Balzani A, Cordell HJ, Edwards SA. **Relationship of sow udder morphology with piglet suckling behaviour and teat access.** *Theriogenology* 2016

DOI: [http://dx.doi.org/10.1016/j.theriogenology.2016.06.007](http://dx.doi.org/10.1016/j.theriogenology.2016.06.007)

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Date deposited: 27/06/2016

Embargo release date: 15 June 2017
Relationship of sow udder morphology with piglet suckling behaviour and teat access.

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Abstract

The aim of this study was to investigate if there is a relationship between the latency to first suckling and udder and teat morphology, and to assess the extent to which piglet and sow characteristics influence teat pair position preference. Udder morphology trait measurements, piglet suckling behaviour and sow productive and behavioural traits were recorded from a population of 74 Large White X Landrace sows of different parities. The inter-teat distance within the same row was larger between the teats that were suckled at the first contact with the udder compared with the un-suckled teats (P = 0.04). There was a tendency for piglets to suckle first from teats placed closer to the abdominal mid-line. A high proportion of siblings (64%) suckled for the first time on a teat previously chosen by another piglet. The majority of the neonates suckled first from a teat located in the posterior part of the udder (41%) or in the anterior part (33%), rather than the middle section. Latency from birth to suckling and the time from the first udder contact to locate a teat and suckle was shorter for piglets first suckling the anterior (28:03 and 9:48 min) and posterior teats (26:31; 8:38 min) than for mid-section teats (34:30 min, \(F_{7,256} = 1.99, P = 0.05\); 10:30, \(F_{7,256} = 2.37, P = 0.05\)). To avoid possible confounds, other potential causes of delay in successful suckling were studied. The latency to suckle was not influenced by piglet vitality score at birth, weight or provision of human assistance to place it at the udder. It was shorter when the piglets were born later in the litter (P < 0.001), from a litter with a low incidence of piglets born dead (P = 0.001) and from a sow with an induced farrowing (P = 0.007). Moreover there was a tendency for
A large litter size (P = 0.07), to have a longer latency to find a teat and suckle once they had made the first contact with the udder. Although suckling itself is clearly an instinctive behaviour, acquisition of colostrum depends on many variables, relating not only to piglet characteristics but to sow behavioural and morphological characteristics as well. Future studies on sow characteristics are therefore recommended.

**Keywords:** piglet; sow; teat access; teat preference; teat seeking behavior; udder morphology traits

### 1. Introduction

Immediately after birth newborn piglets start searching, using nose contact, until they find a teat and start suckling from it. This behaviour has been well studied in order to improve pig management and reduce piglet mortality [1, 2]. After first suckling, piglets tend to suckle many teats with frequent changes. This teat sampling behaviour lasts for about the first 8 h postpartum [3] and facilitates colostrum consumption. During the colostrum period the sow exposes the udder while lying down, enabling the offspring to sample teats freely [4]. Early teat suckling success determines early colostrum intake, which is essential for the piglet’s immediate and long term survival and performance [5]. Colostrum provides energy [6] immune protection [7, 8], as well as helping the gut to mature in the first few hours of life [9]. Colostrum ejection decreases quickly after
parturition, and is gradually replaced by milk. Thus, it is essential that the piglet achieves its first colostrum intake as quickly as possible after birth. Despite the innate expression of teat-seeking behaviour, the latency to first suckling varies considerably between piglets [2, 10, 11]. Understanding the causes of this variation is therefore essential to improve piglet survival. Teat access by newborn piglets in the first hour of life has been well investigated in relation to the physical environment [2], sow pre-partum activity [4], asphyxia at birth [12], rectal temperature, vitality and birth weight [10, 11, 13], physiological variables [14] and the influence of management routines [15, 16]. To date, teat access has never been related in detail with the sow’s udder morphology. Sows with high functional teat number have bigger litters and heavier piglet weight at weaning compared with sows with fewer functional teats [17, 18]. The purpose of the current study was to better understand initial piglet suckling behaviour and its relationship with more detailed characteristics of sow udder morphology. The main objective was to investigate if there is a relationship between the latency to first suckling and udder and teat morphology. To avoid possible confounds, other potential causes of delay in successful suckling were taken into account, including piglet characteristics, such as birth weight, vitality and birth order, sow characteristics, such as parity, behaviour and ease of colostrum extraction, and management around
farrowing. A second objective was to assess the extent to which these factors determine teat pair position preference for first suckling. It was hypothesized that there would be an interaction between teat seeking success and udder traits.

2. Material and Methods

2.1. Animals

The experiment was conducted at Cockle Park Farm, Newcastle University, Newcastle upon Tyne, UK, following approval by the Animal Welfare and Ethics Review Body at Newcastle University. Udder morphology trait measurements and piglet suckling behaviour were recorded between November 2013 and November 2014 from a population of 74 Large White X Landrace sows of different parities. Because of the small numbers of observations in some categories, sow parity numbers were subsequently combined to give 6 categories (13 sows first parity, 11 sows second, 11 sows third, 13 sows fourth, 12 sows fifth and 13 sows with six and more parities). Only one litter per sow was recorded. Animals were moved from the group gestation house to the farrowing unit at 110 days after final insemination, where they were kept in individual crates equipped with a feeder and drinker. Ambient room temperature averaged 21°C. No specific procedures were imposed in the study; feed, environment and management were maintained as standard commercial practice. The farmer was
allowed to assist birth for sows having birth problems; however

cross-fostering of piglets occurred only after the last piglet
studied in the litter had suckled.

