Increase sustainability of organic pig production with more vital piglets

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About every third piglet dies before weaning within the Danish organic pig production, making the organic piglet mortality higher, than what is seen in the conventional indoor production. The high piglet mortality is in conflict with both the idea of increased animal welfare and the organic principles. As most of the piglets die within the first days after farrowing, improving the thermal conditions around the time of farrowing is important, since the thermal environment in many cases may be a significant contributor to piglet death also for piglets that are categorized as crushed or starved to death.
This paper describes a subproject under the larger Danish VIPiglets project with the overall aim to reduce piglet mortality in Danish organic pig production. The subproject described in this paper has three overall aims concerning 1) ways to improve the thermal environment around the time of farrowing 2) how the temperature and humidity inside the farrowing hut relate to piglet mortality 3) how temperature affects farrowing duration and birth interval. Studies concerning aim two and three are still ongoing and so no results are presented. In the study concerning aim one the average total litter size was 17 piglets and total piglet mortality was 31%. The study showed that providing sows with access to poplar trees (a shaded area) significantly affected paddock use compared to sows without a shaded area (control sows), by increasing the use of the paddock before farrowing and day zero and one *post partum* (*pp*) ($F_{4,218}$=2.91, p<0.05) and the paddock use particularly increased at hot temperatures. Furthermore the sows with access to poplar were lying more when outside compared to controls (29 % against 18 % respectively; $F_{1,70}$=15.13, p<0.0005). In general the sows were seen lying more in the paddock at high temperature compared to low temperature particularly before farrowing, on day zero and one *pp* and again after day 11 *pp*.
Keywords: *Piglet mortality, heat stress, lactating sows, animal welfare, behaviour*

Introduction

In organic pig production the animals must have access to an outdoor area and in some countries e.g. Denmark and the UK sows must be kept on pasture One may therefore argue that organic production provides better animal welfare than conventional production since it gives animals more opportunity to perform natural behaviour. The organic production in general is based on four ethical principles; namely the principle of health, the principle of ecology, the principle of fairness and the principle of care (IFOAM, 2016). These four principles all stress the importance of sustainability within the organic production system. Piglet mortality has been increasing since 1999 where a mortality of 18% was recorded (Kongsted and Larsen, 1999), in 2007 the total mortality had increased to 33% (Sørensen and Pedersen, 2015) and so the first part of the ongoing Danish VIPiglets project included quantifying the present level of mortality rate in the organic production. Preliminary data show a total mortality comparable to that recorded in 2007 (average 29%, range 18 to 38%) (Rangstrup-Christensen, 2015).

With a piglet mortality around 33 % the mortality in organic pig production has increased to a level, which is higher than in the indoor production, and this high mortality conflicts with both the idea of increased animal welfare and the organic principles. One way to reduce the mortality may be through the use of genotypes selected for low mortality under outdoor production conditions where farrowing assistance, aid for small under-weight piglets, use of foster sows etc. are not as easily applied as in indoor conditions. Another way is to improve the environmental condition around the time of farrowing to sustain sow health and maternal behaviour as well as piglet viability. The current subproject deals with the latter issue.
Since animals housed outdoors are more exposed to fluctuations in the environmental temperature and both sows and piglets have a narrow thermal comfort zone, particularly around the time of farrowing, improving the thermal environment around farrowing could be one way to improve piglet survival. The thermal comfort zone of a lactating sow ranges from 12 to 22°C (Black et al., 1993). When sows are exposed to higher temperatures there is a risk of heat stress. Heat stress is known to be related to farrowing problems likely due to the inhibitory effect of stress on oxytocin (Lawrence et al., 1997). Heat stress may therefore lead to an increased farrowing duration, longer inter birth intervals between piglets (Oliviero et al., 2008), an increased number of sick sows and may cause reduced feed consumption and reduced milk production (Mullan et al., 1992; Prunier et al., 1997; Quiniou and Noblet, 1999). The behaviour of the sows is expected to change during heat stress - with an increased amount of risky behaviours (e.g. posture changes and resting away from the nest/hut) putting particularly small under-weight piglets at a high risk of crushing. Contrary to the sows piglets are more likely to experience cold stress during winter than heat stress during summer as the piglets thermal comfort zone lies around 30 to 35°C (Mount, 1959; Black et al., 1993). Cold stress is negatively related to survival of the piglets (Tuscherere et al., 2000) and particularly small under-weight piglets are at risk. The thermal environment may therefore in many cases contribute to piglet death also for piglets that are categorized as crushed or starved to death. And so the aims of the current subproject of the VIPiglets project is to identify 1) ways to improve the thermal environment around the time of farrowing by providing access to a shaded area 2) how the temperature and humidity inside the farrowing hut relate to piglet mortality 3) how temperature affects farrowing duration and birth interval. The aims are addressed through three studies.

