Performance, labour and economic aspects of different farrowing systems

Quendler E., Podiwinsky C., Baumgartner J., Winckler C., Boxberger J.
University of Natural Resources and Applied Life Sciences, Department of Sustainable Agricultural Systems, Division of Agricultural Engineering
Peter Jordan Straße 82, 1190 Vienna, AUSTRIA.
Tel 0043 1 47654 3506, Fax 0043 1 47654 3527, elisabeth.quendler@boku.ac.at

Abstract

Pig farming is undergoing significant changes. Animal welfare is gaining importance in our society and the long-term future of the pork industry depends upon production methods being accepted by consumers and retailers alike. Farmers have to find economically viable systems as an alternative to farrowing crates that must also be competitive. There are several different farrowing systems available on the Austrian market today. They can be roughly divided into two categories: pens and farrowing crates allowing various degrees of freedom of movement and nest building of sows and litters.

The eight systems studied differed in design, space allowance, door opening and closing devices; as well as wall, feeder, crate and creep area design. These differences created variations in performance, work time requirements and gross margin. The number of piglets weaned per litter and sow (from 8.87 to 9.73 piglets) differed significantly among the systems investigated. The system related differences in average piglet weight at weaning time were as high as 4.7%. The system related labour requirements (not including work time requirements for management) ranged from 4.2 to 6.0 hours annually per sow. Labour requirement times varied up to 42.7%. According to these differences, the outputs and gross margins were lower for free farrowing pens than for farrowing crate systems. The system-related differences in gross margins annually per sow were as high as 29.3%, the highest variations were found between sows kept in sow pens and those in farrowing crates. Among the different farrowing crates, system related gross margin differences per sow and year were less than 8%.

Keywords: piglet, time requirements, farrowing systems, gross margin, litter.

Introduction

Animal welfare concerns increasingly gain importance in our society. The interest in farrowing accommodations that do not restrict sow movement or nesting behaviour is growing. Farmers are searching for alternatives that assure efficient operation methods and acceptable financial performance. This means weaning a high number of piglets per litter while maintaining, or even minimising, production costs, labour costs in particular. The transition to a more animal friendly system can require changes in farm set up and management, which result in increased costs. In the past, for example, some pen designs have resulted in higher piglet mortality.

Recently, several farrowing crate and pen systems with more or less animal friendly designs have become available on the Austrian market. Eight of them have been chosen for evaluation in an interdisciplinary study.

The farrowing crates aim to make management as easy as possible. This is achieved by using a crate to control sow movement, which reduces the risk of crushing piglets and protects the stockperson from sow aggression. The pens give sows more freedom, allowing them to turn around and also express a higher level of maternal behaviour (Taylor et al. 2006).

Differences in housing design affect not only labour time requirements, but also sow and piglet performance and therefore profit. In order to identify these differences, similar environmental conditions and data collection methods are necessary to ensure a high degree of accuracy. This accuracy enables objective comparison and therefore results that can be applied to improving ecological and economic innovation potential and hence existing techniques. These demands require precise measurement and documentation, for example using digitally based methods.

Material and Methods

Performance, labour time requirements and the economic aspects of eight different pen systems, three farrowing pens and five farrowing cates, were investigated on a large-scale piglet farm in Austria, as part of a project subsidized by the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management.

The stables held around 600 sows and were equipped with eleven rows of ten different farrowing accommodations. In the farrowing unit, the work processes, climate control, and birth management were optimised for keeping sows in farrowing crates.

To determine litter performance variation, the performance data of each sow during the birth and suckling phase was collected with software developed specifically for the collection and analysis of sow reproduction data. The relevant per sow parameters were litters per year, percentage of sows replaced annually and the number and weight of birthed, piglet losses and weaned piglets related to each farrowing accommodation.

The performance of around 600 sows was recorded over 17 months. System effects on the number of piglets per litter, the weight of piglets weaned and piglet losses were evaluated using data from the 1,436 litters born into the eight investigated systems.

In order to objectively measure the system related time requirements and identify differences, the system related work processes were broken down into small, measurable episodes, or work elements. Measurements of these work elements were repeated to gain representative standard times usable for planning purposes (Schick 2005).

Physical and monetary data regarding variable costs and output per sow and system were collected for gross margin calculations. The measured time requirements and collected performance data were pooled in SAS for statistical analysis. The differences in system related performance were tested by GLM (Generalized Linear Model) and GENMOD (Generalized Model) models. The GLM model was used for continuous data, work times (element related) and weight of piglets. The GENMOD was used for categorical data litter size at weaning and the piglet losses in percentage.

Results and Discussion

The different designs of the five farrowing crates and three sow pens in this study influenced litter performance (piglet mortality, litter size, body weight at weaning), work time requirements and, consequently, gross margin results.

