order to make a selection from the delivered pigs, a total of 20 million slaughter pigs are needed before sorting. This implies that nearly the whole of the Dutch sow herd should be group- housed. A better strategy would be to organise the needed 8 million slaughter pigs for this bacon destination in a system of chain-wise production and curing.

In the Danish pig industry, 46.5% of the sows would have to be housed in groups to maintain the present export volume of bacon. If 40 to 50% of the renovated sow places are converted to group-housing systems, it will take about 9 years from 1996 and with an unchanged policy, before the Danes are able to supply their present export volume from group housing systems. Taking into account the recent Danish stimulating policy it may be expected that this volume will be realised much sooner.

In conclusion, the market share of Dutch bacon in the United Kingdom will diminish if the Dutch pig industry fails to cope with the demands of British retailers. The degree of decline depends on the readiness of the present or future bacon exporting countries to obtain a competitive advantage over the British market for pig meat. ■

Report P4.21