A first analysis of piglet mortality identifying important factors

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Introduction

The number of pigs weaned per sow per year was defined as the overall goal for improving reproductive performance during a PRDC workshop in 1997 (PRDC, 1997). This criterion is influenced by two main components, number of litters per sow per year and the number of piglets weaned. Previous work at AGBU (Tholen et al., 1996) has shown that genetic improvement to increase the number of litters per sow per year should focus on weaning to conception interval between the first and second parity. The second component, number of piglets weaned depends on the number of pigs born alive, the number of stillbirths, and piglet survival until weaning. While the number of piglets born alive has been incorporated into breeding programs the number of stillbirths and piglet survival has not been considered yet.

In Australia, the total mortality rate is approximately 21 % of the total number of piglets born with 8 % still births and 13 % pre-weaning mortality (PigStats, 1998). In a comprehensive review by Le Dividich (1999) it was shown that individual piglet birth weight and the variation within litters are the main components affecting piglet viability. However, these traits have not been considered in breeding programs due to the high labour costs of performance recording. As a result, studies are limited to research farms (ie. Rydhmer, 1992; Kisner et al., 1996) and are not available from commercial herds. Currently, a PRDC funded project is under way in cooperation with Bunge Meat Industries (BMI) to determine the use of individual piglet weight traits and piglet survival in genetic improvement programs. As an introduction to this project this paper aims to describe the project and to summarise factors influencing piglet survival and pre-weaning piglet performance in relation to sow reproductive traits which are characteristics of the whole litter.

Description of project

1. Description of piglet traits

Since December 1998 individual piglet weights are being recorded at birth and at 14 days of age in three maternal lines at BMI. By January 2000, data includes 14606 piglets from 1406 litters. Every piglet of a litter is recorded including stillbirths, piglets that have been crushed by their mothers (overlays), and weak piglets that died within 24 hours after birth. Further information is provided about piglet survival since the date of death was recorded for the majority of piglets that died. Finally, piglets cross-fostered to another dam of these three maternal lines have the identification of the foster-dam recorded.

2. Description of litter traits (traits of the sow)

These individual piglet records were then used to derive traits describing the whole litter. These traits include the number of piglets born total, number of piglets born alive and the number of piglets nursed at 14 days. Further traits include the weight of the whole litter and the average piglet weight at birth and at 14 days. Given that every individual piglet is recorded within a litter it is possible to derive the standard deviation of piglet birth weight within a litter. The coefficient of variation for this within litter variation of piglet birth weight is then defined as the standard deviation divided by the mean. Since piglets have their foster dams recorded the effects of cross-fostering on pre-weaning performance are analysed as well. Traits defined for each litter include the number of piglets fostered on and the number of piglets fostered off along with the number of own piglets nursed until 14 days.

Means and standard deviations for the main piglet and litter traits are provided in Table 1. The mean piglet weights at birth and at 14 days were 1.45 kg and 4.42 kg, respectively. The number of records for 14-day weight was reduced to 57% of the number of total piglets born due to piglets dying and cross-fostering of piglets to sows not participating in this project. Both weight traits are characterised by a large coefficient of variation of 24% and 22%. The coefficient of variation was even higher for litter size traits (31 and 32%) but was slightly lower for average piglet weight at birth.

Table 1. Means, standard deviations (sd) and coefficient of variation (CV) for main traits of the piglet and the whole litter.

Trait	N	Mean	sd.	CV
Piglet traits				
Piglet weight at birth (PBWT) (kg)	14606	1.45	0.35	24 %
Piglet weight at 14 days (kg)	8302	4.42	0.96	22 %
Litter traits				
Number born total (NBT)	1406	10.4	3.24	31 %
Number born alive (NBA)	1406	9.82	3.03	31 %
Number nursed at 14 days (N14)	1241	8.13	2.61	32 %
Average piglet birth weight for NBT (kg)	1406	1.48	0.25	17 %
Average piglet birth weight for NBA (kg)	1404	1.50	0.25	17 %
Average piglet weight at 14 days (kg)	1241	4.29	0.77	18 %

Piglet mortality

The overall aim of improving reproductive performance is to maximise the number of healthy piglets weaned. This can be achieved by increasing the number of piglets born and decreasing piglet mortality rates. First information about mortality rates is provided in Table 2 which shows the total number of healthy piglets as well as piglets classified as stillbirths, overlays and weak piglets along with piglets whose death had been recorded. The number of piglets, that died before weaning is expected to be larger than shown in Table 2 since a proportion of piglets were cross-fostered to sows from other lines. Information from these piglets is not available. Overall, piglet.mortality accounted for 16.7 % of all piglets born including 5.5 % stillbirths.

