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PREFACE

At the Research Institute for Pig Husbandry, an organization with 6.5 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 experimental farms at Raalte, Rosmalen and Sterksel are available. The experiments are often multidisciplinary in nature but also disciplinary practica1 aspects of pig farming are investigated. This means that different aspects of pig production are under study. The experiments are financed 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 data published in 1998.

In 1998 the pig industry had to cope with low prices and increasing obstruction in farm management by regulations on farm size, manure disposal and animal welfare. Consumers and retailers increasingly influence the way of production. All these developments have influenced our research programme. The main topics in 1998 were:

1. Economics
   Main activities are the annual collection of technical and economic data from private farms and to compare these results with other European countries. Cost calculation of new farm buildings are published. These costs are affected by all new rules concerning welfare and environment.
2. Health and quality
   Good animal health care must be the first guarantee for safe quality products.
   More publications are available for good farming .
3. Environment
   Most research aims a lowering ammonia emission from pig barns. But there is also a publication on possibilities of reducing the volume of slurry by using solar energy for evaporation.
4. Climate, housing and welfare
   Welfare of pigs is defined mainly by pen and floor design and the inside environment.
5. Feeding
   Products from the food processing industry are popular as pig feed on the larger farms. These rest products reduce feeding costs. Wheat and barley can have the same effect.

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TECHNICAL AND ECONOMICAL PERFORMANCE FIGURES OF FARMS WITH SOWS IN 1996

ir. C.E.P. van Brakel, ing. J. Lubben? ing. P.A.M. Bens[2]

In 1996 the mean gross margin per sow per year reached a record of Dfl. 1,222.-. This is about Dfl. 400.- per sow per year more than was expected by the calculated advanced six-years mean. The gross margin ranged from Dfl. 1,088.- on small farms to Dfl. 1,336.- per sow per year on large farms. In 1995 the mean gross margin was Dfl. 782.- per sow per year. The above mentioned gross margins are based on the following technical and economical performance figures:

- In 1996 the sales prices of piglets weighing 23 kg were Dfl. 112.-. This is nearly Dfl. 25.- higher than in 1995. In 1996 farms with an average of less than 100 sows achieved a price of Dfl. 109.- per piglet. Large farms with an average of more than 218 sows realised a mean corrected piglet price of Dfl. 115.- per piglet.
- The number of weaned piglets per sow per year was 21.5 in 1996 with a range from 20.9 to 22.0 piglets per sow per year for smaller and larger farms respectively. In 1995 the mean number of weaned piglets per sow per year was 21.3. This is 0.2 weaned piglet per sow per year less than in 1996.
- Compared to 1995, the sow feed price in 1996 was Dfl. 2.85 per 100 kg higher. In the same period the piglet feed price decreased by Dfl. 1.81 per 100 kg. Small farms with a mean of 75 sows per year paid 3 cents per 100 kg more for sow feed and Dfl. 1.42 per 100 kg less for piglet feed. However, the larger farms with an average of 302 sows paid 18 cents per 100 kg less for sow feed and Dfl. 1.41 per 100 kg more for piglet feed per year.
  In 1996 the costs for health care were Dfl. 82.- per sow per year. Compared to 1995 these health care costs had decreased by Dfl. 8.- per sow per year in 1996. On small farms the costs of animal health are less than those on large farms, Dfl. 79.- and Dfl. 87.- per sow per year respectively.

Differences between regions are still large for performance figures like feed prices, piglet prices, costs of herd books and artificial insemination. The piglet production per sow per year does not differ much compared to previous years. In 1995 the differences in feed intake for sows were small between regions. However, in 1996 these differences became larger.
The regional differences in mineral balance and mineral production are marginal. In 1996 the mean phosphate production per sow per year increased from 0.2 kg to 14.2 kg as a result of the increased feed intake per sow per year. As in previous years, there are large differences between farms with regard to the phosphate production per sow per year. Just as on fattening farms, a lower mean phosphate production per sow per year seems to be accompanied by a higher gross margin per sow per year. ■

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TECHNICAL AND ECONOMICAL PERFORMANCE FIGURES OF FARMS WITH FATTENING PIGS IN 1996

ir. C.E.P. van Brakel, ing. J. Lubben[1], ing. P.A.M. Bens[2]

In 1996 the gross margin per pig present was Dfl. 161.-, based on 1,178 participating farms with on average 723 fattening pigs. However, the expected gross margin, calculated as the advanced six-years-mean, was Dfl. 30.- less. The gross margin varied between Dfl. 144.- andl Dfl. 178.- per pig for small and large farms respectively. In 1995 the mean gross margin was Dfl. 120.- per pig. The gross margin for 1996 was based on the following economical and technical performances:

- In 1996 the mean price of pork was Dfl. 3.34 per kg slaughter weight. Small farms with fewer than an average of 355 pigs received Dfl. 3.31 per kg slaughter weight. Farms with more than an average of 1,556 pigs received Dfl. 3.38 per kg slaughter weight. In 1995 the mean price of pork was Dfl. 2.89.
- The weight gain per day increased from 729 gram per day in 1995 to 737 gram per day in 1996. The variation in weight gain on farms with an average of more than 1,556 pigs and farms with an average of 577 pigs was 732 and 742 gram per day respectively. The higher weight gain was achieved by providing the pigs with an additional 10 grams of feed. Thus there was an improvement in the feed conversion of 0.01 kg feed per kg weight gain compared to 1995. Farms with an average of less than 355 pigs, farms with an average of 577 pigs and the large farms with an average of more than 1,557 pigs achieved a feed conversion of 2.84, 2.79 and 2.71 respectively. The mortality rate was 2.7%, 2.3%, and 2.4% respectively in 1996. The mortality rate had decreased by 0.2% in 1996 compared to 1995.
- The high prices for pork were accompanied by high piglet prices. The mean piglet price was Dfl. 118.21 in 1996 which was Dfl. 22.- higher than in 1995. The corrected piglet price was Dfl. 112.90 in 1996. The smaller farms paid Dfl. 1.- to Dfl. 0.50 less per pig and the large farms paid Dfl. 1.10 more per pig.

The performance figure for farm size, weight gain per day, feed conversion, mortality rate, piglet price and feed prices are regionally specified. However, this regional specificity is linked to the farm size and so the comparison of regions is not accurate.

The phosphate production per pig has been stable since 1994. In 1994 the mean phosphate production per pig was 5.0 kg phosphate per year with the highest and lowest levels of production being 6.0 and 3.9 kg phosphate per pig per year respectively. Both the differences in phosphate content in feed, and the differences in performance figures have resulted in these differences in phosphate production. Furthermore, a low mean phosphate production per pig per year appeared to be accompanied by a higher mean gross margin per average present pig. In 1996, large farms feeding by products achieved a higher gross margin than farms feeding concentrate. This was due to better growth and feed intake performances and lower total feed prices. ■

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[1] Siva-software B.V., Wageningen
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SITUATION AND POSSIBLE MEASURES ON PIG FARMS IN DEURNE AND YSSELSTEYN IN THE AREAS OF HEALTH, WELFARE AND ENVIRONMENT

ir. M.A. van der Gaag, ing. H.J. M. van der Aa, dr. ir. G. B.C. Backus

Introduction

The epidemical breakout of Classica1 Swine Fever and bills on the Restructuring and Reconstruction of pig farming have speeded up internal and external discussions about the Dutch pig sector with respect to animal health, welfare and the environment. These laws had not yet been passed as this report was written. One of the main aims of the Law of Restructuring is to introduce so called 'pig claims'. This means that there will be a limit to the number of pigs a farmer can keep, instead of a limit to the total amount of phosphate produced. One pig claim unit is equivalent to one place in a pig pen.
The Provinces of Noord-Brabant and Limburg and the united interest groups LLTB and NCB commissioned the Research Institute for Pig Husbandry (PV) to investigate the contact structures (number and kind of contacts of a farm with humans, animals and materials) in the district of Deurne and the village of Ysselsteyn, both areas with a high density of pigs and pig farms. Besides this the expected development in the number of farms and locations with pigs and the views of the pig farmers involved on the (im)possibilities of industrial adjustments to animal health, welfare and environment were mapped.

Methods

The study was divided into three parts. 1) An inventory of the situation on pig farms in 1996. This included the farm size, farm successor, sanitary facilities, direct and indirect contacts with humans, animals and materials and the presence of pig pens with reduced ammonia emissions and group housing systems for sows. All farms with pigs in Deurne and Ysselsteyn were asked to participate in a questionnaire. 2) The participants in the survey were invited to join meetings involving 10 to 15 people to discuss the (im)possibilities of farm-adjustments on animal health, welfare and the environment. 3) An estimate was made of the development of the number of farms and locations with pigs. For this purpose the farms were classified into three groups: small (< 100 sows and < 500 fattening pigs), medium and large (> 200 sows and > 2,500 fattening pigs). The expected number of farms in the year 2001 was calculated on the basis of two parameters: Istly given the experiences of an earlier project in the southern sandy area, 2ndly considering the generic deduction of 10% in 1998 and the 50% cream off by trading pig claims. It was assumed that 75% of the large farms, 40% of the medium farms and no small farms would repurchase the deducted rights. To bring the needed claims on the market in the concentration area "South", 5% of the large farms and 25% of the small and remaining medium farms would have to sell their pig claims. The calculation for the year 2006 was made by an autonomic extrapolation of five years from 2001.

Development of farms and locations

The historica1 development and an extrapolation to the future is shown in figure 1. The total number of farms in the districts Deurne and Venray (including Ysselsteyn) has and will decrease. The number of small and medium farms has and will decrease although the number of large farms has and' will increase.
Under the present policies, most of the locations of small farms will continue to exist. Demolishing the pens is too expensive and

a lack of possibilities to use them for other purposes will cause them to remain unoccupied. The modern medium and large locations are more attractive for a complete take over. The same applies to the remaining locations as to the small locations.

The number of farms in Deurne and Venray in 2001 is estimated to be 584 without the generic deduction of 10%, instead of 528 farms. In 1996 there were almost 21,000 pig farms in The Netherlands. This number is estimated to be 18,000 in 2001 without the generic deduction and 16,000 farms with a 10% deduction.

Farm situation in 1996

75% of the farmers responsed to the questionnaire. These included 282 farms with 344 locations. 8 of these were small farms with less than 100 sows and 47 farms had less than 500 finisher pigs (in total 55 small farms). 78 farms fell into the category 'large farms' with more than 200 sows or more than 2,500 finisher pigs, of which 10 had finisher pigs. In The Netherlands more than 50% of the farms are small ones, mostly with a small number of finisher pigs as a secondary branch.
The managers of the large farms are comparatively young; three out of five are less than 40 years old compared with one in three for managers of small farms.

Risk of importing pathogens during animal transport
Three aspects of the supply and delivery of pigs were analysed; the number of adresses, the distance from the farm to these adresses and the frequency of transportation.
More than half of the locations with sows supplies gilts/sows monthly. 25% supplies more frequently and almost 10% breeds their own gilts. On 30% of the locations the supply-adress for gilts is more than 25 km away. The frequency at which sows are delivered is two-weekly on almost half of the locations. For 25% it is more frequent. A quarter of the locations breeds their own (chaser)boars, the rest buys boars (two-) yearly. 20% of the locations with sows exports piglets.
In 45% of the locations with finisher pigs, the piglets are bred on the same location. When the location buys piglets, the supplier is located within a radius of 25 km in 90% of the cases.

10% of the supply of gilts/sows is from two or more adresses; in 95% of the locations boars and sperm come from one supplier. ▶

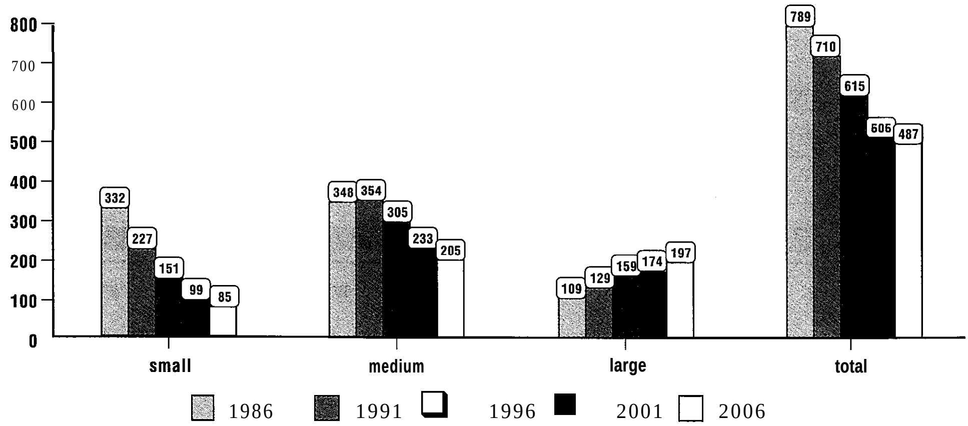

Figure 1: Number and size of farms in 1986, 1991 and 1996 in the districts of Deurne and Venray and an extrapolation to 2001 and 2006

Less than 50% of the locations with sows delivers piglets to more than one adress. A quarter of the locations with finisher pigs buys piglets from two or more suppliers. According to the respondents, 97% of the locations are situated within a radius of 1,000 meters from another location with pigs, 89% within a radius of 500 meters and 71% within a radius of 250 meters. Four out of ten locations are situated within 100 meters of another location.

Risk of importing pathogens by human visits
Approximately 10% of the locations is in contact with other pig farms through their permanent or temporary employees. Many farmers are member of a team which organises study meetings. In connection with these meetings 17% of the managers allow colleagues to enter the pig pens. The average number of visits of service providers (veterinarian, advisor, A.I., truck driver, maintainance providers) is 75 a year. There are large differences between the locations. In Deurne the average number of visits is 65. In Ysselsteyn it is 105 times a year. This difference is caused mainly by the number of visits by the inseminator; Deurne has more owner-A.I.'s. In the small locations less service providers enter the pig pens (36) than in large locations (107).

Sanitaty facilities
There are several measures possible to avoid the import of pathogens, such as a room to change into clothing and boots from the farm, a complete farm outfit, a barrier between the clean and the dirty area, a boot cleaner, a washbowl and a shower. The type of clean-dirty area was divided into several categories: for pigs, for carcasses, for (compound) food, for manure and for other domestic animals and the presence of a disinfection trunk was examined. The sequence of delivering involves the following aspects: the presence of delivery-pens (for sows / boars / piglets / finisher pigs), quarantine-pens, carcass trunks and carcass coolers and how many locations always use a clean and empty truck for the transport of piglets and finisher pigs.

In general the small locations take fewer sanitary measures than the large locations. The closed herds and the farms specialised in sows take the most measures.