Performance variation

On average, each sow bore 2.23 litters and weaned 2.17 litters per year. Around 44 % of the sow stock was replaced each year. The medium group of the Austrian and Saxon large-scale farms obtained similar results (Gerner et al. 2007; Mewes 2006).

System type, sow group, litter number class, management, litter size, piglet weight after birth and genotype of the sow had significant impacts on the system related number of piglets weaned and piglet mortality. The GLM model used was adjusted to allow for these factors.

Piglet weight, measured using the GENMOD model, was significantly affected by system type, sow group, parity number, litter size, piglet weight after birth and suckling days. The data on the reproductive performance parameters in the different systems, sow pens and farrowing crates, are presented in table 1.

Table 1. System related piglets weaned per litter, weaned piglet weight, and percentage of piglet losses for 1.384 litters (2005-2007)

System	Piglets weaned per litter	Weight weaned per piglet	Piglet losses in percent
FS1 (FT)	**8.87 a**	**6.08 ab**	**23.12 a**
FS2 (JY)	**9.05 ac**	**6.26 a**	**20.96 ac**
FS3 (IK)	**9.29 a**	**6.10 ab**	**19.09 ab**
KS1 (SM)	**9.68 b**	**6.08 ab**	**15.75 b**
KS2 (SA)	**9.43 bc**	**6.10 ab**	**17.91 bc**
KS3 (BD)	**9.56 b**	**5.98 b**	**16.10 b**
KS4 (HM)	**9.62 b**	**6.09 ab**	**15.54 b**
KS5 (LT)	**9.73 b**	**6.04 ab**	**18.83 b**

The number of piglets per litter was partly significantly affected by the holding system. The number of piglets per litter ranged from 8.87 to 9.73 piglets, a difference of up to 0.86 piglets. The lowest number of piglets weaned per litter and sow was found in the sow pens, especially in the structured FS1. Significant differences regarding litter size consisted between the two sow pens FS1, FS2 and the five farrowing crates. In the sow pen FS2, sows achieved a litter performance similar to that of the farrowing crate with the poorest litter size weaned, the KS2. There were no significant differences in the number of piglets weaned per litter for the five different farrowing crates, differences being up to 0.3 piglets weaned per litter. Different results were obtained at Swiss farms, where the same litter sizes at weaning were achieved in both sow pens and farrowing crates. In both farrowing systems 9.6 piglets per litter and sow were weaned, independent of the farrowing system (Weber 2007). The litter sizes of Austrian working team farms producing piglets mainly in farrowing crates were 8.9 to 10.5 piglets weaned per litter (Gerner et al. 2007).
For piglet weight, differences of up to 0.28 kilograms per piglet were found. Piglets in the sow pen FS3 and the farrowing crate KS5 achieved the maximum difference, this also being the only significant one. Johansen et al. (2004) identified the most important risk factors as being low piglet birth weight, arthritis, diarrhoea, other infections, forelimb-skin abrasions on a piglet, weak pasterns of sows on concrete slats, poor milking of the sow, low birth weight and gender; and not farrowing system construction differences.
Piglet losses per litter were relatively high on this farm, varying between 15.5% and 23.1% per sow and litter. There were significant differences in piglet losses per litter for sows in the structured sow pen FS1, up to 8.84%, or 0.86 piglets. Sow had partly significant higher piglet losses in the sow pens FS2 and FS3 over the farrowing crate systems. Within the farrowing crate systems there were no significant differences in piglet loss per sow and litter.
Usually, losses are lower than 15%. For example, the piglet losses of Austrian working team farms were 10.9% to 13.1% per litter and sow (Gerner et al. 2007). The assumed reasons for

higher losses on the trial farm include the high frequentation of the farrowing unit by pupils, lecturers and students, and low labour input.
Weber (2007) determined piglet losses of 12.1% per litter on surveyed Swiss farms and no significant piglet loss differences between sow pens and farrowing crates, although there were significant differences between the various causes of loss. The number of crushed piglets in sow pens was 1.1% higher than in farrowing crates (Weber 2007), but in the farrowing crates piglet mortality in crates was mainly due to runts (Weber et al. 1996).