2.2. Experimental treatment

In order to assess the effect of different management routines,
litters were randomly allocated into two treatments groups
(control C and assisted suckling A). The piglets of the litters in
the Control group, after being weighed, were placed back at the
birth site where they were found. All the piglets studied in
litters in the Assisted suckling group, after being weighed, were
dried, positioned under a heat lamp located behind and to one
side of the sow and, when they had stood and started to move,
the operator carefully placed them centrally in front of the
udder. Data collection methodology was the same for both
treatment groups.

2.3 Piglet Characteristics

Piglet observation started at birth and continuous observations
were made during parturition and until the last piglet born
under study had suckled. Not all the piglets in the litter were
recorded. Firstly, we limited the number of pigs per litter which
were recorded in order to give emphasis to the effect of udder
conformation on teat accessibility, rather than the effect of
sibling competition. Secondly, the number of observers was
limited which prevented data collection on all piglets.
Immediately after each piglet was born, when an observer was present, piglet vitality was recorded using a score (VITA: 1 to 4) based on movement during the first 15 seconds of life (Table 1). Because of the small numbers of observations in some categories, vitality score data were subsequently combined to give three categories (category one: score 1 and 2 N = 122; category two: score 3, N = 122; and category three: score 4, N = 123). Subsequently each piglet was lifted gently, marked with its birth order number on its back (BO), and weighed (BW). Because of the small numbers of observations in some categories, piglet birth orders were subsequently combined to give 8 categories (the first newborn piglet was observed in 59 litters, the second born piglet was observed in 53 litters, the third piglet in 51 litters, the fourth in 46 litters, the fifth in 32 litters, the sixth in 29 litters, the seventh in 23 litters, and subsequent piglets born were observed in 40 litters). To assess teat-seeking success, latency to find a teat and suckle was recorded. Time from birth to suckling (TBS) and time from first udder contact to suckling (TUS) were recorded, with suckling defined as taking a teat into the mouth for a period of three seconds or longer and showing suckling and swallowing behaviour. In order to determine the relationship between udder morphology and teat success for each piglet, the first teat suckled was recorded by side (left or right), row (upper or lower) and defined as teat pair position suckled (TPS). The teat
pairs were numbered in ascending order (1, 2, 3 to 7) from the most anterior to the most posterior pair. Video cameras equipped with wide-angle lenses were mounted at the back of each farrowing crate to record piglet behaviour out of working hours. Output from each camera was input into a Panasonic WJ-FS 416 16-camera multiplexer whose output was then recorded using a Panasonic AG-6040 time lapse video cassette recorder (VCR). The VCR was set to record for a 24-h period on a single 120-min tape; using this equipment, an image was captured from each camera at three seconds intervals. All the observations occurred during working hours, except for seven litters where farrowing occurred out of working hours and the piglet behavioural data were derived from video recordings.

[Table 1 near here]

2.4. Sow Characteristics

Sows were allowed to farrow naturally at term over a four day period (Monday to Thursday); sows that had not farrowed within this period, were then induced on Thursday by injection of a prostaglandin analogue. Piglets assisted during the farrowing process were excluded from the study. Records were made of the litter size traits such as total born, the number of fetal dead and mummified piglets. A fetal dead piglet was defined as one that never started to breathe; death could have occurred before farrowing or during the farrowing process.
Because of the small numbers of observations in some categories, litter size data were subsequently combined to give three categories (category one: from 2 to 11 piglets, \( N = 127 \); category two: from 12 to 16 piglets, \( N = 186 \); and category three: from 17 to 20 piglets, \( N = 54 \)). Teat measurements were made as described in Balzani et al. \([20, 21]\) with a summary given in Table 2. In this experiment, a further evaluation was made of posterior udder damage condition. Udder damage score was recorded as a single value for each sow and evaluated on only the three last teats and mammary glands. The scoring system used to identify posterior udder damage was based on a modified version of the system developed by Soede (Personal communication, Table 2). The propensity of the sow to expose the teats was recorded at the beginning of farrowing (“Show”, Table 2) and sows that did not expose the teats were excluded from the study (in total two sows did not show the udder at the beginning of farrowing preventing piglets from suckling). To avoid possible confounds with potential causes of delay in successful suckling, it was recorded if the sow changed position at least one time during the period of the study (yes or no). Teat functionality and a score for ease of colostrum extraction were recorded immediately before the onset of parturition or any suckling, with no apparent disturbance of the sow. The operator quietly approached the sow and obtained a sample by
using hand pressure, exerted approximately in the centre of the mammary gland to aid in making the colostrum flow more freely. Colostrum ease of extraction and teat functionality score definitions are reported in Table 2. Non-functional teats were scored in the same way as in a Swedish study [21].