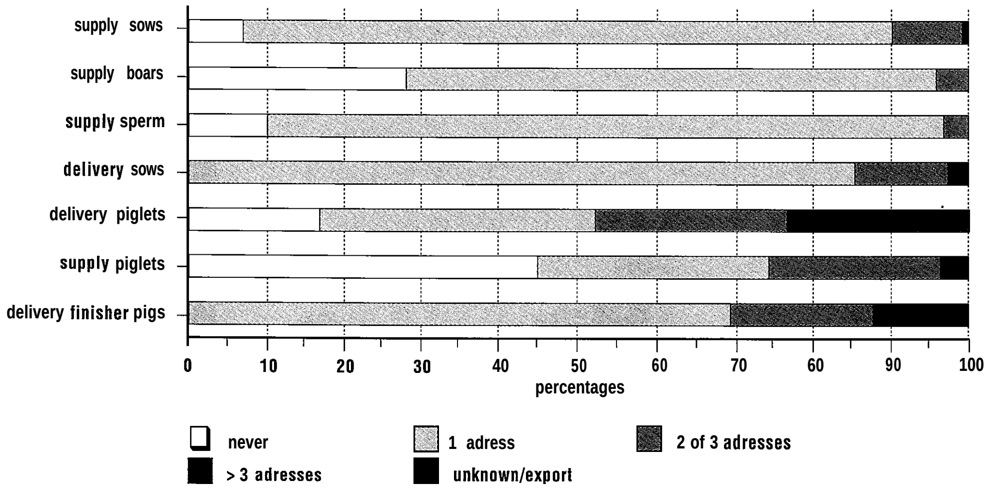

Figure 2: Percentages of locations with sows and/or finisher pigs with a certain number of supply and deliver-adresses in 1996

Group-meetings

30% of the invited farmers went to the meetings. This group is not representative for all the pig-farmers in the Peel or The Netherlands. It was presumed that mainly farmers wanting to continue farming in the (far) future were present. During eight meetings with a total of 68 farmers, the requirements of pig farming in the future were discussed in detail. Over 80% said that a farm should have just one transport adress (both supply and delivery adresses) for sows, boars, sperm and finisher pigs. For piglets a maximum of two transport adresses was found reasonable and all relations with other farms should be steady relations. Such conditions are attainable within three months. Almost 80% of the participants said that the transport of gilts and sows (supply and delivery) once a month should be possible.
According to 40%, the supply of piglets and the delivery of finisher pigs can be reduced to once every two weeks. But the frequency of transports is less important than the use of full trucks. Almost everyone agreed with the obligation of a functional hygiene channel. Three-quarters of the participants said that the frequency of service providers visits could be halved. If farmers were to be allowed to vaccinate their animals themselves, 95% of the participants believed it possible to halve the number of visits.
Discussion on the marketing area for Dutch pig meat and recent research results led to 60% believing that pig husbandry has to meet the needs of the market and agreeing that they should switch to group housing for sows within ten years. Thirty percent thought that it could be necessary to give finisher pigs more space, mostly as a concession towards the politica1 compromise on the so-called Dutch Pig order ("Varkensbesluit"). In spite of these percentages, most farmers were not convinced of the (positive) effects of these measures on animal welfare.
Every participant considered it attainable to feed the pigs with food containing fewer minerals. Nowadays the newly built and renovated pig pens have a reduced ammonia emission (Green Label). Nevertheless 40% answered 'no' to the question whether all pig pens should be Green Label within **10** years. A mentioned reason was: with the current system of regulations it is hard to expand a farm if all pens are Green Label.

Conclusions

The results of this research must be put in the proper perspective. The Swine Fever and intended laws have had a great effect on the perspectives of the managers of pig farms. The research was carried out in an area with a relatively large number of pigs and large pig farms and so the results are not representative of all managers of pig farms in The Netherlands.
The following conclusions were made on the basis of this research:

1. The total number of farms with pigs in The Netherlands is decreasing. This development is seen in Deurne and Ysselsteyn, although to a lesser extent. This is due to the relatively large farms with young managers. Fewer farmers are expected to change their occupation in this group.
2. The participants of the group meetings - mostly stayers - were willing to meet the strict requirements of the pig husbandry ▶

Table 1: Percentage of the locations with a number of sanitary facilities

number of facilities	hygiene measurement	clean-dirty area principle	sequence of delivering (locations with sows)	sequence of delivering (locations with finisher pigs)
0 - 2	25	83	68	82
3 - 4	61	6	30	17
5 - 6	14	11	2	1

in the future, especially requirements to reduce the risk of importing pathogens.

3 The transport structure of sows, boars and sperm in Deurne and Ysselsteyn is quite good. Most locations have less than two supply and delivery adresses. There are more locations with piglets and finisher pigs with two or more adresses. Most of the deliveries of pigs, except finisher pigs to the slaughterhouse, take place within a radius of 25 km. It is not possible to indicate the increase in risk when having more supply and delivery adresses.

4 A way to reduce the risk of importing pathogens is to minimalise the visits of humans to the pigpens and to have proper, functional sanitary facilities. The frequency of visits of service providers is high, especially on the large farms. The sanitary facilities are not sufficient on many small pig locations.

The recommandations based on this research are as follows:

1. A lot of pig farmers are now aware of the need to reduce the risk of importing pathogens. The leaders of the united interest groups and of the (local) authorities must anticipate to increase the level of awareness.
2. Pig farmers are swamped with written information. During the meetings it appeared that much of this information is not recognized as such, although the managers do admit the importance of (background) information. For example: in order to make a balanced decision on management it is important to know something about the marketing area for Dutch pig meat. Further research on the most effective ways of information exchange to pig farmers is needed.
3. In order to reduce the risk of importing pathogens, it is necessary to know more about the risk of each possible activity on a pig farm. This includes the different sanitary facilities, the contacts with humans (service providers, colleagues, visitors, employees) and contacts with other farms concerning the supply and delivery of pigs.
4. The level of supply and demand of quota is (indirectly) influenced by the requirements placed on individual pig farms concerning welfare, animal health and the environment. A good policy on the demands on pig husbandry can control the prices of the quota. ■

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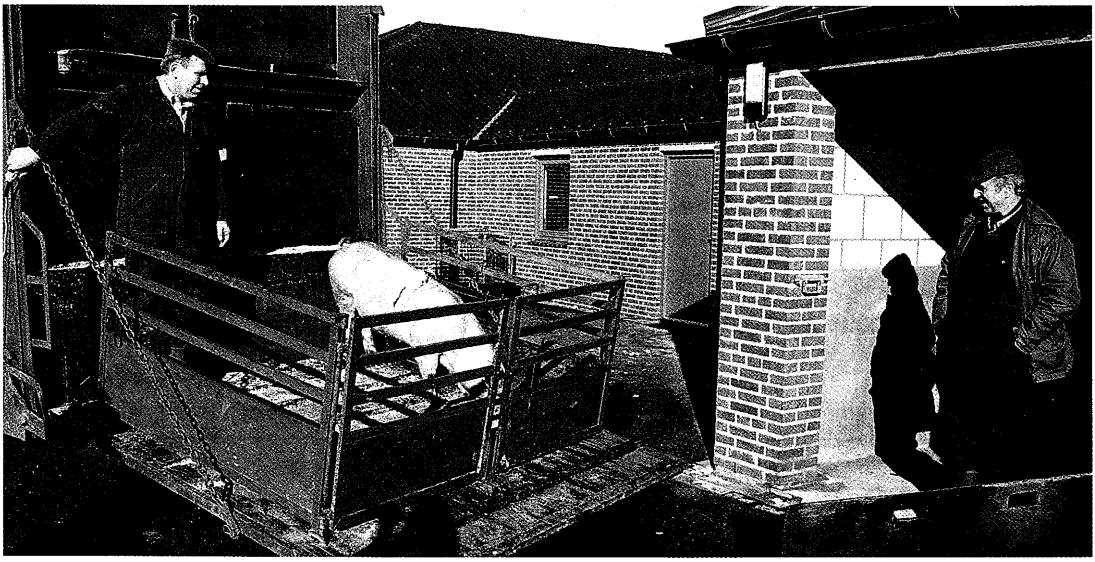

INVESTMENT COSTS OF STANDARD PIG HOUSES IN 1996

ing. J. H.A. N. Adams, ir. C. E.P. van Brakel, dr. ir. G. B.C. Backus, ing. P.A. M. Bens[1]

From 1975 up till now the construction and layout of pig houses has strongly been influenced by changes and modernisation. Pig houses have become larger due to an increase in the number of pigs per farms and to observing regulations on animal welfare and health. Mechanisation and automation are also increasingly made use of. The materials used have become more durable and different methods of sewerage systems have been introduced. That is why building costs of pig houses have increased and housing costs have become a more and more important component to deal with. At the moment widely differing investment costs and costs per pig place are mentioned in practice. There is also uncertainty about the economic and technical lifetime (= duration) of new housing systems for sows and growing/finishing pigs. This study has tried to determine the investment costs of a new standard housing system for sows and growing/finishing pigs. It has also been tried to give an impression of the variation in investment costs, depending on the investment size and quality. The quality is usually expressed in the depreciation period chosen and costs of maintenance. To make realistic and reliable calculations, several constructors and housing designers have been requested to make an offer for a previously defined standard pig house for sows and growing/finishing pigs. The sizes of such pig houses are 172 sow places and 1,840 growing/finishing pig places respectively. These modern pig houses much resemble the compact pig houses, which have been described by Bens et al. (1994). The sow barn is made up of one compartment for empty sows, two compartments for pregnant sows, 8 piglet compartments with each 6 piglet pens and 6 farrowing compartments with each 6 farrowing pens. The pig house for growing/finishing pigs has 23 compartments with 8 pens, each with 10 growing/finishing pigs. One compartment is used for the sick, as storage and as an office.
Based on the offers, the investment costs of the (main) components of the pig house have been calculated. Yearly costs of investment have been determined by calculating the costs of depreciation, interest costs (7% of the mean invested capital) and costs of maintenance.
On the basis of the investment costs calculated, a model called 'Bouwfl' has been developed. This model calculates the investment costs of a pig house using design-based input, such as the dimensions of the pig house, compartments and pens and the number of walls of the slurry pit. With the model, calculations can be made of a number of alternative pig houses in a relatively quick and simple way. By using the standard pig house as a reference, the effects of farm size, size of the compartment and differences in the design of the slurry pit and area per pig place on investment costs can be estimated.
The investment costs per sow place equal Dfl 5,156.- (excluding VAT). In practice, investment costs per sow place range from Dfl 4,045.- to Dfl 5,900.-. Total yearly investment costs equal Dfl 554.- per sow place per year. The yearly investment costs (10.8% of the total investment) consist of 5.9% depreciation costs, 3.5% interest costs and 1.4% maintenance costs. The average lifetime of the pig house for sows is 17 years. For the standard pig house for sows, investment costs per farrowing pen equal Dfl 7,664.-. For a pen in a piglet compartment with 10 piglet places and a cubicle for empty or pregnant sows, an investment of Dfl 5,839.- and Dfl 2,431.- is needed respectively. The yearly costs of these separate ▶

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pens are Dfl 885.-, Dfl 646.- and Dfl 247.- respectively.
Investment costs per growingfinishing pig place equal Dfl 885.- (excluding VAT).
The investment costs per growing/finishing pig place in the offers made range from Dfl 705.- to Dfl 1,095. The average yearly investment costs are Dfl 92.- per growing/finishing pig place per year. These yearly costs consist of 5.7% depreciation costs, 3.5% interest costs and 1.2% maintenance costs. The average lifetime of the pig house for growingfinishing pigs is also 17 years.
With regard to the effect of the slurry pit structure, the investment costs of a pig house with shallow slurry pits are lower than the costs of a pig house with deep ones.
The investment cost of a pig house with so-called shallow manure channels are lower than the investment costs of a comparable pig house with complete shallow slurry pits.
As a result, necessary 'extra' investment in a slurry storage outside the pig house as compensation for the loss of slurry storage capacity under the pig house, total and yearly investment costs of both alternatives with shallow slurry pits or manure channels are higher than the costs of the standard housing systems with the traditional deep slurry pits. Individual farmers have to consider whether a large manure storage facility is required on their premises. Also regular and frequent manure removal is a possibility.
Then investment in a large manure storage facility is not necessary.
As farm size increases, investment costs per pig place decrease. This so-called scale effect decreases, however, if farm size increases further. If the size of the compartments increases, this scale effect can also be seen. This effect is greater with relatively large farms with relatively large compartments than with large farms with relatively small compartments.
By increasing the floor area per pig by 40 to 45%, the investment costs and yearly costs do not increase proportionally, but increase by one-third of the increase in floor area in terms of percentage (thus, the investment and yearly costs increase by 14 to 15% if the floor area per pig increases by 40 to 50%). A constant slurry storage capacity under the pig house is assumed. This implies that for maintaining the same slurry storage capacity under the pig house, the depth of the slurry pits decreases if the floor area per pig increases. ■

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TESTING BREEDING PRODUCTS OF GROWING-FINISHING PIGS USING OBSERVATIONAL DATA

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In 1995, the research team coined "Studie Elektronische Merkentoets" has developed a method for periodic testing of pig breeding products using raw data of management information systems from commercial sow farms. A breeding product is defined as the combination of one commercial sow- and one boarline marketed by one breeding company. In the method, only farms were used that contained a sow population consisting for 90% or more of the same breeding product. The steering committee of StEM has stated that a periodic test can only be performed under the condition that the test provides information for both commercial sow and growing-finishing operations. In this study, the objective was to study whether the developed method can also be used to test breeding products using raw data of MIS from growing-finishing farms. In total, 101 growing-finishing farms have given permission to use a backup of their MIS-data and were willingly to fill out a survey that contained questions about farmer and farm. Of these 101 farms, 65 farms were used to analyse a number of technical index figures. The overall farm average of lean meat was 55.4%. The maximum (corrected) difference among four breeding products was 0.7%. The index figures 'type AA + A' and 'slaughter weight' of the pigs were similar among the four breeding products. Other technical and economic index figures could not be analysed due to the small number of farms per breeding product that were able to provide reliable MIS-data. It was concluded, that in the short term a periodic test of pig breeding products can only be performed using MIS-data from commercial sow farms in combination with experimental data on the growing-finishing pig performance. ■

Report P4.30

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A COMPARISON BETWEEN PIG FARMING IN THE EUROPEAN UNION AND NORTH AMERICA

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Aim of this study was to evaluate structural developments in the sector structure for the EU as well as for the US and to draw a picture of their consequences. The study was carried out as a joint project of the Research Institute for Pig Husbandry and the ABN AMRO BANK NV The number of pigs in Denmark, France, Ireland and the Netherlands increased in 1996 compared with 1995. In the other EU countries there was a decrease in pigs, the largest of which was in Portugal and Germany. France has surpassed the Netherlands as to numbers of pigs. The past few years France and Denmark particularly have increased production. Denmark has the highest self-supporting rate and therefore depends on export the most, after which the Netherlands and Belgium/ Luxembourg follow. In recent years France has developed itself from a net importer towards a net exporter. Production and total consumption are highest in Germany. Denmark, Spain and Germany see the highest per capita consumption with over 55 kg per capita. Greece and the United Kingdom consume not even half this amount with almost 25 kg per capita.