Work load time variation

Routine tasks, such as feeding and mucking, handling litter and health checks, occurred almost daily. Work tasks responsible for significant time differences in routine work were the cleaning of troughs and pens, opening and closing of doors and supplying of rooting material to the creep area.
The total of all routine work tasks for one sow pen or farrowing crate area caused system related time requirements of 3.23 to 16.9 minutes per sow and cycle. The highest requirements were for the structured sow pen. The differences between the other sow pens and farrowing crates were minor; maximum variation was 20%. Overall, 1.97 to 2.95 working hours per sow and year were needed for system related routine work tasks.
Special tasks are tasks that are done once or only few times during a birth and suckling cycle. The special tasks for the sow that caused system related differences in time requirements were moving sows in and out of their stalls, medical care and birth assistance. Time differences were caused by door latching mechanisms, door and crate width, wall height, and fixation bar placement.
Special tasks for piglets included medical care, tail docking, teeth clipping, setting of ear tags and mycoplasma vaccination prior to weaning. The setting of ear tags and mycoplasma vaccination took place in the sow pen or farrowing crate and all other activities outside the pen. There were time differences between the sow pens and farrowing crates for the handling of piglets and entrapment tasks. This was due to the different entering, exiting and catching behaviours caused by system design.
Special tasks for the sow pens and farrowing crates were sweeping, washing and disinfection. Their time requirements were influenced by system size, material and design.
The total time requirements for special tasks in and around sow pens and farrowing crates were 28.1 to 33.6 minutes per sow and cycle. The differences varied only marginally since most main special tasks were executed independently of sow pen and farrowing crate design. The system related time requirement of the special tasks per sow and year differed from between 1.85 and 2.38 working hours per year. The highest time requirement was for the structured sow pen and the farrowing crate KS3, which caused extremely high washing expenses in comparison to the others.
Monitoring tasks included feeding and daily health checks, some routine task elements, farrowing checks during the birth phase, some special task elements. Monitoring tasks restricted to the pen area required 4.9 to 12.6 minutes per sow and cycle. Time requirements were higher for the sow pens FS1, FS2 and FS3 and lower for the farrowing crates, which varied up to 8.5 minutes per sow. The total monitoring work per sow and year was between 0.33 and 0.66 working hours per sow, system and year, a 100% variation.
The total system related work time requirements (excluding management tasks) were 4.2 to 5.99 working hours annually per sow (table 2). The highest time requirements were for the structured sow pen. Time differences between sow pens were as high as 22.3%. There were minor differences in work time requirements between non-structured sow pens and farrowing

crates as well as within them. The maximum work time variation between sow pens and farrowing crates was 42.7%. The work time required during group housing in the dry and pregnant periods accounted for 1.54 hours annually per sow. Overall, these are low time requirements. Reasons were the efficient operations, quality equipment and large stock size.
The work time requirement annually per sow (not including piglet breeding) of Austrian planning data was 16.4 hours annually per sow (Bundesministerium für Land- und Forstwirtschaft, Umwelt- und Wasserwirtschaft 2004). Upper Austrian farms with more than 100 sows and including piglet breeding measured an average 18.1 hours annually per sow (Blumauer 2004). Handler et al. (2006) reported average working time requirements of 34.4 hours for piglet production on Austrian farms. Riegel et al. (2006) published similar figures for Swiss farms with around 60 sows, kept in both sow pens and farrowing crates. Their work time requirements, including management tasks, varied between 23.6 and 39.2 hours annually per sow (p. 61). Haidn (1992) determined work time requirements of 6 to 37 working hours annually per sow for Bavarian farms. The time requirements differed extremely depending on the operation and stock size.

Differences in economic results

Generally, annual output per sow depends on the price per kilogram for piglets, piglet weight at weaning, number of piglets per litter, annual litters per sow, proportion of sows replaced and the per piglet refund for mycoplasma vaccinations. The system related annual average output per sow varied between 960 EUR and 1.039 EUR for the different systems examined during the research time. The average gross price per piglet during this period was 7.19 EUR per kilogram, 4.1% higher than the average price for the three-year period 2003 to 2007. The main reasons for the system related output differences were variation in piglet number and weight, as highlighted above. The output for the piglets differed by as much as 8.32% per sow, system and year. The lowest overall outputs were achieved by sows housed in sow pens. Output differences of up to 41.7 EUR per piglet were found between the different sow pen systems. The farrowing crate KS1 achieved the highest output. The difference to the lowest output (FS1), was 76.4 EUR, or nearly two piglets. Differences of up to 26.6 EUR were found between farrowing crate systems.
The annual direct costs per sow consisted of replacement, feed, veterinary care and medication, insemination, contributions, energy costs and miscellaneous costs for water, straw, cleaning, disinfectant and marking material. Major costs were replacement, feed, veterinary care and medication, which made up more than 75% of the total direct costs and varied between 551 EUR and 559 EUR annually per sow. The differences between the investigated systems were marginal and caused by variations in feed, medicine and contribution costs due to the number of piglets per litter and piglet weight. Similar direct costs were verified by the Saxon large scale farms (Mewes 2007)
Other annual variable costs per sow were for machines and allocable labour costs. Machinery costs were 26.6 EUR annually per sow. Allocable labour costs differed between 44.9 EUR and 64 EUR annually per sow, caused by the identified system related differences in labour time requirements. Overall, labour costs were relatively low due to efficient and extensive work operations supported by synchronisation of group farrowing, medical induction of labour and part time labour. The work time requirements, including management work times, accrued costs of at least 78.8 EUR for the minimum of 10 hours annually per sow on Saxon farms (Klemm et al. 2004).
The system related gross margins, calculated by subtraction of direct and other variable costs from the output, were 318 EUR to 412 EUR annually per sow, or 16.5 to 19.6 EUR per piglet

sold. The gross margin differences between sows kept in the different systems investigated were as high as 29.3% (table 2)