[Table 2, near here]

2.5. Statistical Analysis

Prior to statistical analysis, all data were checked for statistical outlier values; no data were excluded for this reason. Descriptive statistics were calculated, and data are reported as arithmetic mean and standard error. Normality was assessed by application of the Shapiro-Wilk test. Statistical differences in TBS and TUS between treatments were calculated with one-sample Wilcoxon tests; also known as Mann-Whitney tests, since the data were not normally distributed. Variation of TBS and TUS according to TPS was assessed using a mixed effects linear model (nlme package in R; Pinheiro, Bates [22]). The same model was used to compare the udder morphology traits between first suckled and un-suckled teats. The model included a binary dependent variable (suckled and un-suckled) and udder morphology traits (samer, len, dia, aml, Orientation, Functionality, Ease of extraction) as independent variables; sow was included as a random effect. The categorical nature of some dependent variables was ignored since previous results
showed no difference between using a mixed-effects multinomial regression or a mixed-effects linear model (Balzani 2015). To investigate what determined the variation of the dependent variables TBS, TUS and TPS, three models were created. The first considered piglet characteristics as independent variables: BO category (factor with eight levels, BW (continuous variable), treatment group (factor with two levels: control and assisted suckling), and piglet vitality score (factor with three levels) and their interactions. The other models were created considering sow characteristics as independent variables grouped as productive and behaviour traits. In detail, the second model considered as independent variables the litter size category (factor with three levels), sow parity number (factor with six levels), assisted farrowing (factor with two levels), number of fetal dead and mummified piglets and their interactions. The last model considered as independent variables the udder damage scores (two categories with four levels, and one category with two levels), the sow behaviour regarding udder exposure (factor with three levels) and the sow posture change (factor with two levels) and their interactions. Sow was considered as a random effect in all models. Differences were considered significant at $P < 0.05$. The statistical software R version 3.0.2 (2013-09-25) was used for all tests.
3. Results

3.1. First suckled and un-suckled teat morphology

In the mixed effects model for teat preference, inter-teat distance within the same row was larger between suckled teats compared with un-suckled teats ($P = 0.04$), whereas all the other morphology traits were not significantly different between the two groups. However, after exclusion from the model of variables with non-significant $P$-values (orientation: $P = 0.92$; Ease of extraction: $P = 0.21$; functionality: $P = 0.14$) aml became significantly larger in un-suckled teats compared with suckled teats ($F_{1,370} = 4.2, P = 0.04$). Results of the mixed effects model for teat preference are shown in Table 3.

3.2. Piglet characteristics

In total, data were recorded for 370 piglets which were observed during farrowing (89% of the observations began at time zero, 11% within one hour after the first piglet was born (determined retrospectively from video), of which 155 were in litters assigned to the control group and 216 in litters assigned to the assisted suckling group. Due to a limited number of observers, and to minimise confounding effects of sibling competition, the number of piglets recorded per litter was on average 4 (min: 1, max: 12: the first newborn piglet was
observed in 74 litters, the second born piglet was observed in 67 litters, the third piglet in 63 litters, the fourth in 56 litters, the fifth in 37 litters, the sixth in 28 litters, the seventh in 22 litters, the eighth in 12 litters, the ninth in 5 litters, the tenth in 2 litters and the eleventh and twelfth piglets were observed only in one litter; the birth order of observed piglets never exceeded the number of functional teats). Birth weight (BW) on average was 1.51 kg (min: 0.6 kg; max: 2.6 kg). There was no significant difference between treatment groups (Control and Assisted suckling) in piglet vitality score (P > 0.5) and BW (P > 0.5).

3.2.1. Latency to first suckle

The time which elapsed from birth to suckling (TBS) on average was 00:29:35 minutes (min: 00:04:00 min; max: 3:28:00 h); in the control group it was 00:30:11 minutes (min: 00:04:00 min; max: 3:28:00 h) whereas in the assisted group it was 00:29:08 minutes (min: 00:04:00 min; max: 3:00:00 h).

One-sample Wilcoxon test results showed no significant difference in TBS between treatments (P = 0.36). TBS was shorter for piglets first suckling the anterior and posterior teats (28:03 se 3.01, and 26:31 se 3.93 min) than for mid-section teats (34:30 se 4.72, F_{7, 256} = 1.99, P = 0.05). On average, time elapsed from the first udder contact to suckling (TUS) was 00:09:55 minutes (min.: 00:00:00; max.: 01:56:00 hours). Time elapsed from udder to suckle in the control group was 00:8:34
minutes (min: 00:00:00 min; max: 0:54:00 h), and in the
assisted piglets group was 00:10:41 minutes (min: 00:00:00
min; max: 1:56:00 h). One-sample Wilcoxon test results
showed a small but significant difference in TUS between
treatments; assisted suckling piglets, which were placed
manually at the udder, had a bigger delay to subsequently find a
teat and suckle compared with those in the control group (P =
0.05). TUS was again shorter for piglets first suckling the
anterior and posterior teats (09:48 se 3.52, and 8:38 se 4.93
min) than for mid-section teats (10:30 se 4.72, F_{1,256} = 2.37, P =
0.05). Figure 1 shows TUS variability in relation to the teat
position first suckled.

In the mixed effects model with the latencies as dependent
variables, TBS was associated with piglet birth order. The
piglets born later found a teat in less time than early born
piglets (F_{7,286} = 5.28; P < 0.001). None of the other independent
variables affected TBS (piglet birth weight: F_{1,256} = 1.78, P =
0.18; treatment group: F_{1,256} = 0.25, P = 0.61; vitality score:
F_{3,256} = 0.66, P = 0.57). The same results were obtained for the
dependent variable TUS; piglet birth order affected the latency
to suckle once a piglet was already in contact with the udder
(F_{7,286} = 2.21; P = 0.03). However in this case the variability
was not between the first piglets born and later ones, but was
more randomly distributed; results are shown in Table 4. No
other piglet characteristic affected TUS (piglet birth weight: F\textsubscript{1,286} = 1.36, P = 0.24; treatment group: F\textsubscript{1,72} = 1.11, P = 0.29; vitality score: F\textsubscript{3,286} = 1.43, P = 0.23).