This mortality rate is similar to mortality rates found in commercial herds worldwide (PigStats98; van Arendonk et al., 1996; Straw et al., 1998; reviews by Vaillancourt et al., 1992 and Le Dividich, 1999). A high proportion of piglets died within 24 hours after birth (1.7 % overlays and 2.5 % weak) and a further 7.1 % of piglets died before weaning. The mean birth weights for the different classes show that the healthy piglets were the heaviest at birth while stillbirths and weak piglets had the lowest birth weights.

Table 2. Percentage of piglets classified as healthy, stillbirths, overlays, weak and died along with mean piglet weight at birth for each group.

Group	Percentage	Mean	sd.	CV
Healthy piglet	83.3	1.50	0.32	21 %
Stillbirths	5.5	1.19	0.37	31 %
Overlays	1.7	1.31	0.36	27 %
Weak	2.5	0.88	0.33	37 %
Died	7.1	1.33	0.34	26 %

The importance of a high birth weight for piglet viability is demonstrated in Figure 1, which shows the percentage of piglet mortalities for different piglet birth weights. Ninety percent of all piglets with a birth weight of less or equal to 0.7 kg died. Piglet mortality rates remained high for piglets weighing 0.8 and 0.9 kg (58 and 38 per cent, respectively). These three weight classes account for 15% (4.5 + 4.0 + 6.5%) of all piglets born. Together with the high proportion of piglets which die these three weight groups account for a piglet mortality of 8.84% (4.5*0.90 + 4.0*0.58 + 6.5*0.38) which is equivalent to half of all piglet mortalities observed in this data set (see Table 2). Stanton and Carroll (1974) described birth weight as the single greatest predictor of piglet survival. Across analyses and breeds there seems to be no single absolute threshold for birth-weight below which pigs have an increased mortality rate (Le Dividich, 1999). In contrast, this data shows that it is of high importance to minimise the number of piglets weighing less than 1 kg at birth.

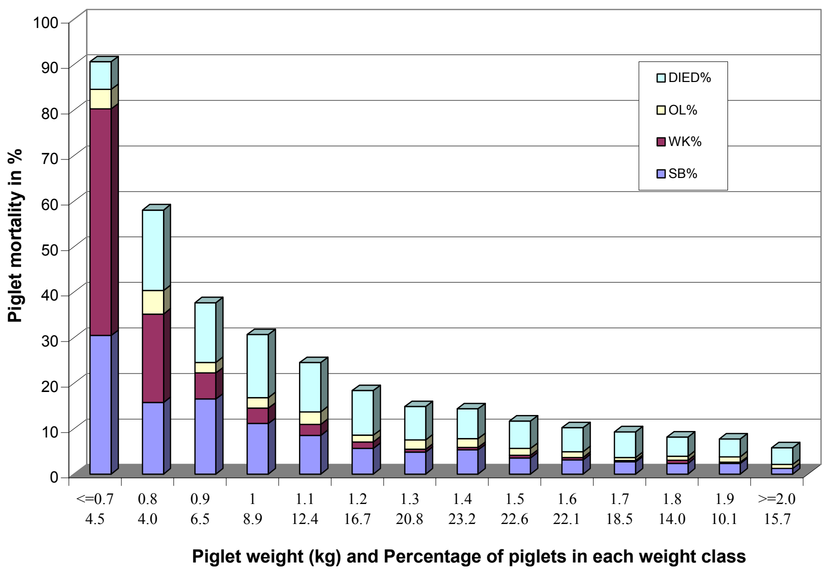

Figure 1. Piglet mortality rates (in percentage of all piglets in each weight class) for different piglet birth weight classes. Please note: the percentage of piglets in each weight class is shown in the second row on the x-axis (based on all piglets N:14606)

Relationships between litter size and piglet weight

Average piglet birth weight and total litter weight are plotted for each litter size (total of piglets born) in Figure 2. Average piglet birth weight decreases with larger litters. However, the total litter weight at birth increases continuously as a result of the larger litter size. It seems that total litter weight is not limited by the sow's capacity to carry a large litter yet given its continuous increase and given that the largest litters in the data set with 22 and 24 piglets had total litter weights of 30 and 32 kg, respectively. However, the decrease in average piglet weight at birth implies that larger litters might also have a higher mortality rate.