Besides slaughtered pigs, the Netherlands also exports many live pigs. In 1996 this export involved 6.5 m piglets and fattening pigs. Denmark is the largest exporter in the world with over 1 .1 m tons of export in 1996. Furthermore, Ireland, France and Spain have a self-supporting rate of over 100%.

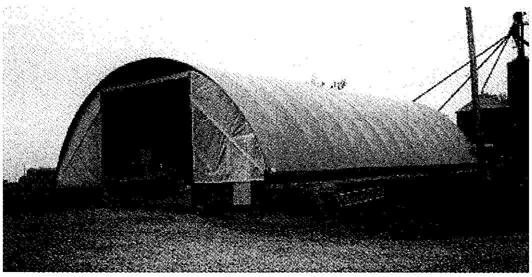
Over 1 million farms had fewer than 10 pigs and over 160,000 farms more than 100 pigs per farm. As these data concern 1993, the latest EU member states Finland, Austria and Sweden are excluded.

Contrary to the Netherlands and Germany, the Danish slaughter structure is characterized by a strong integration and high capacity utilization. In 1996 the 5 largest slaughterhouses accounted for 96% of the total number of slaughterings. The sale of meat and meat products takes place more and more through supermarket chains at the expense of the butcher.

The average cost prices in the three most important countries the Netherlands, Denmark and France do not differ much. The cost price in Brittany, however, is considerably lower. In Germany this is clearly higher. The countries with the lowest output prices are the Netherlands, France, Denmark and Germany. Output prices are the highest in Belgium. The cost price, however, is also higher in Belgium. Cost prices in Italy, Portugal and Spain are relatively high.

Production in the US and Canada involved over 9 m tons of pork in 1996 from a pig population of approximately 70 m pigs. The greater part is for the internal market. The US is, with over 400,000 tons of pork in 1996, the second pork exporter in the world after the EU. From 1990 to 1996 the pig population in the US increased by 8%. Per capita consumption in the US is relatively little compared with Europe. In the US there is a higher poultry and beef consumption.

In the 1960s pigs in the US were mainly kept outside, on mixed farms. In 1970 there were over 870,000 pig farms that together produced 87 m slaughter pigs. In 1995 this number had decreased to 149,000. Together they produced almost 96 m slaughter pigs The 66 largest farms (a yearly production of



A pig farm in the US

on average 244,000 (!) slaughter pigs per farm) accounted for 17% of the production in 1995. There is still a production shift going on from the traditional Corn Belt states to the southern states, among which North Carolina, Kansas and Oklahoma. This shift has particularly been caused by the fact that in these "new" states environmental regulation used to be less strict and land and labour relatively cheap until recently. Particularly in the states near Iowa the number of pig farms that goes out of business is large.
For 1997 it was estimated that 33% of the slaughtered pigs in the US had been kept on a contract basis. Contract production takes particularly place in the "new" pig states, among which North Carolina, Oklahoma and Kansas. As a counterpart to contract production in the "new" pig states, in the traditional "Corn Belt states", networks have been established. Networks play an important part in the pig sector in Minnesota.
The five largest slaughter chains together have a market share of more than 53%.
The overall cost price in the US is considerably lower than in the EU, despite more unfavourable technical results, and is almost $1 per kilogram of liveweight, which comes down to approximately $1.25 per kg of slaughterweight. In a comparison of the US and the EU the dollar exchange rate is therefore important. Besides a low cost price, the US also has low output prices. The average output price in the past 6 years was approximately $1.05 per kg of liveweight.

Both the EU and the US show a tendency towards increase in scale. Moreover, pig farming is more and more concentrated in some important production areas, which results in environmental problems in these areas. There is also an increasing concentration of slaughterhouses/processing industry in both areas. In the US this process has proceeded further than in the EU.
Pig farming in the US is more landbound.
The EU is more advanced in environmentally investments. The US has only recently started to solve environmental problems, which are mainly problems with respect to stench. Contrary to the EU, animal welfare is hardly an issue in the US.
The technical results in the US lag behind compared with the EU. Because of the availability of cheap materials there is less attention for result improvement. Despite worse technical output, cost price in the US is structurally lower. The US production chain is characterized by a strong vertical integration, while the EU structure is relatively fragmented. The chain position of the primary producer is relatively weak in the US. The "market power" in the chain is with the slaughterhouses. There are also differences in sales. US sales focus more on bulk products with a low cost price, whereas the EU produces relatively more for market segments, such as bacon in the UK and Parma ham in Italy.

The following conclusions can be drawn.
- The competitive power of the US on the world market is currently stronger than that of the EU.
- Cost price differences between the US and the EU will become less the coming years.
- Initiated by GATT/WTO agreements and an increasing pork consumption in particularly Asia world trade will increase.
- US export will remain to be aimed at cheaper bulk products, which can be produced at a structurally lower price. For the EU there are opportunities for the so-called value added. To take advantage of these opportunities a far-reaching chain integration is necessary, in which different chain stages cooperate closely.
- By increasing world pork consumption and a relatively strong competitive power of pig farming in the EU as well as in the US, pig farming in both areas can increase in the future.
- The Netherlands should focus more on products with a higher value added in a chain-oriented organization. All this cannot prevent a decrease in the number of pigs as well as farms in the Netherlands in the years to come. ■

Report P5.6

HEALTH MANAGEMENT ON SOW FARMS

ir. E. R. ter Elst- Wahle, ir. M.A. H. Vaessen, drs. ing. H.J. P. M. Vos, ing. G.P. Binnendijk, dr. ir. R.B.M. Huirne[1], dr. ir. G.B.C. Backus

In the pig industry more attention is being paid to the health care. It is necessary for the advisory service to pay more attention to health care in their educational programs. In order to do so it is necessary to have more concrete data concerning relations between farm management, the extent of health problems on the farm and technical and economical results of the farm. Based on this information, the advisory service can provide more applicable advice on a more systematic approach to health care on the farm. The aim of the project was to establish relationships between farm management, the extent of health problems on the farm and technical and economical results on the farm.
Farm data were collected from 438 sow farms and their vets by the Agricultural Extension Service (DLV) by means of questionnaire. The questionnaire was made up of 73 questions on the following subjects: general farm data, farm structure, health care, care for piglets, housing and climate, climate control, feeding, labour and administration. An additional questionnaire was carried out to validate the data given by the farms. The second questionnaire was made up of 24 questions of the 73 questions in the first questionnaire. These 24 questions were presented to 44 of the 438 sow farmers. Another questionnaire was carried out among the vets of the participating sow farms to validate the questions concerning the health care and health problems on the participating farms.
The research dataset contained technical and economical farm results, health care and health problem characteristics and management characteristics. All the variables were reduced to a certain number of variables or aspects using factor analysis. Through factor analysis a total of 20 aspects was obtained. The influence of each aspect on the extent of health problems in sows and/or weaned piglets was analysed. The relationship between the aspect and health problems was determined by means of regression analysis with the most explanatory variable (catch variable) within the aspects being the independent variable.
A cluster analysis was also carried out to determine the relationship between the variables and to determine the relationship with health problems and technical and economical results.
417 of the 438 participating farms were sow

Table 1: The extent to which farmers perceived preventative disease measurements as useful (% of farmers)

more than 90%	67 - 90%	less than 67%
purchase disease free gilts (99)	washing sows (86)	measurements for animals leaving/entering the farm(59)
limit number of contacts (99)	isolate sick animals (84)	preventive medication (40)
all in-all out (98)	desinfecting boots (83)	
cleaning (98)	desinfection (70)	
hygienic corridor (92)	no visitors on the farm (68)	
dirty-clean part principle (66)	cooltainers (67)	

[1] Wageningen Agricultural University, Department of Farm Management

farms, 21 were rearing farms. On average there were 226 sows and 17 rearing sows present per farm.

Measurements

8% of the farms reared all the sows. 89% of the farms bought gilts. On 71% of the farms that purchased the gilts, it was not known whether the gilts were free from specific diseases.

The percentage of farms applying specific measurements to prevent and control sow diseases were as follows: health control during feeding (44%) deworming (98%), scabies (99%), washing sows before entering the farrowing unit (24%) improving sow immunity (72%).The percentage of farms applying specific measurements to prevent and control piglet diseases were: precise climate control before piglets enter the piggery, cleaning (both more than 80%); waiting before letting the piglets into the piggery until the compartment is dry, desinfection (60 - 80%); medication after weaning (20 - 35%).

Health problems

28, 19 and 34 of the farms respectively declared to have no health problems with their suckling piglets, weaned piglets and sows. Results of the questionnaire among the vets of the participating sow farms show markedly differences concerning the perceived health problems on the farms. Final analysis was based on the results of the questionnaire among the vets. Further development and implementation of information systems supporting registration and analysis must have priority. There were problems with overlaying of the piglets and/or non-viability piglets, arthritis and/or meningitis, swing disease/post weaning diarrhoea/oedema disease, bronchial tube disease and ear- and tail biting on more than 50% of the farms. 50% or more of the farms had birth problems, udder infection and fertility problems.

There was a correlation between the extent of bronchial tube problems and udder infection, between worms and scabies and between birth problems and udder infection in sows. There was a correlation between the extent of swing disease and arthritis and/or meningitis, and between bronchial tube problems and ear- and tail biting in weaned piglets.
The mutual relationship between different health problems was too low for being able to determine an overall farm health index. A farm health index can only be determined when it is based on proces based parameters that give an indication for the chance at getting specific health problems. ▶

Table 2: Health problems with weaned piglets and sows

Health problems	Weaned piglets	sows
On less than 25% of the farms	intestinal problems other leg problems non-viability of the piglets	influenza, PRRS, worms, bladder infection leg problems
On 25 - 50% of the farms		scabies bronchial tube disease
On more than 50% of the farms	swing disease, post weaning diarrhoea/oedema disease bronchial tube disease ear-/tail biting, scabies arthritis and/or meningitis	birth problems udder infection other fertility problems

Farm management, economical results and the extent of health problems

The mutual relationship between farm management, technical and economical results and the extent of health problems on the farms was investigated. Seven aspects were related to the extent of one or more specific health problems: labour input per sow, rearing own gilts, modernity of the farm buildings, desinfection, feeding automation, door ventilation, and the frequency of climate control. Each of these aspects was more or less related to other farm characteristics. Although several correlations appeared to be significant, the correlation between the variation in the extent of health problems and farm characteristics was low. Other aspects such as farmer qualifications, were most probably more important.
A relatively low as well as a relatively high labour effort per sow resulted in a lower gross margin per sow. There were relatively more health problems on farms with a relatively low labour effort per sow.

The relationship between labour effort, margin and health problems indicate that on farms with a relatively low labour effort per sow possibilities exist to improve both the economic result and the health status by increasing the labour effort per sow.
Modern stables, feeding automation as well as door ventilation in the farrowing stable were coupled with a higher gross margin per sow. However this was not accompanied by fewer health problems. It can be concluded that there are health problems on most sow farms to a greater or lesser degree. The extent of the health problems on farms with favourable technical and economical results are not necessarily less then on farms with less favourable technical and economical results.
Preventive medication was perceived as useful by 40% of the participating sow farmers. The results of this observational study showed no clear relationship between preventive medication and the extent of health problems. Further research is necessary to improve the knowledge on the possibilities to reduce preventive medication.

Risk awareness

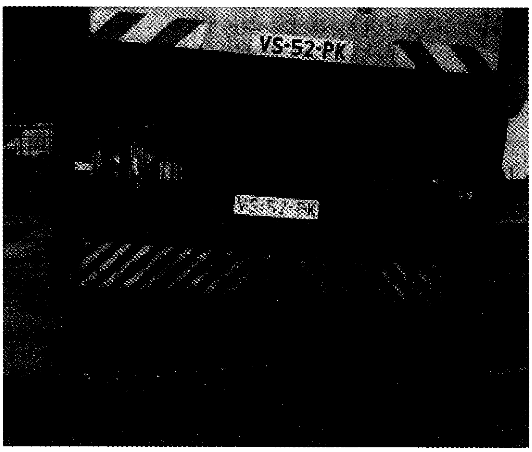
The relationship between preventative measurements and the extent of health problems on the farm was not clear. The questionnaire demonstrated that not all sow farmers were convinced (in 1996) of the effectiveness of certain hygiene measurements, such as desinfection of stables and transport of animals to the farm. These differences in perception are partly due to differences in farm circumstances, but they are also related to differences in awareness of the individual farmer regarding the effectiveness of preventive measurements. ■

Report PI.200

RINSING FACILITIES TO CLEAN LIVESTOCK TRUCKS ON PIG FARMS

ing. P.F. M. M. Roelofs, ing. J. J. W. Nijskens[1]

In the Netherlands, livestock trucks that are used to transport pigs must be cleaned and disinfected directly after unloading the truck and before entering public roads. For this reason transit places, slaughter houses and export places for pigs have rinsing facilities. After removal of manure and litter, the trucks are placed on a 6% backward slope and cleaned with water at a low pressure (about 3 atm.) and a high flow rate (about 50 l/minute). This experiment tested whether labour time and water use to clean livestock trucks after pig transport can be reduced by placing trucks on a 6% backward and 4% sideward sloped rinsing facility instead of a 6% backward sloped rinsing facility. The water use and the labour time required to clean these trucks after the transport of between 25 kg and 30 kg piglets to a transit place were measured. Only the results of truck drivers who cleaned their truck in both places were used for the analysis. These were 18 (backward) and 22 (sideward & backward) measurements.



Livestock truck on the "sideward & backward" rinsing facility

The two different types of rinsing facility did not influence labour time ($p = 0.9$) or water usage ($p = 0.8$). On average, the truck drivers used between 10 and 15 minutes and about 0.75 m^3 water to clean their trucks after transport of piglets. Because backward and sideward sloped rinsing facilities are more expensive than backward sloped rinsing facilities, it is recommended that transit places, slaughter houses and export places should build 6% backward sloped rinsing facilities.