Methods

In all three studies the sows and gilts used are Landrace x Yorkshire crossbred and their piglets are Landrace x Yorkshire x Duroc crosses. The sows are kept on pasture all year and during farrowing and lactation in individual paddocks with access to an insulated A frame farrowing hut. If the temperature exceeds 15°C in the shade a wallow is created as is required by law (Anonymous, 2015a). Within the first week of life the male piglets are castrated. From farrowing and until day ten *post partum (pp)* piglets are prevented from leaving the hut. Piglets are weaned at seven weeks of age.
In all studies environmental recordings are done by use of data loggers (Hygrochron™ iButton (DS1923), Stockholm, Sweden). The loggers collect temperature and humidity inside the farrowing huts and outside on the field every tenth minute from approximately a week before expected farrowing until two weeks after expected farrowing.

Besides environmental recordings, in all studies, the herds record production data e.g. farrowing date and litter results.

Study 1

Study 1 focused on improving the thermal environment around the time of farrowing. Although studies have shown less temperature fluctuations inside insulated farrowing huts compared to uninsulated huts (Edwards et al., 1995; Randolph et al.. 2005), hut temperature during summer often exceeds the thermal comfort zone of lactating sows. The farrowing hut is usually the only shaded area in a standard farrowing paddock. Thus, as sows mainly regulate temperature through behaviour, thermal conditions may be improved by providing access to an alternative shaded area.

The aim of the current study was to investigate how sow behaviour and signs of hyperthermia are affected by giving sows access to poplar trees. We hypothesized that access to poplar would increase the sows use of the paddock and that paddock use would increase at increasing temperature.

This was an experimental field trial study with a parallel group design conducted from July to August 2015 in a private organic pig producing herd. Seventy-two lactating sows (median parity 4; range 1-8) and their litters were included. Fifty-eight test sows were housed in individual farrowing paddocks and allowed access to 8 x 4 rows of poplar trees. Control sows (N=14) were placed in standard individual farrowing paddocks without shade.

Sows were monitored using focal scan sampling on a daily basis from three days before until eight days after expected farrowing and again at approximate day 14 and 28 after farrowing. Data were analysed using the proc mixed procedure in SAS (SAS 9.3, SAS Institute Inc., Cary, NC, USA).

The average total litter size was 17 piglets (range 5 to 23) and total piglet mortality until weaning (at day 49 *pp*) was 31%. The results showed that sows, which had access to poplar used the paddock more before farrowing and on day zero and one *post partum* (59.3% and 19%) ($p<0.05$) compared to controls (42% and 6.4% respectively). When outside the sows used the poplar more before farrowing and after day 11 *pp* compared to the days in between ($p<0.0001$). Furthermore, when outside the huts, sows with access to poplar were observed lying more (29%) compared to controls (18%) ($p<0.0005$). How much the sows with access to poplar used the paddock depended on the hut temperature, thus the sows used the paddock more at high compared to low temperature (at 25°C against 18°C: 45 against 30% of time), for control sows there were no change in paddock use (at 25°C against 18°C: 30 against 30% of time). In general, sows were seen lying more in the paddock at high versus low temperature, particularly before farrowing, on day 0 and 1 *pp* and again after day 11 *pp* ($p<0.01$).

The use of the wallow depended on both treatment and day in lactation ($p<0.005$).

Thus sows with access to poplar used the wallow more (16%) compared to controls (5%) in the days before farrowing whereas controls used it more after day 11 in lactation (18% compared to 25% for poplar and control respectively).

In conclusion access to poplar increased the sows use of the paddock particularly during hot periods, indicating that access to poplar does provide sows with a better opportunity for thermoregulation. Also as the use of the poplar depended on day in lactation and was increased before farrowing and after the piglets were able to leave the farrowing hut. Hence the results suggest that access to poplar will not keep the sows away from the huts (and their piglets) while piglets are restricted to the hut. In general there was a trend for all sows to lie down more when outside the hut at high temperature.
Since access to poplar also increased the use of the wallow before farrowing it is suggested that even though the sows have access to an alternative shaded area, they still need access to a wallow in order to thermoregulate properly.