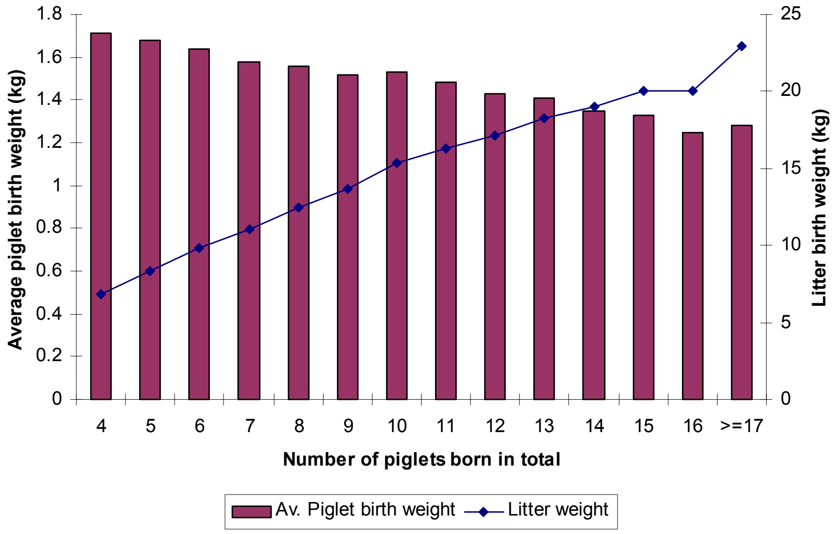

Figure 2. Relationship between litter size and average piglet weight at birth and total litter weight.

The number of stillbirths, overlays, weak piglets and piglets which died pre-weaning are shown for different litter sizes in Figure 3. The mortality rate remains relatively constant (0.5 to 0.8 piglets per litter) until a litter size of eight piglets total born. Mortality rates increase slowly from 1.2 to 1.8 per litter for a litter size of 9 to 12. Only when litter size is larger than 13 does mortality rate increase substantially with every extra piglet born. This Figure demonstrates two points. Firstly, mortality rate is independent of litter size when less than 9 piglets are born in total. A reduction of litters with less than 9 piglets born in total will therefore lead to a direct increase in the number of piglets weaned. Secondly, Figure 3 shows that it is not beneficial to have large litters with 13 or more piglets given the high mortality rate of these litters. No information was found in the literature illustrating the relationship between litter size and mortality rates.

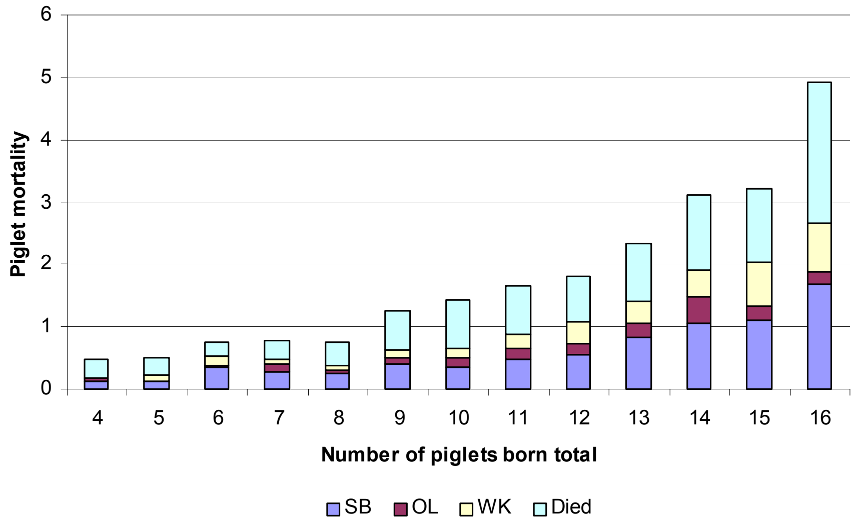

Figure 3. Piglet mortality for different litter sizes (number of piglets born total).

Within litter variation

1. Within litter variation and litter size

A further factor contributing to high mortality rates is the variation of piglet birth weight within a litter. The proportion of piglets with either a low birth weight (less than 1 kg) or a high birth weight (larger than 2 kg) is shown in Figure 4 for different litter sizes. With increasing litter sizes the number of heavy piglets decreases from approximately 20% to less than 5% per litter. The percentage of piglets within a litter weighing less than 1 kg remains less than 5% until a litter size of 10 piglets born in total. The proportion of light piglets increases sharply with litter sizes of more than 14 piglets reaching a level of approximately 20%.