Most farms only need to clear several times each year, although there are big differences between farms. On an average farm, the annual water use is about 12 m^3, so it is hard to recover the costs of an expensive rinsing facility by the reduction of water and manure costs. Because of this, a 1% to 3% backward sloped rinsing facility with a separated discharge of rinsing water and rain water is sufficient on most farms. ■

Report PI.205

[1] The Agricultural Extension Service, Boxtel.

METHODS FOR FLY-CONTROL IN PIG HOUSES

ing. P.F.M. M. Roelofs, ing. J. J. W. Nijskens[1], dr. t? C. Vesseur, ing. J. G. Plagge

Flies found in pig houses and the surrounding area are irritating and harmful. *Musca domestica* (housefly) and *Drosophila spp.* (fruit fly) are found most frequently. A literature study showed that flies can carry many diseases, including different kinds of diarrhoea, Salmonellose, Swine fever and Aujeszky's disease.

In pig houses, a period of about fourteen days usually separates two generations of stable flies. Temperature and relative humidity affect this interval, and in pig houses they are almost perfect for flies. Therefore, measures to prevent plagues of flies are needed.

Pig farmers should initially take preventive measures ('ethologic fly control'). Ethologic fly control includes (1) ensuring that surfaces in the stables are dry and clean and (2) preventing flies from entering. Although some very good results of ethologic fly control have been found in literature, additional fly control tends to be needed. Additional fly control may be chemically based, based on the use of predators or physically based. A survey of the advantages and disadvantages of methods that are described in literature has been made.
Chemical fly control can almost always be used and when both larvicides and adulticides are used properly these methods are safe to operate. Disadvantages are labour costs, frequent exposure to pesticides, emission of pesticides to the environment, the simultaneous killing of predators, the price of insecticides and the development of resistance in flies.
Predators of flies, like mites and beetles, are found in almost all pig houses. However, their number is not sufficient to prevent plagues of flies. For this purpose more predators must be introduced. Killer flies *(Ophyra aenescens)* and insectivorous birds are available, and companies are developing fly control methods using ichneumon wasps. Fly control using killer flies or insectivorous birds are safe and labour saving methods. Maggots of *Ophyra eanescens* eat maggots of *Musca domestica* as a source of proteins.
Insectivorous birds eat adult flies and some of them also eat maggots if they can reach them. Disadvantages of the latter method are that birds leave droppings in the stables, the farmer must pay attention to the birds when he moves sows, pigs or piglets from one room to another and that the birds may spread diseases from one room or batch to another.
Examples of physically based systems for fly control are electric fly traps combined with UV or sticking fly traps combined with pheromones. Most physically based systems are labour-intensive. Only adult flies are caught and in most cases the results are poor.

In this study, the effective strength and practical value of available methods for fly control are compared. An experiment was carried out in 1994 and 1995 on nine Dutch farms and on the experiment farms in Raalte and Rosmalen. Five methods for fly control were studied, namely chemical fly control (CHEM), fly control using insectivorous birds (BIRD), the regular introduction of *Ophyra aenescens* (ENTOMAX), a single introduction of *Ophyra aenescens* (ENGRAFT) and the use of electric traps (TRAP). In REFERENCE rooms, only ethological measures were taken.
CHEM involved the periodical application of larvicides and, only if there were too many stable flies, adulticides. The Larvicides and adulticides belonged to different toxicological groups. In BIRD-rooms air-inlets and fan

[1] National Reference Centre Agriculture

shafts were closed using avairy netting and, bearing in mind the size of the room, a couple of *Lamprotornis purpureus, Sturnus malabaricus* or *Leiothrix lutea* was introduced in each BIRD-room. In ENTOMAX-rooms a box with maggots and pupa of *Ophyra aenescens* was hung in the room in week 1 (introduction), 5, 9, 17 and 24 and after this every 13th week. In ENGRAFT-rooms a box with *Ophyra aenescens* maggots and pupa was spread over the driftbed of slurry in the dung pit two times, with a four week interval. TRAP consisted of one electric trap (Lurectron®, type L201-B) in a room, attracting flies by means of UV light and pheromones (Flylure®) and killing them by electrocution.
The effectiveness of the systems as a means of fly control was measured by weekly counting the number of flies, caught by a 14 x 8 cm sticking trap.

Fly control systems had no effect on the number of fruit flies (*Drosophyla spp.).*
The effect of TRAP on the number of house flies was so small that the farmers stopped using this method prematurely so that nothing could be concluded statistically.
In farrowing rooms only CHEM and BIRD led to fewer house flies ($p < 0.10$) than REFERENCE. In rooms for weaned piglets CHEM and ENTOMAX resulted in fewer flies than REFERENCE ($p < 0.05$) and no effect of ENGRAFT was found ($p > 0.2$). BIRD was not carried out in these rooms. The number of house flies was lowest in rooms with CHEM ($p < 0.01$). According to the farmers both ENTOMAX and ENGRÄFT were satisfactory in rooms for weaned piglets, and they all continued to use one of these systems.
In rooms for growing-finishing pigs CHEM, ENTOMAX and ENGRAFT resulted in fewer ($p < 0.05$) flies than REFERENCE. In BIRD the reduction was not significant ($p = 0.1$).
The farmers judged positively on all fly control systems and most of them continued to use ENTOMAX or ENGRAFT.
Statistical analysis of the effectiveness of the fly control systems in rooms for empty and pregnant sows was not possible, but ENTOMAX and ENGRAFT were certainly not effective there.

Three years after the experiment was started only one farmer continued to use TRAP. He used it in his farrowing rooms and combined it with CHEM. The other farmers stopped because of poor results. In spite of the good results most farmers also stopped using BIRD. Reasons for stopping with BIRD were the droppings in the stables and the fact that the farmer must pay attention to the birds when opening doors. Almost all farmers used ENTOMAX or ENGRAFT or an intermediate form of the system with *Ohyra aenescens* in their rooms for weaned piglets or for growing and finishing pigs. In several pig houses *Ohyra aenescens* had also migrated to farrowing rooms. Most farmers used CHEM in their rooms for dry and pregnant sows and one used BIRD.

▶

Table 1: Annual costs (Dutch guilders) of the fly control systems by type of rooms in pig houses

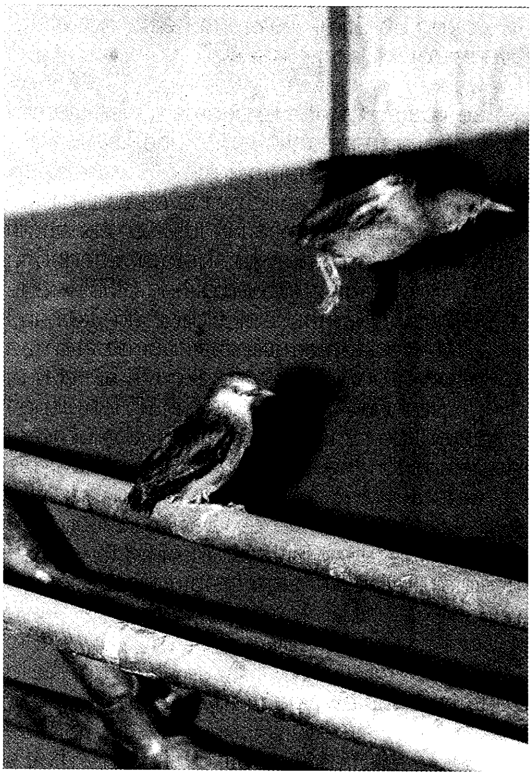
	CHEM[1]	BIRD	ENTOMAX	ENGRAFT	TRAP
6 farrowing rooms	540	180	498	18	1,590
8 rooms for weaned piglets	560	240	664	24	2,120
160 dry or pregnant- sows	962	38	680	20	365
15 rooms for growing/finishing pigs	1,695	450	2,250	75	3,975
total	3,757	908	4,092	137	8,050

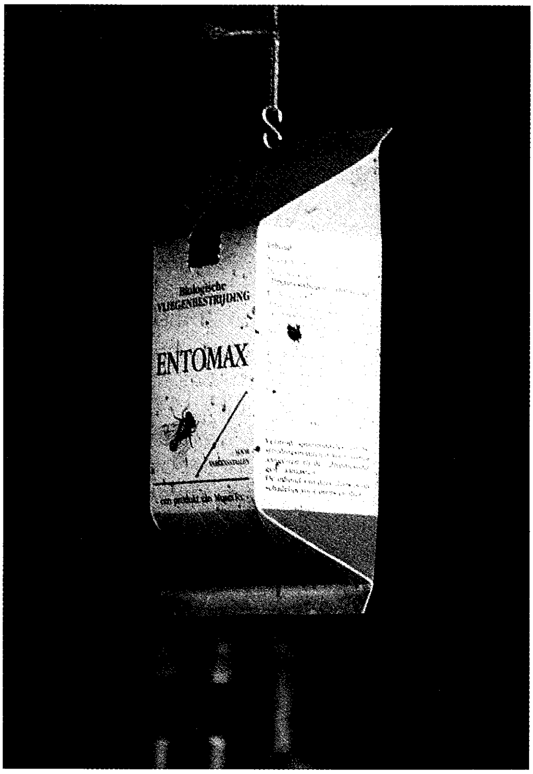
[1] Costs for CHEM according to the protocol. In the experiment less chemicals were needed and the real total costs for CHEM were DFL 2,499.-.

In table 1 the annual costs (V.A.T. incl.) for a farm with 210 sows are presented.

It is concluded that CHEM is most effective. Disadvantages of CHEM are labour and labour conditions, environmental aspects and image of pig meat production. In many rooms for weaned piglets or for growing and finishing pigs fly control using *Ohyra aenescens* is a very good alternate. However, results of this system were poor in farrowing rooms and rooms for dry and pregnant sows. The reason for these poor results is not known, but reasons may be the composition of manure in these rooms or the use of acaricides. There were more stable flies in the rooms with insectivorous birds than in rooms with CHEM, but the former system was suff iciently adequate. However, most farmers stopped using BIRD because of the inconvenience the birds caused. In this study electric fly traps were too expensive and not effective. ■

Report Pl.208





Not only chemical fly control but also fly control by insectivorous birds or by killer flies *(Ophyra aenescens)* is possible

CLEANING OF ROOMS FOR PIGS AFTER SOAKING WITH FOAM OR WATER; COSTS AND QUALITY

ing. P. EM. M. Roelofs, ing. J. G. Plagge

Between February 1996 and March 1997 an experiment was conducted at the Experimental Farm for Pig Husbandry "North- and East-Netherlands" at Raalte. The aim of the experiment was to study the effect of the soaking procedure on working hours and water consumption, needed to clean rooms after all in-all out and on the quality of the cleaning process. The study was done in cooperation with Diversy Lever. The next two soaking procedures were studied in farrowing rooms and rooms for weaned piglets:

WATER: To drench the room with clear water and to keep it wet for 1.5 hours.

FOAM: To soak the room with a foaming soaking detergent (Stafilax Schuim@; minimum soaking period is 15 minutes) and to leave it for 50 minutes.

Before soaking, the pens and passages were swept clean. After soaking, they were cleaned by using a high pressure cleaner (150 - 200 atm. and 16 litres per minute), and by disinfecting them with a detergent (Quat®).
The rooms were soaked according the WATER or FOAM procedure. For the first cleaning in each room, which soaking procedure would be used was randomly chosen. The following cleanings WATER and FOAM were carried out alternately. During the experiment almost all cleanings were done by the same person. Prior to the cleaning, a visual 'dirtyness-score' of the pens was made, on the basis of an assessment record. Working hours and water consumption for cleaning were measured. After cleaning, ATP-bioluminescence tests were done to determine the amount of remaining organic material, and disinfection was checked by using Rodac discs.
No literature was available on the use of ATP tests in pig houses. To get insight into their usefulness, correlations between several tests were determined.

Determining hygiene

A high correlation between visual dirtyness-scores of the same parts of different pens in one room was found. Although there was also a considerable correlation between different parts in one pen, it is advised to assess more parts of the pens (e.g. feeders, floors, pen partitions). Also the results of ATP-tests correlated, but the results of the Rodac-tests hardly did. No correlation was found between ATP-test and Rodac-test.
It can be concluded, therefore, that ATP-test and Rodac test are both useful for hygiene control in rooms for pigs. They are complementary tests, measuring different aspects of hygiene (the amount of organic material (RLU) and the number of colony forming units (CFU), respectively).

Effect on working hours and water consumption

FOAM decreased working hours and water consumption for cleaning, if compared to WATER. In farrowing rooms, cleaning after WATER or FOAM lasted 11.6 and 9.5 minutes per pen respectively ($p < 0.01$). Water consumption was 180 litres and 135 litres per pen respectively ($p < 0.01$). In rooms for weaned piglets, cleaning after WATER or FOAM lasted 7.2 and 6.4 minutes per pen respectively (n.s.), and water consumption was 102 and 90 litres per pen respectively ($p < 0.1$).
For Dutch conditions, costs of labour, water and manure distribution decrease from Dfl 11.86 to Dfl 9.70 per pen and from Dfl 7.03 to Dfl 6.33 per pen in farrowing rooms and rooms for weaned piglets respectively, if the rooms are soaked with FOAM instead of WATER. Including the costs of the detergent, the costs decrease by Dfl 1.74 per pen in farrowing rooms ($p < 0.01$) and Dfl 0.28 per pen in rooms for weaned piglets ▶

(not significant). Also in rooms for growing and finishing pigs it is expected that the use of a foaming detergent saves money. Besides the economic value, working conditions and quality of the cleaning process are important. The use of high pressure cleaning involves heavy physical work under poor working conditions. Due to the reduction in working hours, FOAM will be extra attractive to many farmers.

