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Growing-Finishing Pigs in an Uninsulated House

1. Pig performance and health and the influence of rearing system

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Abstract. Pig performance and health were studied in growing-finishing pigs housed in an uninsulated building. Comparison with insulated reference housing showed that the animals in the uninsulated housing system had a significantly lower daily weight gain (831 vs. 866 g/day), poorer feed conversion efficiency (2.91 vs. 2.79 kg feed/kg gain), and tended to have a lower carcass meat percentage (58.0 vs. 58.4). The health and condition of the pigs in the uninsulated housing system compared with that of the animals in the reference housing were somewhat poorer; more problems with diarrhoea were recorded. No differences were found with regard to culling rate or mortality.

The piglet rearing system of the pigs (in a multisuckling pen vs conventional rearing with one litter per pen) did not have any impact on performance, but the multisuckling pigs had a higher morbidity and a higher frequency of tail biting. The role of competition during the suckling period was unclear with respect to these observations. Pigs reared in the multisuckling system had less injuries after introduction into the growing-finishing house as compared to those conventionally reared, probably because they were not regrouped at this time.

INTRODUCTION

Over the past years, interest in the production of growing-finishing pigs in simpler buildings in Sweden has been increasing. Deep litter systems are commonly used in simple uninsulated buildings, but the high labour- and straw consumption and the poorer carcass classification of the animals make these systems too expensive for commercial pig production (Andersson, 1992). Therefore, there is a need to develop a housing system with limited straw usage and low labour costs. However, all the requirements of the animals (range 17–110 kg) have to be taken into account during both very cold (−15°C) and warm (30°C) periods, and the lack of insulation, fans, heaters, etc., in an uninsulated building makes it even more difficult to create an optimum environment. Thus more variation in the standard production parameters may be expected for this type of animal environment.

A poorer daily weight gain and feed conversion efficiency is found by many investigators (Jensen et al., 1969; Gustafsson et al., 1990) for pigs raised in simple buildings, as compared to those raised in traditional housing systems. A poorer carcass classification during the winter has also been noted by these workers.

Studies in the literature on the impact of temperature on the performance of ad libitum fed pigs are summarized in Table 1. In order to obtain an optimum performance, pig housing temperature should be within the thermal neutral zone, and if possible, in the cooler part of that zone.

In order to reduce investment costs and labour, pigs in simple buildings are usually housed in large groups. At high stocking rates, increasing group size has a positive effect on performance (Randolph et al., 1981) and reduces aggression (Briant & Ewbank, 1972). However, at low stocking rates such as those used in Sweden (0.85–1.20 m^2/pig), increasing group size has a negative impact on performance (Randolph et al., 1981; Petherick et al., 1989) and increases aggression among pigs (Bryant & Ewbank, 1972).

In larger groups, grouping per se may also cause problems with regard to behaviour and performance. Mixing animals significantly depresses performance in growing-finishing pigs (Rundgren & Löfquist, 1988; Tan et al., 1991). Petherick et al. (1989) note that there was a greater variation in weights within a large group 2 weeks after introduction, than there was between pigs housed in smaller groups, indicating that the establishment of the social

Table 1. *The relation between thermal comfort and performance in pigs, literature review*

Thermal comfort		Feed intake	Protein deposition	Fat deposition	Growth rate	Carcass meat %	kg feed/ kg gain
Very cold	Heitman & Hughes (1949)	↑			↓		↑
	Sörensen (1961)	↑	↓		↓		
	Sugahara et al. (1970)	↑					↑
	Close (1981)		↓	↓	↓	↑	
	Nichols et al. (1982)	↑			↓		↑
	Dauncey et al. (1983)				↓		
	Dauncey & Ingram (1983)			↓		↓	
	Riskowski & Bundy (1990)	↑					
	Lopez et al. (1991b)	↑			↓		↑
	Sakai et al. (1992)				↓		
Cold	Heitman & Hughes (1949)	↑			↑		↑
	Sörensen (1961)	↑	↓		↑		
	Nichols et al. (1982)	↑			↑		↑
	Riskowski & Bundy (1990)	↑					
Normal	Heitman & Hughes (1949)	0			0		0
	Sörensen (1961)	0	0		0		
	Nichols et al. (1982)	0			0		0
	Lopez et al. (1991a 1991b)	0			0		0
Warm	Heitman & Hughes (1949)	↓			↓		↑
	Sörensen (1961)	↓	↓		↓		
	Close (1981)				↓		
	Nichols et al. (1982)	↓			↓		↑
	Lopez et al. (1991a)	↓			↓		0
	Sakai et al. (1992)				↓		
Very warm	Heitman & Hughes (1949)	↓			↓		↑
	Sörensen (1961)	↓	↓		↓		
	Sughara et al. (1970)	↓			↓		0
	Nichols et al. (1982)	↓			↓		↑
	Sällvik & Walberg (1984)				↓		
	Sakai et al. (1992)				↓		

structure may require more time in larger groups.