[Table 4, near here]

3.2.2. Teat preference

Posterior teats were chosen first by 41% of piglets (teat pair number seven N= 96, teat number six N= 53). Thirty-three percent of piglets first suckled anterior teats (teat number one N= 70, teat number two N= 53). Middle teats (pairs 3-5) were chosen only by 27% of piglets. On 64% of occasions, different siblings (piglets in the same litter) first suckled the same teat as another piglet. Figure 2 shows the frequency of piglets’ teat preferences in the same litter according to teat position and row. At least two siblings suckled for the first time on the same teat in 65 litters. Three piglets preferred the same teat in 19 litters; four piglets suckled from the same teat in five litters and in one litter more than five siblings suckled the same teat for the first time. In the mixed effects model with TPS as the dependent variable, no association with any of the independent variables was found (birth order: F\textsubscript{7,286} = 1.14, P = 0.33; birth weight: F\textsubscript{1,286} = 0.46, P = 0.49; treatment group: F\textsubscript{1,72} = 0.18, P = 0.67; piglet vitality score: F\textsubscript{3,286}= 2.24, P = 0.08).

[Figure 2 near here]
3.3. Sow characteristics

Average litter size was 12.5 (range from 2 to 20), giving a total of 914 piglets (of which 35 were stillborn and 22 mummified). Sows that had a litter size category one (from 2 to 11 piglets born in the litter) were 32% (N = 24), 53% of the sows (N = 39) had a litter size category two (12 to 16 piglets), and only 14% had a litter size of category three (16 to 20 piglets, N = 10). Forty-three sows (60%) stood up after the first piglet was born and 30 (40%) remained for the entire time of data recording on the same flank. Immediately after the first piglet was born eleven sows (15%) only showed the upper teat rows, six sows (8%) showed the upper teat rows and only the anterior teats of the bottom row, and fifty five sows (73%) showed both teat rows. Mean farrowing duration was 3.10 hours (min= 0.57 h; max= 9.5 h); sixty sows had farrowing induced by prostaglandin injection according to the farm practice, while 35 sows received an injection of oxytocin during prolonged farrowing. Teats orientated perpendicular to the udder were 72% (score 1, N= 265). Suckled teats which were not functional were only 0.2% (score 1, N= 7), 16% of the suckled teats were scored as partially functional (score 2, N= 52), and 82% of teats were scored as perfectly functional (score 3, N= 264). Only in two sows was colostrum available without any intervention (score 0). For 67% of the teats milked, colostrum was very easily available with only the pressure of two fingers
on the teat (score 1, N= 223), 16% of the sample needed a soft massage of the mammary gland (score 2, N= 52), 7% of the teats only gave colostrum after one or two forceful pressures with all the hand exerted approximately in the centre of the mammary gland system and continuing to the end of the teat (score 3, N= 25). More than three forceful pressures were required for 5% of the teats (score 4), and only 2% of the mammary glands did not give any colostrum (score 5). Thirty-four percent of the mammary glands (category A, score 0, N= 125) and 71% of the teats observed (category B, score 0, N= 264) were healthy. One or two mammary glands affected with superficial wounds were recorded on 48% of the animals (category A, score 1, N= 177). Only 19% of the sows had more than one mammary gland affected and deeper wounds (category A, score 2, N= 69). Category B score results showed that 24% of the sows had partially damaged posterior teats (score 1, N= 88). Only a few animals had very damaged teats (score 2, N= 12), and even fewer had the milk channel affected (score 3, N= 7).

3.3.1. Latency to first suckle

A mixed effect model showed that TBS was associated with the number of fetal dead piglets ($F_{6,54} = 4.44, P = 0.001$) and induced parturition ($F_{1,54} = 5.38, P = 0.007$). None of the other variables included in the second model (sow) affected the variability of TBS (litter size: $F_{2,54} = 1.34, P = 0.25$; parity:...
Neither the variables included in the third model (udder damage) affected the variability of TBS (udder damage category A: $F_{2,56} = 0.38, P = 0.67$; udder damage category B: $F_{3,56} = 0.12, P = 0.94$; udder damage category C: $F_{1,56} = 0.13, P = 0.71$; sow udder exposure behaviour: $F_{3,56} = 0.92, P = 0.43$; sow standing behaviour: $F_{1,56} = 2.11, P = 0.13$).

Time elapsed from first udder contact to suckling showed an association with induced parturition ($F_{1,54} = 7.22, P = 0.001$), the number of fetal dead piglets ($F_{6,54} = 6.98, P < 0.001$), sow behaviour regarding udder exposure during farrowing ($F_{3,56} = 4.19, P = 0.009$). Piglets born in a litter with a high number of fetal dead, from a non-induced farrowing and from a multiparous sow had a longer latency to find a teat and suckle (Table 5). There was a tendency for TUS to be associated with litter size ($F_{2,53} = 2.76, P = 0.07$); piglets born in bigger litter sizes had a longer latency to find a teat and suckle once they were in contact with the udder. Sow parity number also showed a tendency for an effect on TUS, but not in a consistent pattern ($F_{6,54} = 2.11; P = 0.06$) is significantly shorter in primiparous sows compared with sows with three, four or five parities, but not statistically different from sows of more than 6 parities. The variables included in the second model (sow) did not affect TUS (oxytocin during farrowing: $F_{1,54} = 1.15, P = 0.28$ and
number of mummified piglets: $F_{1,54} = 0.83, P = 0.47$). Also, none of the variables included in the third model (udder damage) affected TUS (udder damage category A: $F_{2,56} = 0.34, P = 0.70$; udder damage category B: $F_{3,56} = 0.75, P = 0.52$; udder damage category E: $F_{1,56} = 0.64, P = 0.42$; sow standing behaviour: $F_{1,56} = 0.32, P = 0.72$)