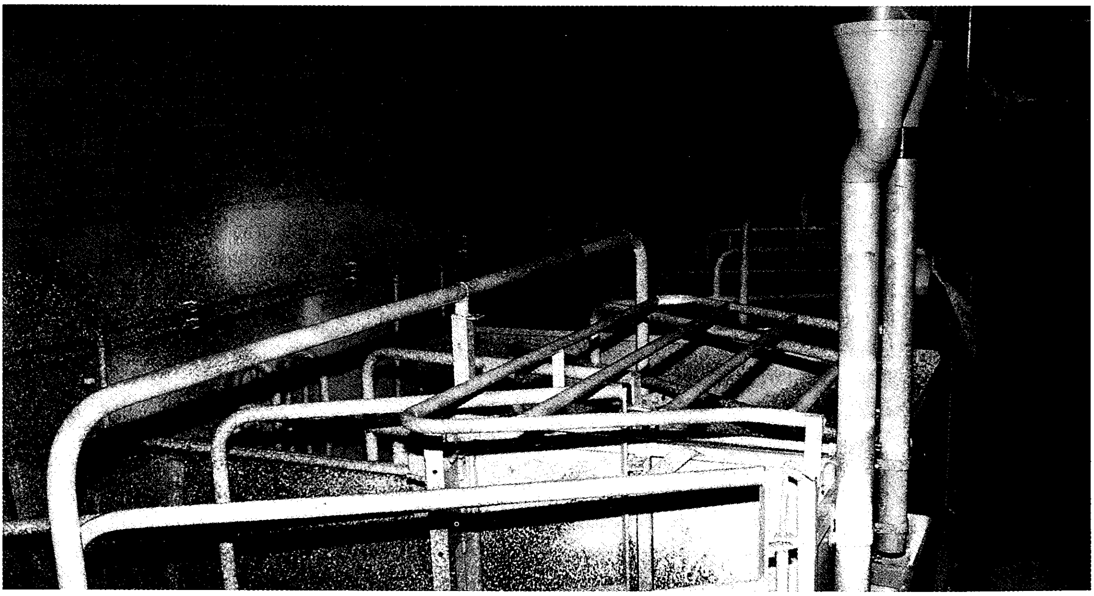
Effect on quality of cleaning

The average hygiene rating, calculated according to the Animal Health Service and based on CFU-counts was clearly good after WATER as well as after FOAM.
ATP-tests were done after cleaning, but before disinfection. In the farrowing pens, the ATP-value on floors was seven times lower after FOAM than after WATER ($p < 0.05$), and total ATP-value in farrowing pens was two times lower (n.s.). In pens for weaned piglets, the ATP-value for feeders, slatted floors and pen partitions was ten times lower after FOAM than after WATER ($p < 0.05$) and total ATP-value in pens for weaned piglets was nine times lower (n.s.).

After cleaning and disinfection, on most parts of the pens also the number of colony forming units was lower after FOAM than after WATER, but the difference was very small and not significant. It is possible to disinfect the surface of materials well. However, underneath this surface there might be many micro-organisms, especially when visual contamination can be seen.
On the basis of current knowledge, an adequate economic assessment of hygiene cannot be done. Adequate cleaning and disinfecting can, however, prevent micro-organisms transferring from one batch of pigs or piglets to another, so as to infect them. Moreover, it is likely to be favourable that piglets come in a clean pen after birth or after being moved to other housing, since during this period they are extra sensitive to diseases. Probably fewer piglets will get a disease and performance will be better when pens are cleaned better.

Based on the effects mentioned before it is advised to use a foaming detergent for soaking instead of soaking with only water. ■

Report P1.216



Soaking of farrowing pens using a foaming detergent

EFFECTS OF TWO TYPES OF FARROWING PENS FOR "FREE RANGE" PIGS AND FREQUENCY OF MUCKING OUT ON PERFORMANCE, LABOUR AND AMMONIA EMISSION

ing. J.H. Huiskes, ing. J. G. Plagge, ing. P.F.M. M. Roelofs, ir. H.M. Vermeer, ir. M. C. Vonk
ing. G. P. Binnendijk, ir. C. E.P. van Brakel

There is an increasing consumer interest for pork produced in an animal and environmently friendly way. The production of "free range" pigs is relevant for this. Extra attention is given to the housing and welfare of the pigs. Farms wishing to participate in this market have to meet requirements concerning available space per animal, use of litter and roughage, an outdoor yard, period of suckling, no tail docking etcetera and use of medicines. The main bottlenecks in the livestock phase for a further development are the economic return, labour conditions and the ability to comply with husbandry and environmental demands/desires.
The performance of sows in free range conditions were inferior to those of sows kept in non-free range conditions. Bottlenecks in the suckling period are the mortality of piglets through crushing and a result of diarrhoea, poor hygiene in the farrowing pen, poor labour circumstances and an expected higher environment pressure due to ammonia emission. These bottlenecks are paradoxical with social desires linked to this way of production and lead, together with the high labour input and extra housing costs, to an increased cost price. In this study therefore, the effects of the design of the farrowing pen and the frequency of mucking out were examined.

The research was carried out from September 1994 to March 1997 at the Experiment Farm at Raalte with a unit of free range pigs. This unit comprises of 50 sows and 200 growing-finishing pigs. The experiment was set up as a 2 x 2 factorial design. The first factor was a New type farrowing pen versus a so-called Danish farrowing pen and the second factor was four times versus two ▶

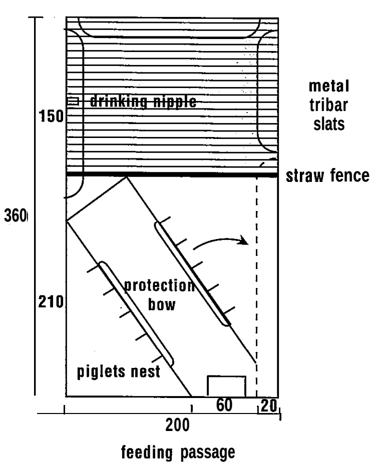


Figure 1: New farrowing pen

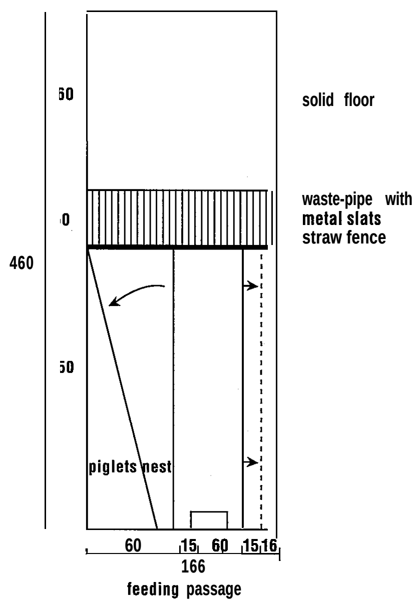
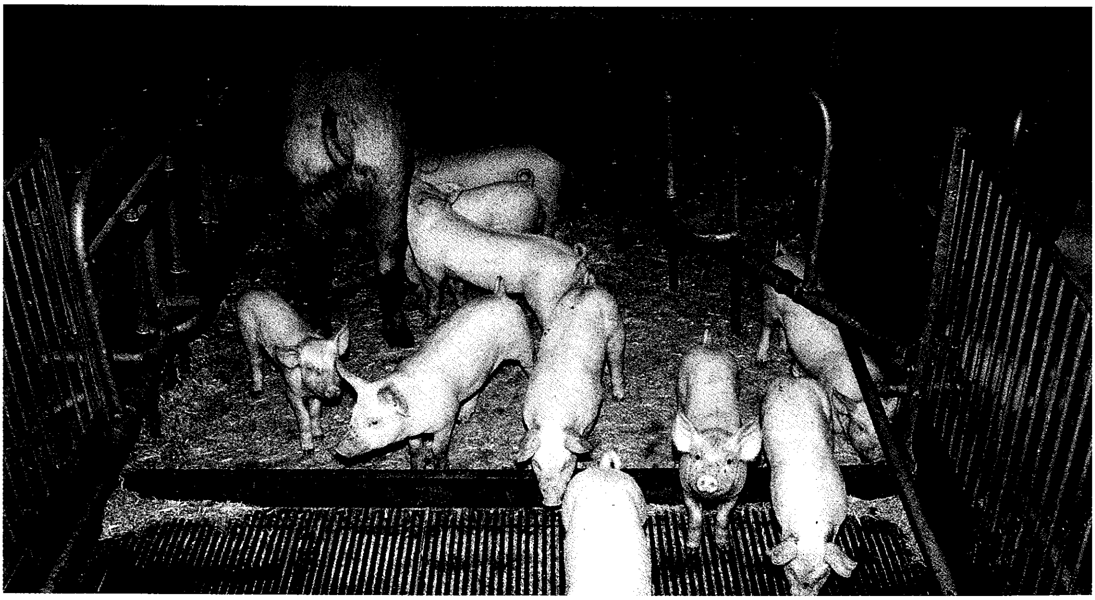


Figure 2: Danish farrowing pen

times mucking out per day.
The housing met the requirements of the International free range meat Control (ISC) (until July 1996) and the Product Board for Livestock and Meat (PVV) (from July 1996 onward).
One compartment comprised of 5 farrowing pens of the New type (figure 1). Each pen had an area to lie down with a solid straw bedded concrete floor without floor heating. The lying area was seperated from the dunging area by means of a plank (straw fence). The floor of the latter area consisted of metal tribar slats. The nett total pen surface was 7.2 m? This was larger than the minimum requirement of 6.5 m^2 (ISC/PVV). Two compartments each comprised of 6 so-called Danish farrowing pens (figure 2). The lying area for sows and piglets was a solid straw bedded concrete floor without floor heating. The lying area was separated from the dunging area by means of bars and a plank (straw fence). The floor of the dunging area consisted of a solid concrete floor with a waste-pipe covered with metal tribar slats immediately behind the lying area. The nett total pen surface was 7.6 m?
The pens were daily supplied with chopped wheat straw in the morning and, if necessary, in the afternoon (during nearly two months with hemp straw). Wet spots on the solid floors were covered with a supply of sawdust. During the period in the farrowing pen, the sows were fed a lactation feed (9.05 MJ Ne_f until January 1th 1996, or 9.49 MJ Nef from that date onward). During suckling at a starting age of about 10 days, the piglets were fed a weaning feed (9.84 MJ Ne_f). Drinking water was available ad lib for the sows and the piglets.

The piglets in the New pen grew better (242 versus 217 gram). As a result of this they had a higher weaning weight than those in the Danish pen (11.4 versus 10.4 kg). In the New pen, mortality of piglets due to diarrhoea was lower (0.3 versus 1.7%) and fewer piglets were treated for intestinal disorders (6.1 versus 12.4%). Mucking out four times daily results in healthier piglets with less diarrhoea (6.1 versus 15%) and a tendency to a higher feed intake. However, it does not lead to increased growth. The legs of the sows improved while they were in the farrowing house. This improvement was higher in the Danish pen, allthough the sta-



The new farrowing pen

tus at the start was also better.
Mucking out four times a day results in a cleaner lying area, especially in the Danish pen, and the use of more litter.The amount of labour required to muck out is lowest (8 minutes per compartment per day, calculated at six pens) in the New pens cleaned twice a day. The New pen requires less labour to muck out than the Danish pen at both four times and two times a day. Mucking out takes up more time when done four times instead of two times in both types of pens.
Cleaning and desinfecting a compartment (calculated at six pens) after each batch takes less time for the New pens than for the Danish pens (3 and 4 hours respectively) and needs less water (2.25 m^3 versus 2.6 m^3). The frequency of daily mucking out was not related to the amount of time and water required to clean and desinfect the compartments.
The 24-hours average concentration of dust is higher in the compartment with New pens (2.11 mg/m^3) than in the compartments with Danish pens (1.69 mg/m^3). Mucking out four times a day results in a higher dust concentration (2.19 mg/m^3) than two times a day (1.61 mg/m^3). The use of chopped hemp straw results in a higher dust concentration (2.37 mg/m^3) than chopped wheat straw (1.43 mg/m^3). The highest concentrations were close to a proposed upper value of 2.4 mg/m^3. The concentration of fine dust (respirable) in the sheds air was so high that there is a realistic chance of respiratory tract complaints from pig farmers and stockmen regularly working in these kind of compartments without the use of personal protective equipment.
The ammonia emission per sow place tended to be lower in the compartment with New pens (4.96 kg ammonia per sow place per year) than in the compartments with Danish pens (6.25 and 7.53 kg). The relatively low ammonia emission from all three compartments is notable, compared with the reference level of the Green Label Foundation. Taking into account these emission levels, the development of a Green Label certifiable farrowing pen for free range pigs must be seen as a realistic option.
The average balance is Dfl 51,- per litter higher for the New pen, but this difference with the Danish pen is not significant. When taking into account the costs of labour and housing the New pen is preferable to the Danish pen. The extra effort required to muck out four times a day instead of twice a day did not lead to an improved economic result.
In conclusion, the New pen is preferable and opens the opportunity to develop a Green Label certifiable farrowing pen for free range pigs. ■

Report Pl. 199

The Danish farrowing pen

AMMONIA EMISSION IN FARROWING ROOMS WITH MANURE TRAYS

ing. A. J.A. M. van Zeeland, ir. N. Verdoes

One of the ways of reducing the ammonia emission in pig husbandry is by adapting the housing systems. At present, a low cost system with low ammonia emission is available for each category of pigs (Den Brok et al., 1997). For lactating sows these include the separate water and manure channel in farrowing pens with fully slatted floors and the farrowing pen with a sloped plate in the manure pit.

The concept of the water and manure channel and the concept of the sloped pit wall can be optimized by manure trays. A manure tray is an undeep plastic tray mounted below the slats. Pre-fab manure trays can be integrated into each existing type of building. Another advantage of the manure tray is that more hygienic conditions are created, which is very important especially for farrowing pens. Futhermore, the incoming ventilation air passes through a passage under the trays. In this way heat exchange can occur before the air reaches the animals (figure 1).

These advantages have stimulated two equipment suppliers to produce an optimized shape for manure trays. One type is based on the concept of the water and manure channel (figure 2). The other one has a sloped form (figure 3). Combined with frequent manure removal the emitting surface is decreased in such a way that the level of ammonia emission remains low. Before introducing these manure trays onto the market, the ammonia emission must be known. The aim of this research therefore was to measure the ammonia emission in accordance with a strictly formulated protocol when using manure trays in farrowing rooms.

The measurements took place between 24th July 1997 and 7th October 1997. During the first and second farrowing period from the rooms using the manure tray and the water and manure channel 3.30 and 3.23 kg NH_3 per sow place per year were emitted, respectively, the average being 3.27 kg. During the first and second farrowing period from the rooms using the manure tray and the sloped form 2.92 and 2.61 kg NH, per sow place per year were emitted, respectively, the average being 2.77 kg. These values of ammonia emission were not corrected for the ammonia concentration from the incoming air.

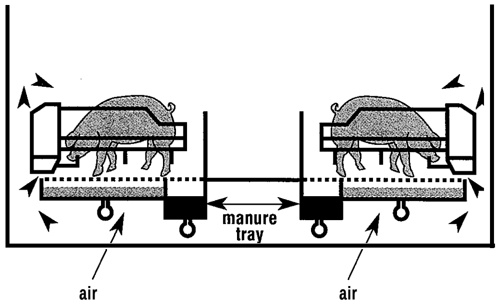


Figure 1: Cross section of farrowing room with manure trays and air inlet channel

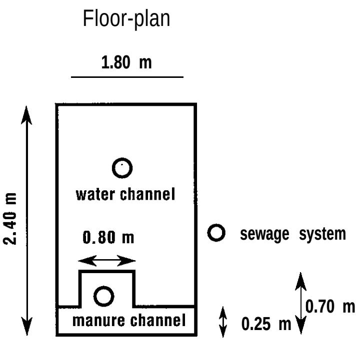


Figure 2: Floor-plan manure tray with separated water and manure channel

After manure removal the ammonia emission decreased, especially for the manure tray with the water and manure Channel. This correlation was not very clear for the manure tray with the sloped form, probably due to the very frequent manure removal every 2 to 4 days. With increasing pen dirtiness, the influence of the manure removal on the ammonia emission decreased.