It has been suggested that pigs grouped during the suckling period in the so-called 'multi-suckling' systems might have fewer problems when introduced in the growing-finishing house, possibly leading to better performance. The advantage of premixing might even be greater when grouping into large groups. On the other hand, mixing during the suckling period would evoke more competition at an early, sensitive period (Bryant et al., 1983), which may result in poorer performance, health and negative social development during the suckling period (Petchey et al., 1978), and later in life.

The aim of the following studies was to determine how two different housing and two different rearing systems affected the performance and health of growing-finishing pigs. The results comprised part of a project studying production, health, pen function, thermal comfort, climate and working environment in an uninsulated housing system for growing-finishing pigs. The studies with respect to rearing were a part of an ongoing project studying the effect of different management procedures and housing systems for pigs at weaning (Rantzer et al., 1993).

MATERIALS AND METHODS

Experimental design

This investigation included 2 treatment groups (housing systems) and 2 rearing systems. Eight batches of piglets (trials), introduced at different seasons of the year, were used for this investigation. These batches were divided into two groups, and housed in the reference housing system and uninsulated housing system, respectively.

Housing systems

The studies were carried out at the JBT research farm, Odarslöv, with 40 purebred Swedish Landrace sows in production. Technical details of the housing systems and pen design are fully described by Andersson et al. (1994).

Reference housing system. Eight pigs per pen (Danish design) were housed in the insulated reference housing system. The pens had a bedded lying- and feeding area (2.6 * 2.25 m) and one single-space feeder. The excretory area (2.6 * 1.5 m) had 2 drinking nipples and slatted flooring.

Uninsulated housing system. The pens in the uninsulated building housed 16 pigs each and had the same basic pen design. The well-bedded lying area (2.5 * 3.0 m) was covered with an insulated roof during cold periods (daytime temperatures lower than 18°C), and for the first 4–5 weeks after introduction plastic flaps in the entrance of the kennel kept the warm air inside the lying area. Two single space feeders were placed on the feeding area (1.0 * 3.0 m). The excretory area (3.5 * 2.25 m) had a solid concrete floor with an urine channel and 3 water nipples.

The space distribution and the total space per pig (1.2 m^2/pig) was the same for both housing systems. The set temperature in the reference housing system was 18°C for pigs up to 50 kg and 16°C for pigs of more than 50 kg. The air temperatures in both houses are presented in Botermans et al. (1995).

Rearing systems

The piglets before entering this experiment were reared in the following systems:

Multisuckling rearing. The piglets were born in a conventional farrowing pen. At 7 to 14 days post partum, four sows with their litters were grouped into a large well-bedded pen. When weaned at 4.5 weeks of age, the piglets were moved to one large weaning pen. At 10 weeks of age and weighing approximately 16 kg (range 9–26 kg) all piglets were marked and weighed. The large group of pigs was divided into two groups, taking into account their genetic background and sex, of which one was transfered to the insulated reference housing system and the other to the uninsulated housing system. These pigs were never mixed after the first grouping at 7 to 14 days of age (see Fig. 1).

Conventional rearing. The piglets were born in a conventional farrowing pen and stayed there until weaning (4.5 weeks of age) when each litter was moved to a separate weaning pen. At 10 weeks of age, the pigs were moved to the two housing systems and mixed (pigs from 5–10 litters), taking into account their genetic background and sex.

Feeding

At introduction in the growing-finishing houses, piglet feed (Startfoder, Lantmännen) was provided. After 2 weeks, standard pelleted diet for growing-finishing pigs was given (Slaktsvinsfoder, Singel pelletskross, Lantmännen, having: metabolizable energy, 12.6 MJ/kg; crude protein, 14.0%; and lysine, 8.5 g/kg). The amount of feed given to each pen was recorded using volume measurement. The weight of this volume measurement was checked regularly. All pigs had ad libitum access to feed.