3.3.2 Teat preference

Teat pair position suckled was not associated with any of the sow characteristics as independent variable (model two: litter size: $F_{2,54} = 0.01, P = 0.98$; parity: $F_{6,54} = 1.83, P = 0.11$; oxytocin during farrowing: $F_{1,54} = 0.09, P = 0.76$; induced parturition: $F_{1,54} = 1.93, P = 0.15$; fetal dead piglets: $F_{6,54} = 0.84, P = 0.53$; number of mummified piglets: $F_{2,54} = 0.30, P = 0.82$). Model three: udder damage category A: $F_{2,56} = 0.71, P = 0.49$; udder damage category B: $F_{3,56} = 0.41, P = 0.75$; udder damage category E: $F_{1,56} = 2.93, P = 0.09$; sow udder exposure behaviour: $F_{3,56} = 0.78, P = 0.51$; sow standing behaviour: $F_{1,56} = 0.65, P = 0.52$

4. Discussion

The present study was designed to determine the relationship between latency to suckle and udder morphology. The results indicate that newborn piglets immediately after birth most often made the first contact and suckled teats located in the upper row in the posterior or anterior part of the udder. This result
seems to be consistent with other research, which found that less than half of the sows’ functional teats were suckled by neonates on first contact with the udder [23]. Even though more than half of the sows exposed both teat rows during farrowing, piglets suckled from teats located in the bottom row only in the anterior part of the udder. Teat preference results are in accordance with De Passille and Rushen [3], who observed newborn piglets from birth to 8 hours of life. In their study each piglet suckled on average seven different teats and there was no preference for anterior teats. In the current study there was a tendency for the teats located in the middle part of the udder to be suckled more often by assisted piglets than control piglets, which may have been because assisted piglets were placed centrally when returned to the udder. Teat preference was not affected by piglet vitality score or birth weight. These results match those observed in earlier studies [3]. However there was a tendency for piglets with low vitality score to suckle teats located in the posterior part of the udder and a tendency for the later piglets born to suckle a teat located in the anterior part of the udder. First- and second-born piglets usually suckled for the first time on a posterior teat; this same tendency was observed in the study of De Passille and Rushen [3]. Posterior and anterior teats have similar teat length and diameter, they are close to the abdominal mid-line and more separated from each other, allowing more space for the siblings to suckle [20]. The
comparison between suckled and un-suckled teats showed that piglets first suckled more frequently from teats with larger inter-teat distance within the same row. However the morphological similarity between teats located in the anterior and posterior part of the udder and their higher preference suggests that newborn piglets suckle more easily and quickly from teats with small dimension and close to the abdominal midline.

The results obtained in this study for teat seeking behaviour, considered as the time from birth to suckling and from the first contact with the udder to suckling, were consistent with the data obtained in some earlier studies (mean ± se (min); 30.68±1.96, Baxter, Jarvis [10]; 26.9±3.5, Tuchscherer, Puppe [13]). Christison, Wenger [15] reported on average a 40 min interval (range 5 to 349 min), whereas Vasdal, Østensen [16] observed 62 min latency from birth to suckling range from 1 to 496 min). The behaviour of newborn pigs, as described by the time taken to first contact the udder, find a teat and suckle, was only slightly affected by treatment of human intervention to assist suckling. Piglets placed under the lamp and subsequently onto the udder tended to have a longer delay than unassisted piglets to then find a teat and suckle, although the latency to suckle from the time of birth was not affected by treatment. Even though the assisted piglets suckled more from the middle teat, the longer delay to find a teat and suckle compared with the un-
assisted piglets supports the hypothesis that the middle teats in general are more difficult to access for newborn piglets than the teats placed on the posterior and anterior part of the udder.

Even though these results differ from the study published by Andersen, Naevdal [24] they are consistent with those of Christison, Wenger [15] who did not find an effect of drying piglets and placing them in the creep area on time to first suckling. Vasdal, Mogedal [25] reported that dried piglets had a lower mortality, but when comparing unassisted piglets with those dried and placed under the lamp or in front of the udder there was no difference in mortality. However they observed the highest mortality in piglets placed in front of the udder but not dried first. Once the piglets had made udder contact, the time to find a teat and suckle was shorter for offspring of first, second, third and sows with more than 6 parities than for sows of middle parities. It has been previously found that fourth parity sows lose more piglets due to starvation than younger sows, but there was no relationship between sow parity and number of surviving piglets [24]. Vasdal and Andersen [23] stated that piglets born from older sows had less access to a functional teat, but this result was not totally confirmed in our experiment. It could be argued that in our study the majority of the sows had less than six parities, whereas in the Vasdal and Andersen [23] study the number of sows with high parity number was greater. Piglets born from sows that did not have
an induced farrowing, or which had a very large number of fetal dead offspring, had a longer delay to find a teat after birth. The reason for this is not clear, although litters with many fetal dead may have related health or prolonged farrowing problems. It has been shown that more stillborn pigs in a litter suggests either poor placental efficiency during gestation or a prolonged farrowing [10]. Both of these might result in lower vitality of the liveborn piglets due to hypoxia and hence increase suckling time. More research on this topic needs to be undertaken before the association between sow characteristics and piglet teat-seeking behaviour is more clearly understood.