In an economic evaluation the application of manure trays in new building situations was compared with traditional situations without manure trays for 12 farrowing sows per compartment. Three situations were compared with the traditional farrowing compartment:

- a traditional compartment with manure trays,
- a compartment with an air channel of 15 cm at the front of the farrowing pens and
- a compartment with an air channel integrated in the manure tray.

Compared with the traditional farrowing room without manure trays the extra annual costs of these three situations with manure trays are 110.66, 126.54 and 79.91 Dutch Guilders per farrowing pen per year.
The manure tray with the water and manure channel realized a reduction in ammonia emission (compared with traditional rooms) of 5.03 kg per sow place per year. The extra annual costs per kg ammonia reduction for these three situations with manure trays are 20.01, 25.15 and 15.88 Dutch Guilders, respectively.
The manure tray with the sloped form realized a reduction in ammonia emission (compared with traditional rooms) of 5.53 kg per sow place per year. The extra annual costs per kg ammonia reduction for these three situations with manure trays are 22.00, 22.88 and 14.45 Dutch Guilders, respectively. ■

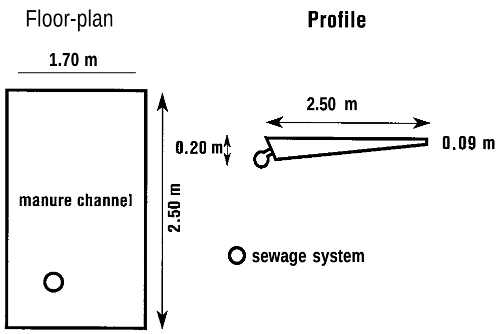


Figure 3: Floor-plan and profile manure tray with sloped form

Report Pl.201

HOUSING LARGE GROUPS OF WEANED PIGLETS IN LOW EMISSION SYSTEMS

ing. A. J.A. M. van Zeeland, ir. N. Verdoes

In the Netherlands many farmers are interested in housing weaned piglets in big groups because of lower housing- and cleaning costs, better performance in the growing/ finishing phase (Vermeer and Hoofs, 1994) and the future obligation to use stable groups (mixing is forbidden). Besides these advantages the piglets have more freedom of movement, which probably increases their welfare. Research shows a lower performance in big groups in comparison with small groups, but the performance may increase by the application of better feeding techniques in large groups. For these reasons piglets will be housed in large groups more frequently. The need for a low cost system with low ammonia emission for large groups is growing.
On the Experiment Pig Farm in Sterksel a study was carried out using two systems with large groups piglets. In the first compartment a water and manure channel was applied under fully slatted floors. The slats above the manure channel were tribar, those above the water channel were plastic. The second compartment was equiped with a partly slatted floor and sloped walls in the manure pit. The pit wall was placed at an angle of 45" and the manure was removed one to two times per nursery period. The expectation was - based on experiences from recent research using the water and manure channel for farrowing sows (Den Brok et al., 1997) and sloped walls for fattening pigs (Van Zeeland, 1997) - that the ammonia emission of both systems would remain below the threshold for Green Label Awards (0.30 kg NH_3 per pig place and year).
The aim of the research was to measure the ammonia emission in accordance with the protocol for measuring animal house with low emission, formulated by Van der Hoek et al., 1996. In the protocol, data on performance, climatization and feeding must also be measured.

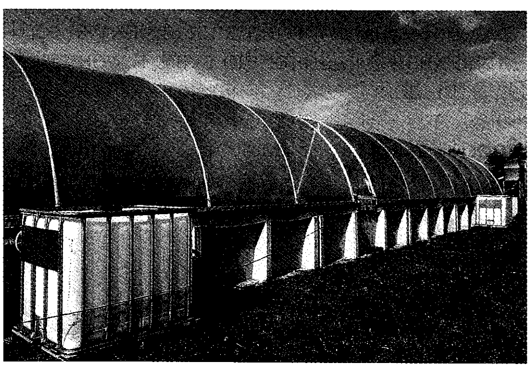
The parameters were measured in the period from March to October 1997. The ammonia volatilization during the first, second and third period in the water and manure channel and fully slatted floor was 0.38, 0.33 and 0.30 kg NH, per pig place and year respectively (with a mean of 0.34 kg NH,). The ammonia emission in the room with partly slatted floor and sloped pit walls was 0.30, 0.19 and 0.35 kg NH_3 per pig place and year (with a mean of 0.28 kg NH,) respectively.
The research showed that weaned piglets in large groups defaecate and urinate on a limited number of places in the room. In the room with the water and manure channel and fully slatted floor, too much manure was dropped in the water and manure channel in spite of adaptions in the third period. In the room with partly slatted floor and sloped pit walls, the pens remained very clean and the ammonia emission remained below the threshold for Green Label. The average level of the manure in the pits was 8.4 cm and the maximal level was 16.5 cm. This corresponds with an emitting surface of 0.12 m^2 and 0.13 m^2 per piglet place respectively.
The costs of these rooms were compared with rooms in a traditional pig house with new building situations. The surface of a room for 60 piglets in a traditional pig house is equal to the surface for 80 piglets in a large group system, since no control path is necessary. In comparison with the traditional pig house the extra annual costs in a room with a water and manure channel and fully slatted floors are Dfl 10.38 lower. The costs of a room with partly slatted floors and sloped pit walls are Dfl 12.13 lower. The extra annual costs per kg ammonia reduction are Dfl 34.60 and Dfl 43.32 respectively. At present these systems are the cheapest way of housing large groups of weaned piglets with a low ammonia emission. ■

Report P 1.207

EVAPORATION OF WATER FROM SLURRY USING SOLAR-ENERGY

ing. J. J. H. Huijben, ir. A. V. van Wagenberg

The Dutch legislation concerning the application of animal slurry on land has been tightened during the last few years. As a result of the fact that slurry-application is not allowed in the winter period, large number of slurry stores have been built. It is compulsory that slurry stores built after 1987 are covered to reduce ammonia emission.
By using slurry stores with a transparent cover, it is possible to evaporate water from the stored slurry. Solar-energy enters the store and stimulates evaporation of water from the slurry. Condensation appears on the inside of the relatively cold cover. This clear condensation-water is collected outside the storage. Computer simulation indicated that evaporating water from slurry within a slurry store could be a viable technique. As a result of the model calculations, a study was designed.
The store had two compartments and a closed cover. The slurry surface of one of the compartments was covered with an isolation-layer. A relatively thin layer of slurry was pumped on this isolation-layer.



Slurty storage with a transparent foil cover constructed upon a trench silo

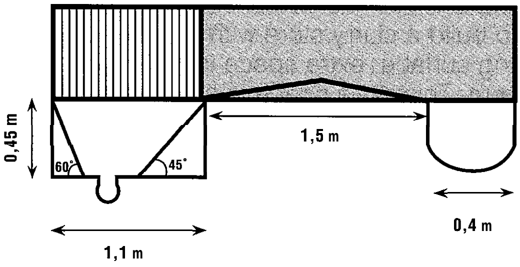
The slurry cover was made of foil.
The reduction in the slurry level was registrated per day and per compartment (with and without isolation-layer). The temperature in different places in both compartments was also measured. The evaporation in the compartment without an isolation-layer was 261 litres water per square metre slurry surface between the first of April 1997 and April 1998. In the compartment with an isolation-layer it was 304 litres water per square metre. The measured results were compared with the results of the simulation model. Thereafter the simulation model was renewed and the measured climate data for the research period was used as input. The measured and estimated temperatures in the slurry store were nearly the same ($r^2 = 0.97$). The estimated evaporation proved to be a little more than the measured evaporation (324 and 278 l/m^2 instead of 304 and 261 l/m^2).
To build a slurry store with a big evaporating surface, extra space is needed on the farm. This extra space is not always present, so it is not always possible to use this method of evaporation of water from slurry.
The total financial savings for slurry transport and application including the extra investment costs (Dfl 10.- per sow or Dfl 1.- per fattening pig) is enough to make the investments profitable, when investment in a slurry store is necessary. If the costs for slurry transport and application rises, the profit may be higher.
On farms with insufficient capacity for storage of slurry, investments in a storage system with a transparent cover is a real alternative to improve the quality of the manure on the own farm in an energy friendly way. ■

Report Pl.213

AMMONIA EMISSION IN A ROOM FOR WEANED PIGLETS WITH A SLOPED PIT WALL

ing. A. J.A. M. van Zeeland, ing. G.M. den Brok

In 1995 a low cost system with a low ammonia emission was developed for weaned piglets: the so-called DeLVris system (Voermans and Hendriks, 1996). The concept of this housing system was based on narrow and deep pens with a narrow water channel at the front of the pen and a broad manure channel at the back. This system received a Green Label Award (BB.96.03.033) and was officially registered with an average ammonia emission of 0.26 kg NH_3 per piglet place per year. Research on the ammonia emission in fattening pigs had demonstrated that the ammonia emission could be decreased further by mounting sloping plates in the broad manure Channel. Therefore research was carried out on the Experiment Farm for Pig Husbandry 'South- and West-Netherlands" in Sterksel to measure the ammonia emission and level at which the pens were



Figuur 1: Cross section DeLVris system with sloping pit walls for weaned piglets

fouled in the DeLVris housing type optimized with sloping pit walls.
The amount of ventilated air and the ammonia concentration were measured during two nursery periods between July 17th and October 2nd 1997. The ammonia emission was not corrected for the ammonia concentration in the incoming air. The results of the measurements were that the ammonia emission was 0.19 and 0.15 kg NH_3 per piglet place per year for the first and second period respectively and averaged 0.17 kg NH_3.
The highest manure level in the channel was 14 cm. This was equivalent to a maximal emitting manure surface of 0.073 m^2 per piglet place. Compared to the DeLVris system the reduction of the emitting surface was minimised to 33%. Annoyance from flies, caused by dirty sloping pit walls, was not recorded in this research.
In an economic evaluation this system was compared with a traditional house for weaned piglets in a new building situation. The extra investment costs for the DeLVris system and for the DeLVris system with sloping pit walls were Dfl 13.30 and Dfl 16.39 per piglet place per year. The extra annual costs were very low: Dfl 0.90 and Dfl 1.40 respectively. The extra annual costs per kg ammonia reduction for the system were Dfl 3.25. ■

Report P4.31

ENERGY USAGE AND LACTATING SOW AND PIGLET PERFORMANCE IN FARROWING COMPARTMENTS WITH A LOWERED SET POINT OF THE ROOM TEMPERATURE

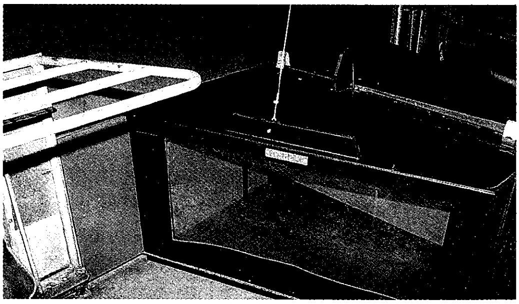
ir. t? J. W. M. Geurts, ing. G.P. Binnendijk ing. J. J. H. Huijben, dr. ir. J. W.G. M. Swinkels

Heating costs form the main part of the total energy cost of commercial sow operations. Within a commercial sow farm, most of the energy usage occurs in the farrowing compartment, because the temperature requirement is high for the suckling piglets. In this study it was examined whether a reduction in temperature setting of 2°C in combination with an adequate micro-climate for suckling piglets can contribute both to energy savings and improvement of lactating sow performance.

In total 96 sows were used in this study. The study was conducted in four naturally ventilated farrowing compartments (six sows per compartment) with a combination of indirect and direct air-inlet during November 1996 and May 1997. In the compartment with the standard temperature setting (control), the "set point for heating" and "set point for ventilation" were set at 21°C and 23°C, respectively, when all sows in the compartment had produced their litter. In the experimental compartment, both set points were reduced with 2°C. A hoover with local heating was installed in each pen of the experimental compartments to provided the suckling piglets with an appropriate micro-climate. In total eight batches of sows were followed in the winter period. After each batch, the control and experimental treatments were switched between compartments.

In each of the eight batches, a difference in room temperature was realised between the compartment with the standard and reduced temperature settings. The room temperature was on average 1.1°C lower in the compartment with the reduced temperature setting. The reduction in room temperature had no effect on lactating sow and piglet performance. In conclusion it is possible to reduce the room temperature in naturally ventilated farrowing barns, where the air-inlet is direct and the optimum micro-climate of the suckling piglets can be guaranteed using a hoover. Energy savings in the compartments with reduced temperature settings mounted to DFI 3.- per sow and year, without negative effects on lactating sow and piglet performance. The increased cost for electricity (DFI 3.50 per sow and year) can be avoided when using floor heating and letting the call light in the hoover burn for only a few days after farrowing. ■

Report P 1.202



Farrowing pen with a hoover for local heating

TECHNICAL FUNCTIONING OF THE AIR PATHOGEN FREE (APF)-FACILITY: AIR TREATMENT AND HYGIENE MEASURES

ing. J. J. H. Huijben, ing. D. J.P.H. van de Loo, ir. A. V. van Wagenberg, dr. ir. J. WG. M. Swinkels, dr. P.C. Vesseur

When fewer pathogens can enter a pig facility, there is less risk of these pathogens causing disease amongst pigs free from them. The pig health status can more easily be kept on a pig farm. Depending on the kind of pathogen, the advantages can either be better economic results or better sales potential. For example, the export of piglets to a growing number of German provinces is reserved for only farms with an Aujeszky-free certificate. Many pathogens are spread through the air. Air filtering can prevent these pathogens from entering a pig facility via the air.

The Air Pathogen Free (APF)-facility has been built for the Research Institute for Pig Husbandry. The APF facility contains two nursery rooms and four growing-finishing rooms.

In the APF facility, the introduction of airborne pathogens is prevented by an air treatment installation. The air treatment installation consists of a central pre-treatment unit, an air distribution channel and, for each room, a treatment unit, an air distribution channel and an air outlet. The introduction of pathogens in other ways is prevented by measurements described in a strict hygiene protocol (Van de Loo et al., 1996). The functioning of the air treatment installation and the effectiveness of some of the hygienic measures were tested between June 1996 and July 1997. Two batches of growing-finshing pigs and five batches of piglets were housed in the APF facility.