Study 2

Study 2 aims at investigating how temperature and humidity inside the farrowing hut relate to piglet mortality. There are several indications of increased piglet mortality both during summer (Randolph et al., 2005) and winter (Berger et al., 1997; Edwards et al., 1995). However, better documentation for the relation between hut climate and piglet mortality is required in order to clarify whether sows and piglets experience hyperthermia during summer and/or cold stress during winter. We hypothesize that when the temperature inside the hut, on day zero until day seven *pp*, exceeds 25°C or falls below 15°C piglet mortality will increase. Study 2 was initiated at four Danish private organic pig producing herds in July 2015 and data collection will run for a one year period. Environmental recordings and production data are collected. Data loggers have been placed inside 30 standard A frame farrowing huts at each herd and recordings of about 720 farrowings are expected. As the study is still running no results are available. However, preliminary data from the temperature recordings made in the summer 2015 will be briefly mentioned. Despite the summer (June, July, August) of 2015 being the coolest Danish summer in three years, with an average temperature of only 15.2°C (Anonymous, 2015b) temperatures above 35.5°C and hours with an average temperature above 30°C were recorded inside farrowing huts in all four herds. As this temperature exceeds the thermal comfort zone of lactating sows by around 10°C it was possible that the sows were experiencing hyperthermia, despite the low average temperature of the summer months.

Study 3

In study 3 the aim was to investigate how temperature affects farrowing duration and birth interval. Heat stress can lead to an increased farrowing duration and longer inter birth intervals between piglets (Oliviero et al., 2008), both of which are associated with an increased risk of piglet mortality (Baxter et al., 2009; Pedersen et al., 2011; Panzardi et al., 2013). We therefore investigate the hypothesis that longer farrowing durations and increased inter birth intervals will be seen when hut temperature exceeds 25°C and more stillborn and crushed piglets will be seen in litters born at >25°C.
Study 3 was initiated November 2015 at a private free range herd and will continue for a one year period. Besides data loggers (recording temperature and humidity inside the hut), video cameras (IPC-HDBW4100EP-0360B, Dahua Technology, 23 Hubble, Irvine, CA92618, USA) have been placed inside 20 farrowing huts. As the study has just been initiated no results are presented.

Perspectives

By identifying at what temperatures and humidity peaks in piglet mortality occur it will be possible to identify when the thermal discomfort of the animals becomes so extreme that it is reflected in the piglet mortality. Furthermore, piglet mortality may be due to either stillbirth or death of live born piglets. These mortalities may increase at different environmental conditions meaning that the type of management initiatives needed and the time in lactation where they need to be implemented differ across the year. E.g. we expect that during summer the proportion of sows experiencing farrowing problems, and thus also the proportion of stillborn (and weak born) piglets, will increase. Hence (if this is the case), during summer, management initiatives should be implemented prior to farrowing and aim at reducing heat stress in the sows. Contrary we hypothesize that a larger proportion of live born piglets die during winter and so management routines during winter should be implemented after the birth of the piglets and aim at reducing cold stress among piglets.

The principle of fairness: "*insists that animals should be provided with the conditions and opportunities of life that accord with their physiology, natural behaviour and well-being*" (IFOAM, 2016). Even though some aspects of animal welfare are increased in organic pig production, due to the animals' opportunity to display a broad spectrum of natural behaviours such as rooting and nest building, other aspects around the time of farrowing may be jeopardized in today's organic pig production. This is particularly reflected in the high piglet mortality.

In the large litters born by the high prolific sow lines used in both the Danish conventional and outdoor production, a large number of underweight (less viable) piglets are seen. These piglets are difficult to manage in an outdoor production system, where farrowing assistance, aid for small under-weight piglets etc. are difficult to apply, and so the survival chances of underweight piglets are slim. One way to reduce early piglet mortality may therefore be through the use of genotypes selected for low piglet mortality under outdoor production conditions e.g. sows that give birth to smaller litters consisting of larger sized piglets. Another way to reduce piglet mortality could be to improve the environmental conditions around the time of farrowing to sustain sow health and maternal behaviour as well as piglet viability. This would be in consensus with the organic principle of fairness as it would provide conditions that to a larger extent meet the animals' needs with regards to physiology and well-being.

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