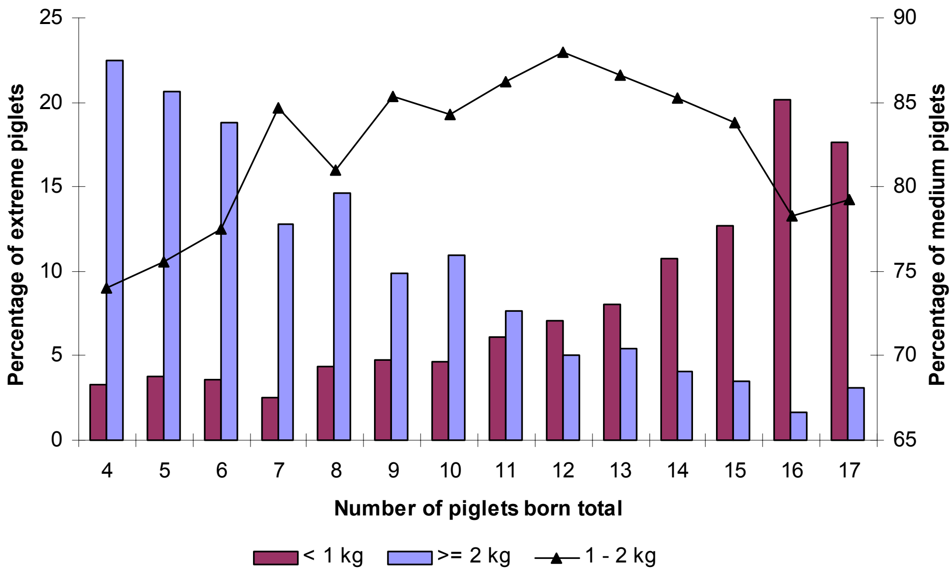

Figure 4. Proportion of light (less than 1 kg), heavy (more than 2 kg) and medium piglets for different litter sizes.

2. Piglet mortality

There are considerable differences in the within litter variation itself. Figure 5 shows that the majority of litters has a within litter variation of 10 to 25%. These differences in within litter variation influence piglet mortality, which increases from 10% for litters with the lowest variation to 25% for litters characterised by a large variation of piglets birth weights. The number of overlays and the number of piglets that died remains relatively constant between different groups while the number of stillbirths and the number of weak piglets increases for litters which are characterised by a larger within litter variation.

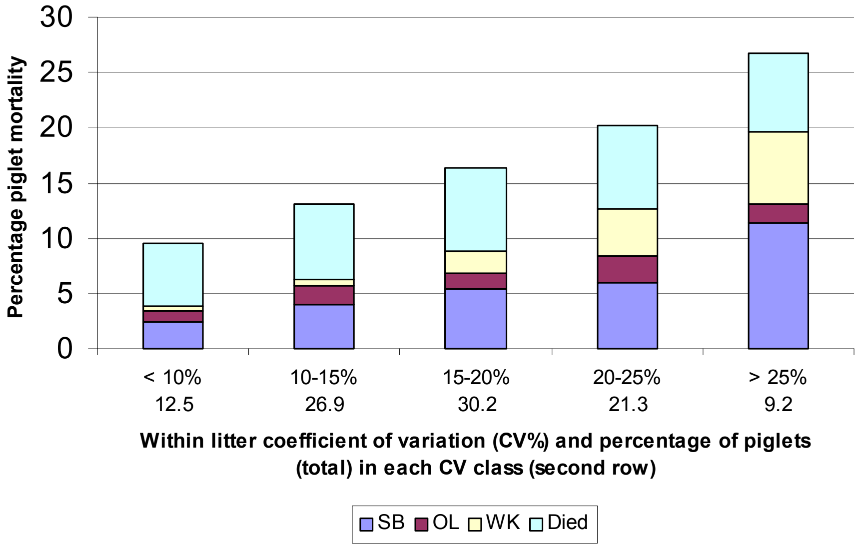

Figure 5. Piglet mortality for litters with different coefficients of variation.