Piglet birth order affected the time delay from birth to first suckling. The later born piglets found a teat more quickly than the early born ones. This result is in agreement with Tuchscherer, Puppe [13], although Rohde Parfet and Gonyou [2] did not find a consistent effect of birth order on time to suckle. However Vasdal, Østensen [16] observed that latency to first suckle was shorter where there were few piglets per teat and generally it is thought that early piglets have an advantage over late born piglets to find a teat and suckle [26]. However, in this study results showed the contrary and it is possible that later piglets benefitted by cues left by earlier born piglets, since they often suckled first from a previously used teat. This discrepancy could be also attributed to the small number of litters in which more than seven piglets were observed, due to
observer availability, since the later piglets in these litters would have experienced much greater competition at the udder.

Birth weight did not affect time to suckle a teat after birth or once piglets had made udder contact; our result is in agreement with Rohde Parfet and Gonyou [2] and Christison, Wenger [15], but in contrast with Vasdal, Østensen [16], Baxter [20,12] and Tuchscherer, Puppe [13]. These latter authors found that higher weight piglets had a shorter latency to find a teat and suckle. Piglet vitality score also did not affect time to find a teat and suckle. Again, our results are in agreement with Christison, Wenger [15], who reported that the vigour of piglets did not affect suckling time, but are in disagreement with the results of Baxter, Jarvis [10]. There was a tendency for piglets born in bigger size litters to have delayed teat success once they made the first contact with the udder. Vasdal, Østensen [16] observed as well an increased latency in big litter sizes.

Overall, the inconsistency of some results of this study with previous findings suggests that, although suckling itself is clearly an instinctive behaviour, acquisition of colostrum depends on many variables, related not only to piglet characteristics but to sow behavioural and morphological characteristics as well. Future studies on the effects of sow characteristics are therefore recommended.

5. Conclusion
Taken together, the results of this experiment indicate that: (1) piglets most often first suckle teats located in the upper row in the anterior and posterior part of the udder. (2) Latency from birth to find a teat and suckle is influenced by piglet birth order. (3) The time from the first udder contact to locate a teat and suckle is not influenced by piglet vitality at birth, weight, or provision of human assistance; there was a negative tendency of assistance on TUS but not TBS. (4) Preferred teat location affects the time to find a teat and suckle; posterior and anterior teats were suckled more readily than middle teats. (5) Piglets from multiparous sows and from sows with induced farrowing spend less time seeking for a teat. We tested the main factors that could affect teat-seeking behaviour at farrowing and the results showed that this complex behaviour is not related only to piglets’ characteristics. The delay to find and suckle a teat is shorter when the teats are located in the posterior or anterior part of the udder, where teats are more distant from each other, and closer to the abdominal mid-line. This evidence leads to the conclusion that the morphology of the udder influences the success in quickly finding a teat and suckling, thus achieving early colostrum intake. Further study should focus on improving udder morphology in order to increase piglet survival.

Acknowledgements
The authors are grateful to the British Pig Executive (BPEX), for funding this project. Furthermore, we thank the University of Newcastle farm team for their support, especially Mark Brett for providing expertise in animal management.
References


[24] Andersen IL, Naevdal E, Boe KE. Maternal investment, sibling competition, and offspring survival with increasing litter


Table 1. Piglet birth vitality score (VITA) description

<table>
<thead>
<tr>
<th>VITA Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No movement, no breathing after 15 s</td>
</tr>
<tr>
<td>2</td>
<td>No body or leg movement after 15 s, piglet is breathing or attempting to breathe coughing, spluttering, clearing its lungs</td>
</tr>
<tr>
<td>3</td>
<td>Piglet shows some movement, breathing or attempting to breathe and rights itself onto its sternum within 15s</td>
</tr>
<tr>
<td>4</td>
<td>Good movement, good breathing, piglet attempts to stand within 15 s</td>
</tr>
</tbody>
</table>
Table 2. Sow farrowing behaviour and udder damage score descriptions.

<table>
<thead>
<tr>
<th>TRAITS</th>
<th>DESCRIPTION</th>
<th>SCORE</th>
</tr>
</thead>
<tbody>
<tr>
<td>show</td>
<td>‘Show teat’ score evaluated the sow’s propensity to expose the udder. This score was recorded only once at the beginning of farrowing</td>
<td>Scores from 1 to 3; where 1 was defined as: sow exposed half the number of teats – only the upper row; 2: sow exposed three quarters of the teats - the upper teat row and only the anterior teats of the bottom row; 3: sow exposed both teat rows in full.</td>
</tr>
<tr>
<td>position</td>
<td>First posture change of the sow recorded from the beginning of the farrowing</td>
<td>Was defined as YES if the sow changed from a lying down posture on one flank to the other flank or she stood up, and NO if the sow remained lying down on the same flank for the entire length of the data collection process.</td>
</tr>
<tr>
<td>change</td>
<td>The damage on the last three posterior teats and mammary glands was classified according to 3 categories. Each sow has a single score for each category.</td>
<td>Category A: score from 0 to 3; where 0 was defined as healthy mammary gland; 1 one or two mammary glands affected with superficial wounds; 2 more mammary glands affected and one or two deep wounds ; 3 same as 2, but wounds larger (&gt;1 cm and deep).</td>
</tr>
<tr>
<td>udder damage</td>
<td>A and B were linear scores from absent (0) to severe (3) damage, coinciding with: A damage of mammary gland, and B teat. C classified the</td>
<td>Category B: score from 0 to 3; where 0 was defined as healthy teats; 1 one teat damaged with wounds smaller than 1 cm, milk channel is not</td>
</tr>
</tbody>
</table>
tissue and skin, determining if the tissue and skin were hard. Wounds larger than 1cm, milk channel not affected; 2 two or three teats damaged or with wounds larger than 1cm, milk channel not affected; 3 more than three teats damaged and/or milk channel affected.