Animal management and slaughter

In the reference housing system, the pens were cleaned once a day, if necessary; fresh chopped straw was given once a day in the lying area (1.2 kg/pig/week). The pens in the uninsulated housing system were cleaned 2–3 times a week, using a tractor to scrape the excretory area, and the eating and lying areas were also cleaned manually, if necessary. Fresh straw was given 2–3 times a week (1.5 kg/pig/week). For details about general management, feeding, handling and husbandry see Olsson et. al. (1990) and Andersson et al. (1994).

At 1 and 7 weeks after introduction, the pigs were examined and injuries were recorded. Injuries on the head, body, front and back legs were registered for each pig, using a scale of 0–3 (where 0 = no injury, 3 = severe injury) (Svendsen et al., 1990). The total injury scores

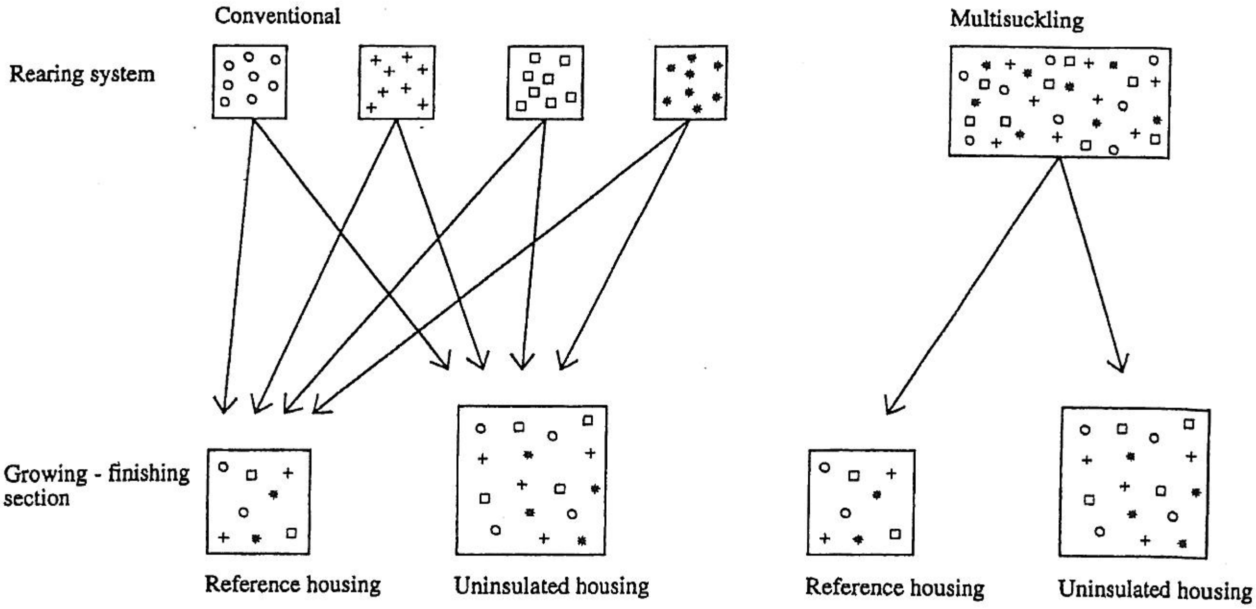

Fig. 1. Experimental design; animal flow.

were calculated per pig (minimum value 0, maximum value 12), and the average injury scores were calculated per pen.

During the entire growing period, the occurrence of disease and treatments were recorded for each pig (Svendsen et al., 1988). There had to be at least a 3 weeks difference between the occurence of two diseases of the same kind before they were recorded as separate diseases. At slaughter, the presence of disease (included organ control) was noted for each pig. All pigs dying during this investigation were post-mortem examined and the causes of death established and noted. Reasons for culling were also recorded.

The pigs were slaughtered at about 110 kg live weight. Live weight at slaughter was calculated on the basis of the carcass weight at slaughter, using a dressing percentage of 72% (Andersson, 1980). The individual commercial carcass meat percentage was recorded at the slaughter house. For each pen, the performance was calculated based on the data obtained for all identified slaughtered pigs. The feed intake was measured per pen and corrected for dead, culled and unidentified pigs at slaughter. In addition, feed conversion efficiency was calculated.