To judge the functioning of the air treatment installation during the test period the air pressure was collected and observed in several places in the system and measurements of the indoor climate within the rooms were carried out.

Blockages and leakages in the system could succesfully be detected using the air pressure data. It was possible to control the amount of ventilation air in the rooms after several technical improvements. There were no problems with the air distribution within the rooms since three pieces of wood were placed in the air channel beneath the alley. The pieces of wood were placed in the air stream in the air channel to force part of the air stream up.

The room and floor temperature gave no problems.

The measured values of CO_2 and NH_3 were always lower than the maximum acceptable concentrations. The same was found to be the case for the dust concentration. The mean relative humidity in the nursery room was 46%; 60% is seen as an acceptable lower limit (Wergroep Klimaatsnormen, 1989). In a growing-finishing room the relative humidity was lower than the lower limit of 50% in 66% of the time. During the test period no problems occured that could be caused by dry air.

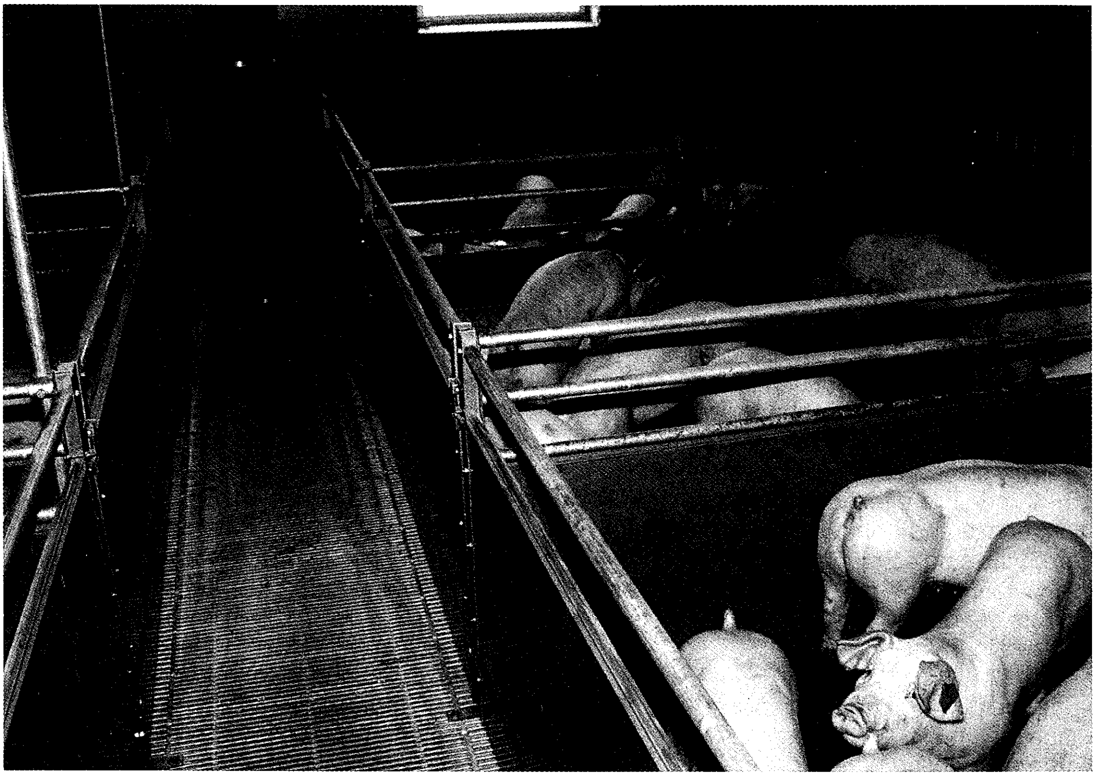
The energy use of the air treatment installation was also measured. The calculated energy costs were Dfl 19.- per piglet place per year and Dfl 30.- per growing-finishing pig place per year.

The measures taken to maintain a good level of hygiene are described in a hygiene protocol. The effectiveness of several hygiene measures was tested. Cleaning the rooms was effective as was the treatment with formaldehyde to kill remaining agents in the room. During the test period no problems concerning hygiene occured.

The economic perspective of an APF facility for 1,840 growing-finishing pigs was evaluated as a part of this study. The extra opera-

tional costs had to be offset by an improvement in pig performance. The extra investment costs compared to a regular faciltiy were Dfl 191.- per pig place per year. The extra operating costs were Dfl 50.- per pig place per year.
To raise the gross margin by Dfl 50.- per pig place per year, the daily gain had to increase by 9% (from 737 to 819 gram per day) and the feed conversion had to improve by 9% (from 2.78 to 2.53 kg food per kg gain) (Geisterfer, 1998). For farms with a regular facility and mean production results (737 gram per day and 2.78 kg food per kg gain) an APF facility could be interesting. ■

Report Pl.209



Air inlet via the air channel beneath the feeding alley in the APF facility

PEN TYPE AND WELFARE OF A.I.-BOARS

ir. E. M.A.M. Bruininx, ir. H.M. Vermeer, ir. P.F.G. Vereijken[1], T. Wassenaar[2], dr. ir. J. W.G.M. Swinkels

Introduction

The Dutch Welfare and Health Regulations for Pigs of 1994 states that the accommodation of boars should be such that the boar can turn round and hear, smell and see other pigs. Additionally the boar should have a clean resting place. This resting place should be dry and comfortable. Furthermore the pen for an *adult* boar should have a floor surface of at least 6 m? If the pen is used as a mating area, it should have a surface of at least 7 m? Finally, the boar pen should, in the case of a partially slatted floor, have a non-slatted area of at least 66%. These regulations are based on advice for boar pens in breeding farms which in general only have a few boars at their disposal. However, in Artificially Insemination (A. I.)-centres several hundred boars are often kept in crates (0,8 x 2,5 m) or in pens with a partially slatted floor or in pens with straw (5 - 7 m^2). The effect of housing on production, health and behaviour (all part of welfare) was studied since little research has been carried out on boars regarding the effects of housing on welfare. This project is divided in three parts:

- the definition of boar categories to clarify the statement "adult boar";
- the description of relationships between the housing of A.I.-boars and their production and health, using raw data from the management information systems of six A. I.-centres;
- the description of relationships between the housing of A.I.-boars and data on behaviour and health, based on an experiment at one A.I.-centre.

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[2] Agricultural College, Delft

Definition of boar categories

In the case of the housing of boars, the expression adultness, as it is used in the Dutch Welfare and Health Regulations for Pigs of 1994, can best be interpreted in terms of bodysize for the formulation of pen specifications. In literature, the space requirements of pigs to perform certain behaviour (e.g. turning) are related to the body length and the body height of the animals. However, little data is available on relations between body size and the age of modern A. I .-boars.
At the Research Institute for Pig Husbandry a protocol was developed to measure the body height and length of A.I.-boars of the breeds Yorkshire-terminal boar and Krusta. Based on the maximal body size measured according to this protocol it was concluded that Yorkshire-terminal boars and Krusta boars are able to lie totally recumbent on a lying space of 2,5 m?

Relations between housing of A.I.-boars and production and health based on a database study

Relations between pen characteristics on the one hand and production and health features on the other were studied by means of statistical analysis of data from management information systems (MIS) from six A.I.-centres and from a questionnaire. Preceding this analysis the MIS-data were checked carefully for errors.
Because of the very unbalanced distribution of the data over the experimental factors the analysis was performed with the data of only one A.I.-centre in which the distribution of the data was acceptable.
The results of the analysis gave no indication of the effects of housing type (crates versus pens with partially slatted floors versus pens with straw) on sperm production. However, the results indicated a better quality (better morphology of the sperm cells) of the sperm

produced by boars housed in pens with straw than by boars housed in'crates or pens with a partially slatted floor. This difference in sperm quality may be explained by the isolating properties of straw. In this way boars are less affected by fluctuations in temperature. Another possible explanation for this difference is the occurrence of differences between compartments which have no relationship with pentype (e.g. climate control)

This database study gave no indication of the effects of housing type on the health of A.I.-boars.

Relations between housing and welfare of A.I.-boars based on experimental research

From experimental research on an A.I.-centre with three kinds of boar pens (crates, pens with a partially slatted floor and pens with straw) it was concluded that A.I.-boars housed in crates show less oral activity. In contrast with sows, the occurrence of oral activity in A.I.-boars was considered to be a poor indication of the occurrence of stereotype behaviour in A. I.-boars.

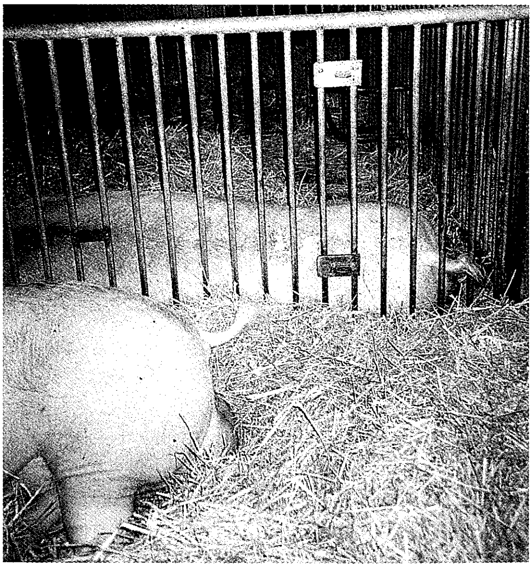
Furthermore, it was concluded that the occurrence of skin and leg lesions was higher in crates than in pens with straw. The occurrence of skin and leg lesions in pens with a partially slatted floor was intermediate. Additionally, the results indicated that because of the limited freedom of movement, boars housed in slatted crates were forced to lie down in their own manure in as far as it remained on the slatted floor. That is why the boars housed in crates were dirty and the slatted floor stayed clean.

Conclusions

The results of this research project indicated that the housing of A.I.-boars should be differentiated into different areas for lying and dunging. A lying area of 2,5 m² is sufficient for totally recumbent lying. Based on a total floor space of at least 6 m² (Dutch Welfare en Health Regulations for Pigs, 1994) this implies 40% solid floor. For optimal health (minimal leg and skin lesions and minimal dirtiness) and maybe also for sperm quality, the use of straw on the pen floor is preferable. Labour aspects (quantity and safety) and hygiene concerning the use of straw should also be considered. ■

Report P 1.203

A.I.-boars housed in crates



A.I.-boars housed in pens with straw

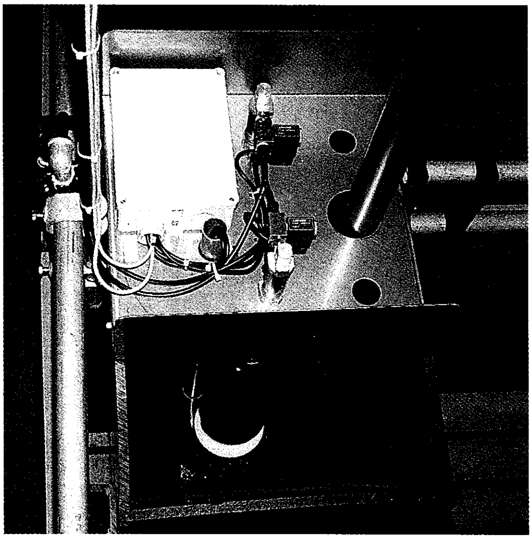
FEEDING LIQUID FEED FROM VARIO-MIX OR USING A LONG TROUGH TO GROWING-FINISHING PIGS

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

Several different liquid feeding systems for growing-finishing pigs have been introduced during the last years. The systems have only 1 or 2 feeding places and differ from the conventional long trough, in which the number of feeding places is equal to the number of pigs per pen. The new systems take up less floor space and allow ad lib liquid feeding. Since March 1995 the Vario-Mix Feeder, a new feeding system from the company Verbakel B.V., is available for growing-finishing pigs. This is a system with one feeding place and storage space for liquid feed. Little is known about the effect of ad lib liquid feeding on performance and slaughter quality. Therefore, a study was conducted to examine the effect of ad lib liquid feeding using Vario-Mix on the performance, slaughter quality and health of growing-finishing pigs at the Experiment Farm for Pig Husbandry in Sterksel. Besides that, technical and practical aspects of working with the Vario-Mix Feeder were registrated. Two experimental treatments were tested:

1 Ad lib liquid feeding using Vario-Mix Feeder
2 Semi-ad lib liquid feeding using a long trough

The liquid feed included standard compound feed mixed with water in a water : feed ratio of 2.4 : 1 and 2.2 : 1 during the first four weeks and the remaining weeks respectively. Seven rounds (from 26 kg to 111 kg live weight) with 464 growing-finishing pigs were tested. Animals were housed in groups of 8 pigs per pen.



Source: Verbakel B.V.
Vario-Mix Feeder for growing-finishing pigs

The group fed using the Vario-Mix Feeder realised a significantly higher feed intake although daily weight gain was not improved significantly. The higher feed intake occurred between 26 and approximately 47 kg live weight. No significant difference in feed to weight gain ratio was observed between the two treatments. Moreover the lean meat percentage and type judgement did not differ. Groups fed a liquid diet using the Vario-Mix Feeder tended to require fewer veterinary treatments due to oedema-disease.
During the whole experiment between January 1995 and July 1996 Vario-Mix Feeder functioned well. However, hygiene aspects of the storage of liquid feed were not optimal. It is noteworthy that no liquid by-products with a low acidity were used in these experiments. A pilot study showed that liquid feed containing liquid by-products resulted in better hygiene than a diet without by-products. No visual differences in feed spoilage are observed between the two experimental treatments.
The gross margin per delivered pig did not differ between the two treatments. ■

Report PI.206

THE USE OF LIQUID BY-PRODUCTS. A REVIEW

ir. R. H. J. Scholten, ir. M.M. J.A. Rijnen

There is a rapidly increasing demand for independant information on liquid by-products. However, there are few scientific papers on studies in which pigs are fed diets with liquid by-products. Several trials at the Research Institute for Pig Husbandry in Rosmalen, the Netherlands, show increasing performance, increasing health status and lower feeding costs when pigs are fed a diet including liquid by-products, such as liquid wheat starch, whey and smashed potato steam peel. The exact mechanism by which liquid by-products cause these changes is still unclear.

This literature study describes several aspects regarding the use of liquid by-products, such as:

- a general description of commonly used liquid by-products and their production processes
- the use of liquid by-products by pig farmers
- results of trails with liquid feed, with or without liquid by-products
- a short explanation of fermentation processes
- a description of several specific properties of carbohydrate rich liquid by-products and their possible influence on the performance and health of pigs.