**Category C**: was defined with *YES* when the mammary gland tissue was hard, and *NO* when the mammary gland tissue was healthy.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>samer</strong></td>
<td>Inter-teat distance within the same row</td>
<td>Millimetres recorded with ruler</td>
</tr>
<tr>
<td><strong>len</strong></td>
<td>Length of the teat</td>
<td>Millimetres recorded with ruler</td>
</tr>
<tr>
<td><strong>dia</strong></td>
<td>Diameter of the teat</td>
<td>Millimetres recorded with calliper</td>
</tr>
<tr>
<td><strong>aml</strong></td>
<td>Distance between teat base and the abdominal mid-line</td>
<td>Millimetres recorded with ruler</td>
</tr>
<tr>
<td><strong>orientation</strong></td>
<td>Teat orientation with respect to the mammary gland</td>
<td>Score from 0 to 1, where 0 was defined as: teat orientated towards/away from the midline or teat orientated towards the cranial/caudal direction; and 1 was defined as: teat orientated perpendicular to the mammary gland.</td>
</tr>
</tbody>
</table>
| **functionality** | Teat functionality | Score from 1 to 3, where 1 was defined as: non-functional teat, milk channel not working, including teats which were blind: teats that were impaired early in the life of the pig, and remain as
a small protuberance; inverted: the top of the teat, or even the entire teat, is inverted to form a crater; very damaged: teat injured such that milk ejection is not possible; or supernumery: small teats in-between two normal teats; 2: reduced availability of colostrum, milk channel only partially working; and 3: teat perfectly functional.

Score from 0 to 5; where 0 was defined when no massage was needed and colostrum was freely ejected; 1 when colostrum extraction was very easy by applying a stripping action to the teat with a thumb and one forefinger; 2 when a pressure with all the hand was exerted approximately in the centre of the mammary gland system and continued to the end of the teat; 3 when two forceful pressures were required; 4 when more than three forceful pressures were required; 5 no colostrum was ejected.

<table>
<thead>
<tr>
<th>ease of extraction</th>
<th>Colostrum ease of extraction</th>
</tr>
</thead>
<tbody>
<tr>
<td>709</td>
<td>710</td>
</tr>
</tbody>
</table>
Table 3. Comparison between characteristics of teats that were first suckled following contact with the udder and un-suckled teats (mean and standard errors in millimetres).

<table>
<thead>
<tr>
<th>traits</th>
<th>teat</th>
<th>N</th>
<th>mean</th>
<th>se</th>
<th>F-value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>samer</td>
<td>unsuckled</td>
<td>274</td>
<td>108.1</td>
<td>1.51</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>suckled</td>
<td>185</td>
<td>114.2</td>
<td>1.98</td>
<td>4.40</td>
<td>0.04</td>
</tr>
<tr>
<td>len</td>
<td>unsuckled</td>
<td>310</td>
<td>17.8</td>
<td>0.24</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>suckled</td>
<td>218</td>
<td>17.7</td>
<td>0.22</td>
<td>0.30</td>
<td>0.58</td>
</tr>
<tr>
<td>dia</td>
<td>unsuckled</td>
<td>311</td>
<td>10.6</td>
<td>0.11</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>suckled</td>
<td>218</td>
<td>10.4</td>
<td>0.12</td>
<td>1.91</td>
<td>0.17</td>
</tr>
<tr>
<td>aml</td>
<td>unsuckled</td>
<td>311</td>
<td>79.1</td>
<td>1.33</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>suckled</td>
<td>218</td>
<td>75.5</td>
<td>1.65</td>
<td>0.26</td>
<td>0.05</td>
</tr>
<tr>
<td>orientation</td>
<td>unsuckled</td>
<td>310</td>
<td>0.7</td>
<td>0.03</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>suckled</td>
<td>218</td>
<td>0.7</td>
<td>0.03</td>
<td>0.01</td>
<td>0.92</td>
</tr>
<tr>
<td>Ease of extraction</td>
<td>unsuckled</td>
<td>313</td>
<td>1.8</td>
<td>0.07</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>suckled</td>
<td>216</td>
<td>1.6</td>
<td>0.07</td>
<td>1.55</td>
<td>0.21</td>
</tr>
<tr>
<td>functionality</td>
<td>unsuckled</td>
<td>296</td>
<td>1.1</td>
<td>0.02</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>suckled</td>
<td>198</td>
<td>1.2</td>
<td>0.03</td>
<td>2.23</td>
<td>0.14</td>
</tr>
</tbody>
</table>
Table 4. Mean and SD of time elapsed from birth to suckling (TBS) and from first udder contact to suckling (TUS) in minutes, according to piglet birth order categories (BO).