Statistics

In all, the production results were calculated for 49 pens (27 and 22 pens in the reference and uninsulated housing systems, respectively). These results were considered to be independent. The data were statistically analyzed, using analyses of variance to determine significant differences between the two housing systems and rearing systems. The following model was used:

$$y_{ijkl} = u + t_i + s_{ijkl} + b_{ijkl} + r_j + h_k + e_{ijkl}$$

where:

y_{ijkl} = the $ijkl$th observation
u = general mean
t_i = effect of the ith trial ($i = 1, 2, \ldots, 8$)
s_{ijkl} = correction for the average initial live weight in the pen
b_{ijkl} = correction for percentage barrows in the pen
r_j = effect of the jth rearing system ($j = 1, 2$)
h_k = effect of the kth housing system ($k = 1, 2$)
e_{ijkl} = residual random term.

Mortality, reasons for culling, and occurence of diseases were calculated per pen as percentage of the number of animals. The pens were considered to be independent. Wilcoxon tests were used to determine differences in health between the two housing systems, and the two rearing systems. The average injury scores were calculated per pen and analyses of variance were used to determine differences between the two housing and rearing systems.

RESULTS

Performance

There was a significant effect of trial on performance. The initial weight, corrected for trial, of the pigs reared in the multisuckling system was significantly lower upon entering the growing-finishing house than was that of pigs reared in the conventional system (15.5 vs. 16.5 kg, $p = 0.007$, SED = 0.35).

Effect of growing-finishing housing system. The pigs in the uninsulated housing system showed a significantly higher number of feeding days, poorer daily weight gain, poorer feed conversion efficiency and tended to have a lower carcass meat percentage (Table 2). Examination of the data showed that the pigs in the uninsulated housing system had a lower carcass meat percentage (corrected for sex and live weight at slaughter) when slaughtered during the winter period (October–March) (57.5 vs. 58.4%, $p = 0.018$, SED = 0.30). During the winter period, the feed conversion efficiency tended to be poorer for the pigs in the uninsulated housing system (2.94 vs. 2.85, $p = 0.1214$, SED = 0.057) and the daily weight gain tended to be lower (843 vs. 864 g, $p = 0.1173$, SED = 12.8), but the amount of feed consumed per pig/day was the same in both houses (2.47 vs. 2.46 Kg, $p = 0.8301$, SED = 0.051).

During the summer period (April–September), there was no significant difference in carcass meat percentage at slaughter for the pigs between the 2 housing systems (58.6 vs. 58.4%, $p = 0.6362$, SED = 0.30). The feed conversion efficiency was significantly poorer for the animals in the uninsulated housing system compared to the reference housing system (2.86 vs. 2.73, $p = 0.0500$, SED = 0.062) and daily weight gain tended to be lower (813 vs. 856 g, $p = 0.0575$, SED = 21.0), but the amount of feed consumed per pig/day was uninfluenced by housing system during the summertime (2.31 vs. 2.33 Kg, $p = 0.7189$, SED = 0.061).

Effect of rearing system. The pigs reared in the multisuckling system showed the same performance as those reared in the conventional system, when corrected for trial, initial weight, percentage barrows and growing-finishing housing system. In some trials, the pigs from the multisuckling system performed better, while in other trials they did not have as good a performance as those reared in the conventional system.

Disease

Effect of growing-finishing housing system. During trials 7 and 8, an outbreak of dysentery-like diarrhoea occurred. The morbidity of this disease was higher in the reference housing system. The disease occurred among younger animals; 1 or 2 pigs suddenly became thin and had dysentery-like, blood-stained, chocolate coloured mucoid, watery faeces. Individual pigs

Table 2. *Least square means for performance results and carcass evaluation for growing-finishing pigs in the reference and uninsulated housing, respectively. Corrected for the effect of trial, initial weight, percentage barrows and rearing system*

	Reference housing	Uninsulated housing	S.E.D.	Level of significance
No. pens	27	22		
No. pigs slaughtered	207	332		
Live weight at slaughter (kg)	111.8	111.5	0.84	n.s.
Days in experiment	112.9	117.0	1.48	**
Daily weight gain (g)	866	831	13.6	*
Daily feed intake (kg)	2.42	2.40	0.039	n.s.
Feed conv. efficiency (kg/kg)	2.79	2.91	0.040	**
Carcass meat percentage	58.4	58.0	0.21	+

n.s. = not significant. + = $p < 0.10$, * = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$.

were treated with anti-dysentery drugs, usually with satisfactory effect. Pen treatments were usually not performed. The dysentery-like disease was not considered to be related to the housing system. The pigs in the uninsulated house tended to have a higher frequency of other types of diarrhoea in comparison to the pigs in the reference housing system (Table 3). In these cases the blood-stained, chocolate coloured diarrhoea was never observed; the pigs became unthrifty, long haired and had a greyish, watery diarrhoea. Individual treatment of these pigs with with Tetracyclines and B-vitamin for 5 days was usually effective; pen treatments were never performed.