Table 2. Annual gross margin per sow and per piglet sold, gross margin differences in percent and work time requirements by system

Systems	FS1	FS2	FS3	KS1	KS2	KS3	KS4	KS5
Gross margin/sow/year	318	375	377	412	391	382	404	403
Gross margin/piglet sold	16.5	19.1	18.7	19.6	19.1	18.4	19.4	19.1
Gross margin differences in percent /sow/year (related to KS4, ($\Delta = 0$))	-29.3	-9.7	-9.3	0	-5.4	-7.7	-1.9	-2.0
Working time requirements* (h/sow/year)	5.99	4.66	4.71	4.24	4.35	4.58	4.20	4.47

* Without management

The highest differentiation was between sows kept in the structured sow pen and the most economic farrowing crate, the KS1. Gross margin differences between sow pens were as high as 20%. The gross margins for sows kept in the FS1 system were worse than in the other sow pens. Sows kept in sow pens FS2 and FS3 obtained similar gross margins, not much lower than the gross margins of sows kept in farrowing crates. The differences were under 10% and the gross margin per piglet sold was akin to that of piglets kept in farrowing crates. Differences within the farrowing crates varied up to 7.7%. Variations in gross margins were mainly caused by design effects responsible for differences in the number of piglets, in piglet weight and in work time requirements. These results imply, as Appleby (2005) mentioned, that higher animal welfare in pig production requires premium prices.

Conclusions

Eight farrowing accommodations on the Austrian market, three sow pens and five farrowing crates, were evaluated for performance, work time requirements and financial efficacy. Their designs varied in space allowance, door opening and closing devices, walls, feeder, crate and creep area.

Design differences in the farrowing accommodations influenced litter performance, which had an impact on work time requirements and financial results. Significant differences were determined for litter size, piglet mortality and piglet weight, especially between the sow pens and the farrowing crates. The number of piglets per litter varied between 8.87 and 9.73 piglets. Cushing of piglets was highest in sow pens, especially in the structured one. The differences in piglet losses between the sow pens and farrowing crates were up to 8.84 % or 0.86 piglets per litter. The weight differences of up to 0.28 kilogram per piglet were rather low.

Sow pens had the highest time requirements for routine, special and monitoring tasks, in particular the structured sow pen, which had another manure removal system, litter, a non-perforated floor and more floor area. Within the sow pens and farrowing crate systems, work time variations were caused by the size of the farrowing accommodation, door latching mechanisms, floor and door material, door and crate widths, crate and feeder design, wall heights, position and design of the creeps and arrangements of the fixation bar. The system related total work time requirements (measured and calculated by the time element method), were 4.2 to 5.99 hours annually per sow. The maximum differences existed between sow pens and farrowing crates, up to 42.7% annually per sow. The work time differences among the sow pens were as high as 22.3% and among farrowing crates less than 10%. This variation indicates an existing work transaction optimisation potential within both groups of systems.

The work time during group housing, in the dry and pregnant states, was 1.54 hours annually per sow. Overall, these are low time requirements for both units. Reasons were the efficient work operations, ensured by grouping of sows, large stock size and part time employees.

The output per sow or piglet varied with litter size and piglet weight. Among sow pens, the output difference was as high as one piglet per year; and between sow pens and farrowing crates the difference was nearly two piglets annually per sow. The system related differences in direct costs were marginal, to the highest being 1.34%. The other variable costs varied according to allocable labour costs, which are tied to the system related time requirements. The system related gross margins were from 318 EUR to 412 EUR annually per sow; or 16.5 to 19.5 EURO per piglet sold. There were remarkable gross margin differences of up to 29.5% for keeping sows in the investigated systems, caused by the above-mentioned design differences. Within the sow pens, gross margin differences of up to 20% were recorded; within the farrowing crates up to 7.7%. Differences in gross margin between the non-structured sow pen and farrowing crates were less than 10%.

These results imply that the sow pens recently available on the marked cannot guarantee the same productivity and financial performance as farrowing crates. Short term alternatives to offer free movement and more space to animals are higher producer prices for animal friendly produced piglets, or government subsidies. There is a potential for optimisation and minimisation of the current considerably differences in performance and work load, which would better meet customer and farmer needs.

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