Cross-fostering

Cross-fostering is a standard management practice to minimise the variation in piglet birth weights within a litter in order to decrease piglet mortality. Across commercial herds there are fast differences in fostering protocols defining the number of piglets moved and the ages at which piglets were cross-fostered (Straw et al., 1998). The vast majority of litters in this project have been influenced by cross-fostering. Piglets are fostered off even in smaller litters in order to reduce the variation among piglets within a litter. Ninety percent of litters with 11 or more piglets have piglets fostered off showing that more piglets are taken from larger litters. However, half of these litters also have piglets fostered on to reduce the within litter variation. Straw et al. (1998) concluded that farms in their study (300 Midwestern and Ontario farms using PigChamp®) under use cross-fostering as a management tool. The authors state that 20 to 25% of piglets would have to be moved to equalise piglet weights within litters. The management requirement of cross-fostering a large number of piglets has a large influence on the number of piglets weaned. Figure 7 shows that the number of piglets weaned is independent of the total number of piglets born once litter size is larger than eight piglets born (Figure 7.). However, the number of own piglets weaned increases until a litter size of 10 piglets total born. The large influence of management factors on number of piglets weaned limits the use of this trait for genetic improvement, which has been confirmed by internal studies (Hermesch, not published). These studies found a low heritability of 0.02 for number of piglets weaned. In conclusion, the number of piglets weaned is not a very useful trait for genetic improvement in breeding programs where cross-fostering is practiced in nucleus herds.

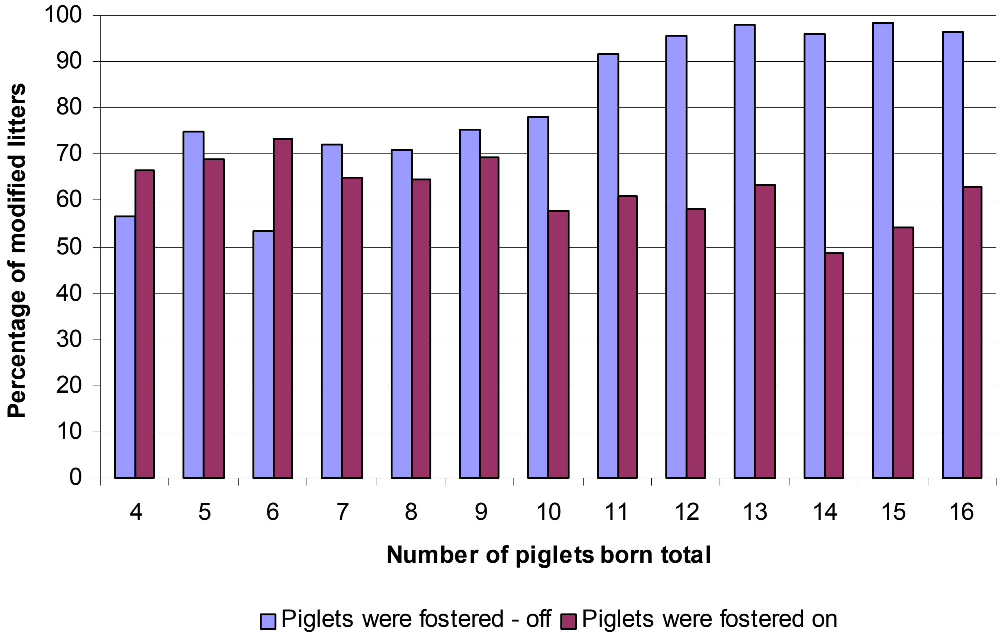

Figure 6. Proportion of litters with piglets fostered off and piglets fostered on for different litter sizes.