Effect of rearing system. The pigs reared in the multisuckling system, compared with conventional rearing, tended to have more diarrhoea and had more problems with tail biting (Table 3). Tail biting was observed in 6 out of the 8 trials.

Causes of death and culling

Effect of growing-finishing housing system. There were small differences in the culling rate and mortality between the housing systems. In the uninsulated housing system, 2.6% of the pigs were culled and 1.4% of the pigs died. In the reference housing system, 2.3% of the pigs were culled and 0.9% of the pigs died. The main reason for culling was tail biting (pigs which had bitten other pigs).

Effect of rearing system. Pigs reared in the multisuckling system were more often culled because of tail biting ($p = 0.0002$); 5.1% of the animals reared in the multisuckling system were culled because of this reason, vs. 0.3% of the animals reared in the conventional system.

Condition and injury studies

Effect of growing-finishing housing system. There was no difference in pig injury score between the housing systems at 1 or 7 weeks

Table 3. *Disease and slaughter notations (as percentage of pigs slaughtered) according to growing-finishing system and rearing system; multisuckling (Multi) and conventional (Conv.) rearing system*

	Reference housing		Uninsulated housing		Level of significance	
Rearing system	Multi	Conv.	Multi	Conv.	Housing	Rearing
No. pens	7	20	8	14		
No. pigs per pen at start	7–8	8	13–16	15–16		
Total no. pigs at start	54	160	123	223		
No. pigs culled	4	1	7	2		
No. pigs dead during experiment	0	2	1	4		
No. pigs slaughtered	50	157	115	217		
Diseases during the growing period (%)						
Dysentery	14.3	13.4	9.3	6.1	n.s.	n.s.
Other diarrhoea	13.3	4.6	17.5	11.6	+	+
Coughing/Sneezing	18.9	16.4	20.3	14.6	n.s.	n.s.
Locomoter problems	2.4	0.6	–	0.9	n.s.	n.s.
Tail bitten	10.9	2.1	20.5	–	n.s.	***
Ear bitten	–	1.3	9.5	6.1	+	n.s.
Tail or ear biters	–	0.7	4.7	–	n.s.	n.s.
Other	4.2	1.4	–	1.4	n.s.	n.s.
Slaughter notations (%)						
Pneumonia or pleurisy	4.1	3.8	2.6	3.7	n.s.	n.s.
Joint infl. or periathritis	1.8	0.7	–	–	n.s.	n.s.
Liver damage – parasites	1.8	3.1	3.5	5.5	n.s.	n.s.
– other causes	1.8	3.3	3.2	4.1	n.s.	n.s.
PSE or died during transport	5.9	3.1	3.3	3.7	n.s.	n.s.

n.s. = not significant. + = $p < 0.10$, * = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$.

Table 4. *Condition and injury score for growing-finishing pigs at 1 and 7 weeks after introduction in the reference and uninsulated housing systems, respectively, according to rearing system; multisuckling (Multi) and conventional (Conv.) system*

	Reference housing		Uninsulated housing		Level of significance	
Rearing system	Multi	Conv.	Multi	Conv.	Housing	Rearing
One week after introduction						
Thin, %	7.4	2.5	9.8	3.2	n.s.	n.s.
Injury score, average	1.00	2.40	1.05	2.25	n.s.	***
Seven weeks after introduction						
Thin, %	0	5.7	10.8	9.2	**	n.s.
Injury score, average	1.10	1.54	0.98	1.55	n.s.	+

n.s. = not significant. + = $p < 0.10$, * = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$.

after introduction (Table 4). At 7 weeks after introduction, the percentage of animals which were thin was significantly higher in the uninsulated housing system.

Effect of rearing system. The pigs reared in the multisuckling system had significantly fewer injuries at 1 week after introduction, compared to the pigs reared in the conventional system. Even at 7 weeks after introduction, this difference could be observed.