<table>
<thead>
<tr>
<th>BO</th>
<th>N</th>
<th>TBS mean</th>
<th>TBS SD</th>
<th>TUS mean</th>
<th>TUS SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>67</td>
<td>36.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>34.68</td>
<td>12.8&lt;sup&gt;a&lt;/sup&gt;</td>
<td>15.99</td>
</tr>
<tr>
<td>2</td>
<td>61</td>
<td>27.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>18.43</td>
<td>8.2&lt;sup&gt;b&lt;/sup&gt;</td>
<td>8.16</td>
</tr>
<tr>
<td>3</td>
<td>58</td>
<td>31.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>28.47</td>
<td>11.6&lt;sup&gt;a&lt;/sup&gt;</td>
<td>10.80</td>
</tr>
<tr>
<td>4</td>
<td>52</td>
<td>31.0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>30.65</td>
<td>8.0&lt;sup&gt;b&lt;/sup&gt;</td>
<td>7.58</td>
</tr>
<tr>
<td>5</td>
<td>35</td>
<td>26.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>23.69</td>
<td>7.7&lt;sup&gt;b&lt;/sup&gt;</td>
<td>8.11</td>
</tr>
<tr>
<td>6</td>
<td>32</td>
<td>28.1&lt;sup&gt;a&lt;/sup&gt;</td>
<td>23.59</td>
<td>10.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>11.51</td>
</tr>
<tr>
<td>7</td>
<td>24</td>
<td>27.0&lt;sup&gt;b&lt;/sup&gt;</td>
<td>21.31</td>
<td>7.4&lt;sup&gt;b&lt;/sup&gt;</td>
<td>8.43</td>
</tr>
<tr>
<td>&gt;7</td>
<td>42</td>
<td>21.2&lt;sup&gt;b&lt;/sup&gt;</td>
<td>14.72</td>
<td>7.7&lt;sup&gt;b&lt;/sup&gt;</td>
<td>6.92</td>
</tr>
</tbody>
</table>

<sup>a,b</sup> Within a column, means without a common letter differ (P < 0.05).
Table 5. Mean value of time elapsed in minutes from first udder contact to suckling (TUS) and birth to suckling (TBS) in the 74 litters according to the number of fetal dead piglets, whether the sow had an induced farrowing or not, and sow parity number. (N = number of piglets per group; SE = standard error).

<table>
<thead>
<tr>
<th>Variation source</th>
<th>N</th>
<th>TBS MEAN</th>
<th>SE</th>
<th>TUS MEAN</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fetal dead piglets</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>193</td>
<td>28.4</td>
<td>a</td>
<td>8.4</td>
<td>a</td>
</tr>
<tr>
<td>1</td>
<td>114</td>
<td>25.7</td>
<td>a</td>
<td>9.9</td>
<td>a</td>
</tr>
<tr>
<td>2</td>
<td>8</td>
<td>16.5</td>
<td>a</td>
<td>8.1</td>
<td>a</td>
</tr>
<tr>
<td>3</td>
<td>7</td>
<td>25.4</td>
<td>a</td>
<td>7.9</td>
<td>b</td>
</tr>
<tr>
<td>4</td>
<td>6</td>
<td>20.8</td>
<td>a</td>
<td>6.3</td>
<td>a</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>107.2</td>
<td>b</td>
<td>39.0</td>
<td>c</td>
</tr>
<tr>
<td>Induced farrowing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Y</td>
<td>305</td>
<td>27.6</td>
<td></td>
<td>8.7</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>66</td>
<td>37.5</td>
<td></td>
<td>13.3</td>
<td></td>
</tr>
<tr>
<td>Sow Parity number</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>62</td>
<td>38.3</td>
<td></td>
<td>6.8</td>
<td>a</td>
</tr>
<tr>
<td>2</td>
<td>50</td>
<td>25.2</td>
<td></td>
<td>7.9</td>
<td>a</td>
</tr>
<tr>
<td>3</td>
<td>67</td>
<td>25.5</td>
<td></td>
<td>9.7</td>
<td>ab</td>
</tr>
<tr>
<td>4</td>
<td>58</td>
<td>30.5</td>
<td></td>
<td>13.3</td>
<td>b</td>
</tr>
<tr>
<td>5</td>
<td>60</td>
<td>26.1</td>
<td></td>
<td>10.1</td>
<td>b</td>
</tr>
<tr>
<td>6</td>
<td>40</td>
<td>30.8</td>
<td></td>
<td>7.4</td>
<td>a</td>
</tr>
<tr>
<td>&gt;6</td>
<td>34</td>
<td>28.6</td>
<td></td>
<td>8.6</td>
<td>ab</td>
</tr>
</tbody>
</table>

Values that do not share the same letter are significantly different.
Figure captions

Figure 1. Variability of time elapsed from a piglet’s first contact with
the udder to suckling (TUS) in minutes, for each teat pair first
suckled, according to treatment (a= assisted piglet, c=control).

Figure 2. Frequency of teat position (I to VII) and row (U= upper; B=
bottom) for first suckling by individual piglets or siblings. Dark bars
show the frequency of the teats chosen by more than two piglets in
the same litter and grey bars represent the frequency of single piglet
preference. The teat pair positions where dark bars are missing
indicate that no piglet suckled for the first time from these teats in all
observed litters.
Highlights:

- The linkage sow udder morphology- piglet teat seeking behaviour has been investigated
- Piglets suckled from small teat close to the abdominal mid-line and with an inter-teat distance within the same row larger than un-suckled teats
- Time elapse from birth and udder first contact to suckle was shorter for posterior and anterior located teat
- A high proportion of siblings suckled for the first time on a teat previously chosen by another piglet