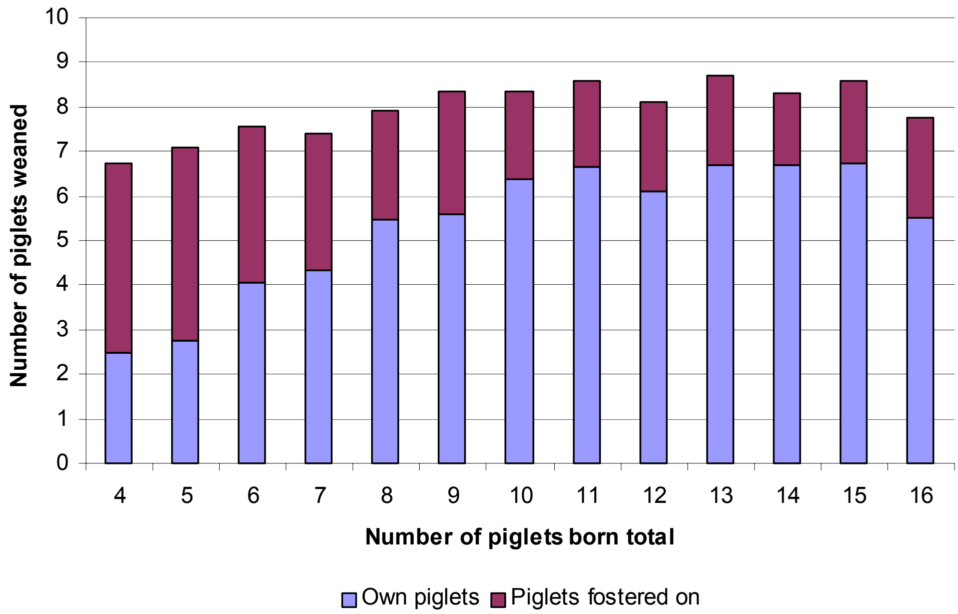

Figure 7. The number of own and fostered piglets weaned for varying litter sizes.

Summary and further analyses

The aim of this initial analysis was to identify and illustrate factors influencing piglet mortality. Further analyses will now focus on possibilities (genetic and management) to

- Reduce the number of piglets weighing less than one kg at birth. It was shown that piglets weighing less than one kg accounted for half of all mortalities although these piglets only represented 15% of all piglets born.
- Optimise selection for litter size. These initial studies showed that large litter with 13 or more piglets are not always desirable given the high mortality rates of these litters. Furthermore, the number of litters with less than 8 piglets born in total needs to be reduced since number of piglets weaned was reduced for these smaller litters.
- Reduce the within litter variation in piglet weight at birth. Mortality rates were increased for litters with larger variation. In litters with the largest variation every 4th piglet died. In contrast, litters with the lowest variation had a mortality rate of 5% only. Reduction of within litter variation will reduce requirements for cross-fostering.
- Investigate the effect of cross-fostering on piglet growth and survival. Cross-fostering is a valuable management tool to reduce within litter variation in piglet weight and is used extensively in this herd.

These further studies will involve estimation of heritabilities and genetic correlations for piglet weight traits and litter traits of the sow. The traits of the piglet and reproductive traits of the sow will then be linked with growth and carcase traits recorded routinely at BMI. Furthermore, survival analysis will be performed to explore possibilities of genetic improvement of piglet survival.

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References

Kisner, V., Brandt, H., Glodek, P. and Moellers, B. (1996). "Die Analyse von Sauenaufzuchtleistungen in der Versuchsstation Relliehausen zur Entwicklung von Kriterien der Wurfqualität. 2. Mitteilung: Die Entwicklung von Kriterien der Wurfqualität für die praktische Anwendungen." *Archiv für Tierzucht* **38**(6): 643-652.

Le Dividich, J. (1999). A Review – Neonatal and weaner pig: Management to reduce variation. In: Manipulating Pig Production VII. Editor: P.D. Cranwell. *Proceedings of the Seventh Biennial Conference of the Australasia Pig Science Association.* Adelaide 28th November – 1st December. 135-155.

Pig Research & Development Corporation (1997). Variability in Reproduction Workshop. 9th-11th September, 1997. Melbourne

Rydhmer, L. (1992). Relations between piglet weights and survival. Neonatal survival and growth. M. A. Varley, P. E. V. Williams and T. L. J. Lawrence, British Society of Animal Production. *Occasional Publication No*. **15**: 183-184.

Stanton, H. C. and Carroll, J. K. (1974). Potential mechanisms responsible for prenatal and perinatal mortality or low viability of swine. Journal of Animal Science **38**:1037-1044.

Straw, B. E., Dewey, C. E. and (UMLAUT), E. J. B. (1998). "Patterns of crossfostering and piglet mortality on commercial U.S. and Canadian swine farms." *Preventive Veterinary Medicine* **33**: 83-89.

Tholen, E., K L Bunter, S. Hermesch, H.-U. Graser (1996). The genetic foundation of fitness and reproduction traits in Australian pig populations: I. Genetic parameters for weaning to conception interval, farrowing interval and stayability. *Australian Journal of Agricultural Research* **47**:1261-1274.

Vaillancourt, J. P. and Tubbs, R. C. (1992). "Preweaning mortality." *Swine Reproduction* **8**: 685-706.

vanArendonk, J. A. M., vanRosmeulen, C., Janss, L. L. G. and Knol, E. F. (1996). "Estimation of direct and maternal genetic (co)variances for survival within litters of piglets." *Livestock Production Science* **46**: 163-171.