DISCUSSION

Both housing systems resulted in good performance. However, the performance results of the pigs in the uninsulated housing system were significantly poorer than that of the animals in the reference housing system, a tendency observed in similar investigations (Jensen et al., 1969; Gustafsson et al., 1990). The low initial weight might have been a disadvantage for the pigs entering the uninsulated housing system. Introducing pigs at a weight of 25–30 kg might have resulted in fewer introduction problems during the winter periods and thus better performance, since pigs with a higher body weight have a better tolerance for lower temperatures than those with a low body weight (Bruce & Clark, 1979).

The colder environment in the uninsulated housing system did not lead to an increase in daily feed intake and higher daily weight gain in comparison to the reference housing system, as found by other investigators (Table 1). Nevertheless, the pigs in the uninsulated housing system, especially when slaughtered during the winter, had a lower carcass meat percentage than pigs in the reference housing system. This cannot be explained by a higher feed intake or greater daily weight gain. The colder environment may have affected the carcass meat percentage negatively, as observed by Dauncey & Ingram (1983) and Sörensen (1961), but the more extensive environment, larger group size or some other stressors may also have had a negative impact on carcass meat percentage. The generally low carcass meat percentage (slightly lower than the average for the slaughter house) observed for pigs from both housing systems may have been due to the animals having ad libitum access to feed through to slaughter. It is recommended that the feed ration be restricted from about 60 kg body weight to slaughter in order to reduce the amount of fat deposition (Andersson, 1985). More research has to be done on feeding methods for restricted feeding in simple housing systems, while maintaining good performance and animal welfare.

Comparison of the performance results for the two rearing systems did not reveal any significant differences. The pigs reared in the multisuckling system had a significantly lower initial weight than the conventionally reared animals. However, the animals from the multisuckling and conventional systems were reared in two different buildings. It is not clear if the difference in initial weight was due to the competition during the suckling period between the piglets in the large group, or due to climatic or other environmental differences between the two housing systems. In some trials, the multi-suckling pigs had more disease problems during the rearing period, which affected subsequent production. Not as many pigs were reared in the multisuckling system as were in the conventional system. More data are required in order to be able to draw reliable conclusions with regard to the impact of rearing system on performance.

The morbidity was high, which was partly due to the very accurate methods of monitoring and registration. Even clinical diseases such as coughing and sneezing, which did not result in treatment, were registered. The health and condition of the pigs in the uninsulated housing system was a little poorer in comparison to that in the reference housing system. In addition, it was more difficult to find the sick animals in the uninsulated housing system because of the kennel.

Multisuckling pigs showed significantly more disease and incidences of tail biting, and significantly more of these animals had to be culled because they were tailbiters. Tail biting among multisuckling pigs during the growing-finishing period was a significant problem, since it was observed in 6 out of 8 trials. Competition in the multisuckling system might have had an effect on social development (Schouten, 1986), resulting in tail biting later on in life (Olsson & Hederström, 1989). Beattie et al. (1993) found that pigs reared in an enriched environment showed more tailbiting than pigs reared in a barren environment, when housed in a barren environment during the growing-finishing period. Similar observations were made in the present study.

In this investigation (1.2 m^2 total pen area/pig), mixing animals into a group of 8 or 16 animals per pen did not appear to affect the level of injuries. Thus under these conditions, in contradiction to the literature (Bryant & Ewbank, 1972), no negative effect was found for mixing large groups with regard to injuries, but group size may have affected performance. Pigs reared in the multisuckling system showed significantly fewer injuries at 1 week after introduction, which suggests that they fought much less when they were moved to the growing-finishing houses than those conventionally reared did. The social structure of pigs reared in the multisuckling system appeared to be more stable, because even at 7 weeks after introduction the multisuckling pigs tended to have fewer injuries, as compared to the conventionally reared pigs. This probably reflected the fact that the multisuckling pigs were not mixed after weaning.

Besides production characteristics and animal health, other factors such as labour costs, working environment and straw usage, have to be taken into account by pig producers when constructing or reconstructing growing-finishing facilities. These aspects have been investigated and discussed by Andersson et al. (1994). The effect of pen function and thermal comfort have been further studied by Botermans & Andersson (1995), to get a better understanding of the functioning of the system.

It can be concluded that it was possible to produce growing-finishing pigs in an uninsulated housing system. However, performance results were poorer and somewhat more disease problems were found in the uninsulated housing system in comparison to the reference housing system. Introducing heavier animals into the growing-finishing house might eliminate these problems.

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