The general description of liquid by-products shows the wide range of different liquid by-products from several industries that may be used in pig feed. The succesful use of liquid by-products in pig husbandry is dependant of many aspects, such as the correct calculation of the feeding value, the hygiene of storage and feeding systems, representative sampling of the by-products, the value of analyses and management by the pig farmer.

Liquid by-products can be divided into groups on the basis of their nutritional components: carbohydrate rich, protein rich and fat rich by-products. About 60% of the Dutch by-product market has been captured by three carbohydrate rich by-products: liquid wheat streach, whey and smashed potato steam peel.

The number of feeding and digestibility trials carried out with liquid by-products is low. Only liquid wheat starch and smashed potato steam peel are sometimes used in this kind of trial. These trials show that liquid wheat starch and potato steam peel are very suitable for use in pig diets.

Carbohydrate rich by-products have some specific properties needed for storage. They are delivered warm, stored from several days to several weeks and fed regularly. Moreover they have a low dry matter content, contain high levels of easily degradable carbohydrates, have a low pH and contain lactic acid bacteria and organic acids.

These properties make the storage tanks act like fermentation tanks, in which carbohydrates are femented by lactic acid bacteria into lactic acid, volatile fatty acids and ethanol. Many studies show a possible positive effect of organic acids and probiotics in pig feed on pig performance. The exact action path of these components is still not clear and is dependent on may external factors.

Common liquid diets, composed of compound feed and water, also ferment spontaneously if stored long enough. If these fermented liquid diets also have positive effects on the performance and health of pigs, then a wider use of these fermented liquid diets may be possible. The control, mechanism and use of the fermentation processes still need more research.

Researchers in Denmark, United Kingdom and the Netherlands are carrying out studies on many of the specific aspects of liquid feed and liquid feeding systems. ■

Report Pl.210

FERMENTATION OF LIQUID DIETS AND BY-PRODUCTS DURING STORAGE

ir. M.M. J.A. Rijnen, ir. R. H. J. Scholten

In the Dutch pig husbandry increasing amounts of liquid by-products, most commonly with high contents of carbohydrates, are fed to pigs. These by-products are usually stored in big tanks, in which fermentation can easily take place. Products most commonly formed during fermentation are lactic acid, acetic acid and alcohol. Fermentation may also occur in liquid diets, although it is not known to what extent fermentation products are formed. The fermentation products may have a positive effect on the health and performance of pigs. In this study, therefore, the changes in physical and chemical traits of liquid diets and liquid by-products are quantified during a storage of 6 days.
Two liquid diets and three liquid carbohydrate-rich by-products were used in this experiment. The liquid diets were a grower and a finisher diet mixed with water in a water to feed ratio of 2.5 : 1. The liquid by-products were whey, wheat starch and mashed potato steam peel. Both liquid diets and products were stored in 50 l pvc-storage tanks for a period of 6 days. The experiment consisted of two phases. In both phases, the storage of liquid by-products and diets were repeated three times. In the first phase dry matter content, pH and temperature were measured over time to determine the optimum time points of sampling for the second phase of the experiment. In the second phase samples of all products were taken at 10 times during storage. Each of the samples were frozen to be later analysed for pH, dry matter, buffering capacity, (in)organic matter, crude protein, true protein, crude fat, deoxidizing monosaccharides, lactose, (soluble) starch, formic acid, acetic acid, propionic acid, (iso-)butyric acid, (iso-)valeric acid, lactic acid and ethanol. Differences between components due to storage time were statistically analyzed for all components within products, where only the 0 and 144 h time points are considered.

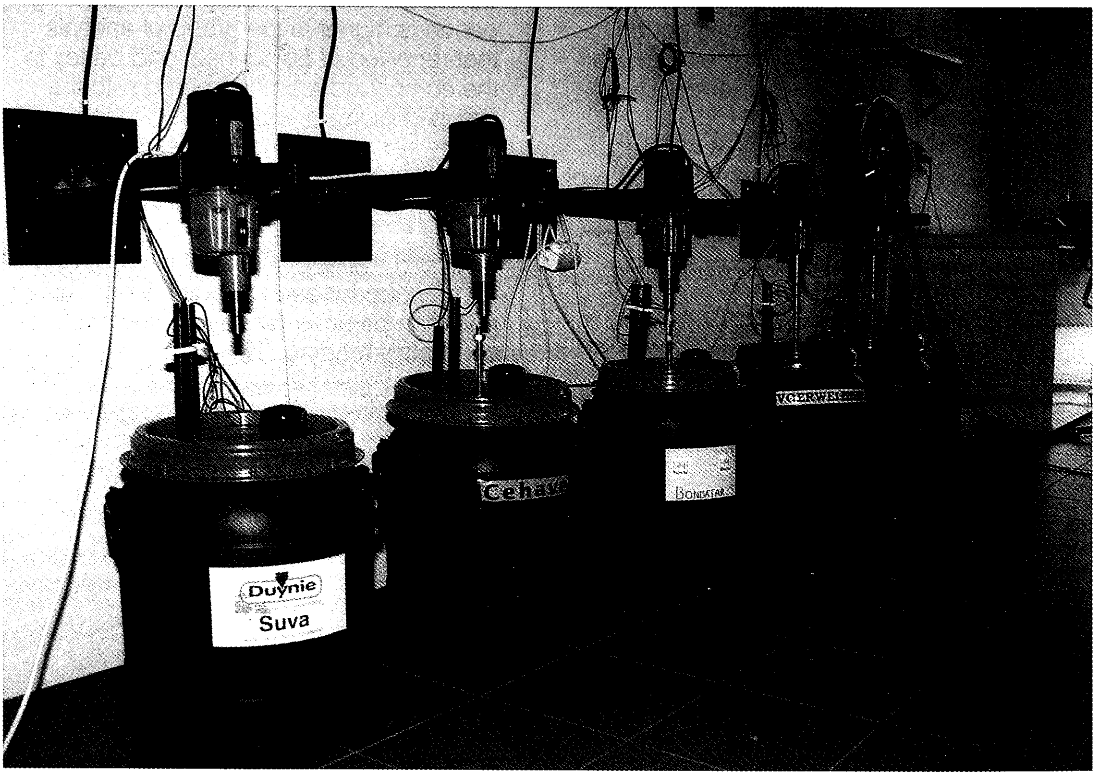
The most important results and conclusions of this experiment are:

- Acidity of all products decrease during storage. At the end of the storage period the pH of the by-products and liquid diets is 3.5 and 3.8 respectively. Noticeable is the turned S-curve pattern of the reduction of the pH in both liquid diets.
- The dry matter content of the liquid grower diet, whey and potato steam peel decrease significantly during storage. On the other hand dry matter content of liquid finisher diet and liquid wheat starch after 144 hours of storage did not differ from the content at the beginning of storage.
- Dry matter content adjusted for volatile components of whey and potato steam peel decrease significantly during storage. The dry matter content of both liquid diets and liquid wheat starch did not decrease significantly during storage.
- The difference between the dry matter content and the adjusted dry matter content may increase to 13.9 g/kg after 144 hours storage, absolutely.
- Except liquid wheat starch, buffering capacity of all products decreases significantly over time. Buffering capacity of the two liquid diets is higher than that of the three liquid by-products.
- Contents of inorganic matter, crude protein, true protein, crude fat of all products did not change during storage. Only the inorganic matter content of finisher liquid diet and the true protein content of potato steam peel showed an increase.
- Starch content of both liquid diets and potato steam peel decrease significantly during storage. The starch content of liquid wheat starch did not change during a storage of 6 days.
- Content of sugar of liquid grower diet and content of lactose of whey decreased significantly. The sugar content of potato steam peel has a tendency to increase,

that of liquid wheat starch and liquid finisher diet did not change.
- Content of soluble starch of the liquid diets and potato steam peel after 144 hours of storage do not differ from the content at the beginning of storage. The soluble starch content in liquid wheat starch has a tendency to decrease.
- Formic acid concentrations increased significantly in liquid grower diet. The content of acetic acid increased significantly in both liquid diets. The propionic content did not change in all products.
- Lactic acid concentrations increase significantly in all products, except for liquid wheat starch. Noticeable is the S-curve pattern of the lactic acid level of both liquid diets during storage.
- Content of ethanol of liquid grower diet and whey increased significantly during storage and it has a tendency to increase in liquid finisher diet. The content of ethanol of liquid wheat starch did not change.
- Variations in chemical composition between the three repeatments occur.

Based on the results of this experiment, it may be concluded that remarkable differences in physical and chemical properties of liquid by-products and liquid diets are observed at the time of delivery. If storage period is prolonged, however, in the liquid diets fermentation occur also. During storage, fermentation does not only occur in liquid by-products, but also in liquid diets. The main components of the fermentation process are the lowered pH due to increased levels of lactic acid and acetic acid. These fermentation components may contribute to improved growth performance and pig health. ■

Report PI.21 1



Storage tanks for fermentation at the Research Institute for Pig Husbandty

FEEDING 50% OF WHEATAND BARLEY TO GROWING AND FINISHING PIGS: SEPERATELY OR IN COMPOUND FEED

ir. M.M. J.A. Rijnen, ir. R. H. J. Scholten, ing. J. G. Plagge

Low prices of cereals make them economically interesting for use in pig diets. Most research on cereals that has been done by the Research Institute for Pig Husbandry focused on the replacement of compound feed by wheat. This wheat was not processed into the compound feed, but was fed separately in combination with complementary compound feed. Wheat was treated by a hammer mill, a crusher or a structure mill. These experiments showed that feeding wheat separately increased feed to gain ratio than when feeding complete compound feed. In the experiment described in this report also barley was fed separately. The goal of this experiment was to determine the effect of feeding barley and wheat separately instead of feeding compound feed with meat and barley on growth performance, pig health and slaughter quality of growing-finishing pigs.
Two experimental groups were examined:

1 Complete compound feed diet with 50% of barley and wheat (control).
2 Diet with 50% of barley and wheat separately in combination with 50% of complementary compound feed.

The growing pigs received 25% of barley and 25% of wheat and the finishing pigs 15% of barley and 35% of wheat.

The most important results and conclusions are as follows.

- No significant differences in growth and feed- and energy intake between the two groups have been found.
- There is an increase in feed- and energy conversion when animals were fed 50% of barley and wheat separately compared with a complete compound feed diet with 50% of barley and wheat.
- Pigs fed the diet with cereals in the compound feed prove to drink more ($p < 0.10$) water than pigs that were fed barley and wheat separately.
- Meat quality, number of veterinary-treated animals, culled pigs are not different between the two treatments.
- The occurrence and severity of diarrhoea during the first two weeks of the growing period is higher in the group of animals that received of 50% wheat and barley in the compound feed compared with the group of animals that were fed wheat and barley separately and complementary compound feed.
- Feeding costs are reduced when the cereals used are fed separately from the compound feed and a financial gain of Dfl 3.56 can be reached for each pig delivered. This gain can be used for paying the costs of separately feeding. ■

Report Pl.215

INFLUENCE OF BENZOIC ACID IN THE DIET ON PERFORMANCE AND URINE PH OF GROWING-FINISHING PIGS

ir. C.M. C. van der Peet-Schwering, ir. N. Verdoes, ing. J. G. Plagge

Ammonia emission from pig houses can considerably be reduced by a combination of housing and feeding measures. Research at the Experimental Farm for Pig Husbandry at Raalte showed that adding an acidic mixture containing 70% of benzoic acid reduced ammonia emission to a level of 1.22 kg ammonia per pig place per year. Up to now benzoic acid has not been allowed yet in pig feed. As part of the registration procedure of benzoic acid, an experiment was conducted to examine the effect of benzoic acid in the diet on the performance and health of growing-finishing pigs and on the pH of urine and slurry.

Three experimental treatments were compared comprising in total 60 individually housed growing-finishing pigs:

1 *0% of benzoic acid*: *sows* and barrows were fed a starter diet and a growing-finishing diet with 0% of benzoic acid;

2 1% *of benzoic acid*: *sows* and barrows were fed a starter diet and a growing-finishing diet with 1% of benzoic acid;

3 2% *of benzoic acid*: *sows* and barrows were fed a starter diet and a growing-finishing diet with 2% of benzoic acid.

All pigs were fed twice a day. Water was supplied four times a day.

The most important results and conclusions are:

- Pigs fed diets containing 1% of benzoic acid grew faster and had a better feed conversion ratio than pigs fed diets with 0% or 2% of benzoic acid. The growth rate was 40 g/day higher and the feed conversion ratio was 0.1 better. Pigs fed diets containing 0% and 2% of benzoic acid showed the same performance.
- Pigs fed diets containing 1% or 2% of benzoic acid had less diarrhoea problems than pigs fed diets with 0% of benzoic acid.
- Gross margin per pig place per year was highest when pigs were fed diets containing 1% of benzoic acid. The difference between pigs fed diets with 0% and 2% of benzoic acid was Dfl 1 O.- and Dfl 14.80 respectively.
- The pH of the urine and slurry was influenced by the percentage of benzoic acid in the diet: the higher the percentage of benzoic acid in the diet, the lower the pH of the urine (7.52, 6.45 and 5.59 respectively) and slurry (8.18, 7.76 and 7.26 respectively).
- When the pH of the slurry is lower, there is more nitrogen in the form of ammonium nitrogen in the slurry. ■

Report P5.8

Individually housed growing/finishing pigs at the Experimental Farm at Raalte

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P 5.2
Spray-dried blood plasma and spray-dried blood cells in diets of weaned piglets. C.M.C. van der Peet-Schwering and Binnendijk, G.P., March 1997.

P 5.3
Research Reports 1996. May 1997.

P 5.4
A raised soft farrowing mat during lactation. H.M. Vermeer and Binnendijk, G.P., November 1997.

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A comparison between pig farming in the European Union and North America. M.A. H. Vaessen, Bastiaansen, M.A.C. and Backus, G.B.C., March 1998.

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Urinary pH, ammonia emission and performance of growing/finishing pigs after the addition of a mixture of organic acids, mainly benzoic acid, to the feed. G.M. den Brok, Hendriks, J.G.L., Vrielink, M.G.M. and Peet-Schwering, C.M.C. van der, January 1999.

P 5.8
Influence of benzoic acid in the diet on performance and urine pH of growing/finishing pigs. C.M.C. van der Peet-Schwering, Verdoes, N. and Plagge, J.G., January 1999.

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The influence of induced parturition and the moment of vaccination against Swine erysipelas during lactation on the weaning-to-oestrus interval in sows. M.C. Vonk, Binnendijk, G.P., Vesseur, P.C., March 1999.

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