Final Report to the

Agricultural Produce Commission

Pork Producers Committee

Fans in free range farrowing huts before and during farrowing to reduce the percentage of still born piglets during summer

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Summary:

The objectives of this project were to provide some relief during summer to the free range sow from high ambient temperatures in the days before and during farrowing and thereby reduce the percentage of still born piglets in free range litters farrowed during summer. The installation of low-cost, solar powered, personal fans into farrowing huts to create air movement was identified as a potential strategy to assist in cooling the sow during pregnancy and early lactation in hot weather.

Total number born was significantly higher for sows in the fan treatment groups (12.6 vs 11.7; $P < 0.05$), with parity contributing as a significant factor. However total number born alive did not differ between fan and control groups (11.4 vs 10.8; $P > 0.100$) and therefore the total number still born was higher for sows in the fan treatment group (1.28 vs 0.8 piglets/litter; $P < 0.05$). The number of piglets born dead was not impacted by the fans and the analyses indicated that it was explained by larger litter sizes because as litter size increases, the risk of piglets later in the birth order being still born increases.

The low-cost solar fans were not robust enough for the production environment. Improved equipment which has a greater impact on the internal hut environment may result in outcomes that are closer to what was expected. Data indicated that daily maximum ambient temperature, within the farrowing hut, exceeded the lactating sow's upper critical temperature (UCT) of 27ºC on more than 50% of the days during the experimental period (30 January – 23 April 2020). This clearly demonstrates that sows are exposed to significant levels of heat stress during the summer period and continuing to search for practical solutions to improve the comfort of the free range sow in late pregnancy and early lactation during summer may benefit farrowing performance and piglet survivability.

Background:

Free range production systems are a significant part of the Western Australian pork industry, contributing to more than 30% of WA's annual pig slaughter (Trezona, 2019). There is also a percentage of pigs slaughtered that are produced from outdoor sow herds (Outdoor bred).

High ambient temperature (and relative humidity) in the days immediately before farrowing can reduce the number of live born piglets (Wegner et al., 2014) and increase the number of stillborn piglets (Omtvedt et al., 1971). During summer, heat stress is very likely to be a significant issue for free range (FR) sows particularly around the time of farrowing. The upper critical temperature (UCT) for lactating sows (intensive housing systems) has been identified as 27ºC and 28ºC for 180 kg and 140 kg sows respectively (Farran, 1990). For dry sows UCT is about 35ºC in still conditions and 38ºC with a draught. In the weeks preceding farrowing, sows become more sensitive to high temperatures and in the days preceding farrowing we might expect the UCT approaches that of the lactating sow. Actual ambient temperature measured inside farrowing huts located in the South West of WA found that for the period between 5 January – 13 April 2017 the maximum daily temperature exceeded 27ºC for 45 out of 68 days (Trezona, 2019).

A proof-of-concept study conducted by Pork Innovation WA (GGRD-2015-0069-AGSC; Trezona, 2019) found that free range sows that farrowed in huts fitted with an outlet providing a source of cooled air (similar to snout cooling) had a significantly higher percentage of the litter born alive compared to sows that farrowed in standard farrowing huts (95.6% cooled; 85.9% standard; $P = 0.02$). The study had a low number of replicates (10 litters from cooled huts vs 19 litters from standard huts) but with the 10% difference it was concluded that the concept of providing a more comfortable farrowing environment for the free range sow by managing the impact of heat stress during summer, warranted further investigation.

Observations from the PIWA study also suggested that sows that farrowed in the huts with snout cooling tended to spend more time in the hut with piglets during the first 5 days after farrowing compared to sows that farrowed in standard huts. Benefits of this may include increased suckling opportunities for the piglets and therefore improved survivability and robustness during the first days after birth.

Other information collected during the study confirmed that the sow's preferred position in the farrowing hut was to sit or lay with her head facing the doorway. This information was considered to determine

the positioning of the cooling source which was located near the doorway, with airflow moving across the hut (and not from front to back). This location successfully gave the sow access to the air whilst avoiding the risk of chilling piglets (Figure 1).

Figure 1. Location of cooled air inlet in the hut and direction of airflow (blue arrow - PIWA study) and potential location and airflow direction for solar powered fan (green fan and arrow)

Currently there are no commercially viable solar powered snout cooling systems available for free range farrowing huts. Investigation into other simple and more affordable options, such as solar powered fans ($25-$90/unit) is warranted. Fans will provide a directed source of moving air which may prove effective at the milder summer temperatures (25-30^{o}C) that are common to the South West region of WA, where the majority of the state's free range pig production occurs. It is suggested that a fan be located in a similar position to the cooling outlet, although higher to avoid access by the sow (Figure 1).

Hypothesis:

It was hypothesised that during the summer period there would be a higher percentage of live born piglets per litter for free range sows farrowing in huts fitted with fans compared to litters of sows that farrowed in standard huts.

Objectives:

- To provide some relief for the sow from high ambient temperatures in the days before and during farrowing.
- To reduce the percentage of still born piglets in free range litters farrowed during summer.

Expected Outcome:

Identification of a low-cost piece of equipment that can be utilised to improve the percentage of live born piglets across free range litters farrowed during the summer period.

Method:

Between January and April 2020 a total of 163 farrowing sows were identified from 16 farrowing paddocks (~10 sows/paddock; ~80 sows/treatment), across 5 farrowing batches (see Table 1).

Farrowing huts in each batch were identified as treatment or control with the treatment huts being fitted with solar powered 'personal' fans (see Appendix 1). Control huts were left untouched. Two types of huts were used during in the trial. Rectangular metal huts made from refrigeration panel (Figure 2) and wooden huts with angled sides (Figure 3). Both types of huts had the door at one end and a smaller window on the opposite wall which could be closed if required.

Figure 2. Rectangular, refrigerator panel, metal farrowing huts

Figure 3. Wooden farrowing huts with angled walls

Table 1. Allocation of treatments and hut type within each batch farrowed

Batch	Hut Type	Treatment	Sows farrowed	Installation date	Farrowing dates	Weaning date
1	Wooden A type	Fan	10	30/01/20	10/02/20-19/02/20	12/03/20
	Wooden A type	Control	11			
	Metal insulated type	Fan	10			
	Metal insulated type	Control	11			
2	Wooden A type	Fan	10	20/02/20	25/02/20-03/03/20	27/03/20
	Wooden A type	Control	10			
	Metal insulated type	Fan	10			
	Metal insulated type	Control	10			
3	Metal insulated type	Fan	10	06/03/20	12/03/20-16/03/20	09/04/20
	Metal insulated type	Control	11			
4	Wooden A type	Fan	10	12/03/20	17/03/20-24/03/20	16/04/20
	Wooden A type	Control	10			
	Metal insulated type	Fan	10			
	Metal insulated type	Control	11			
5	Wooden A type	Fan	10	20/03/20	25/03/20-30/03/20	23/04/20
	Wooden A type	Control	11			

Sows entered the farrowing paddock approximately 10-14 days before their estimated farrowing date and remained in the paddock for approximately 5-6 weeks until weaning (4 week lactation). Fans were fitted approximately 7 days before farrowing and they operated automatically during daylight hours (the units did not have battery storage capability). During the trial it was intended for the fans to operate throughout the pre-farrowing period and for approximately 7 days after farrowing (while piglets are confined to the huts by fenders).

Farrowing records and pre-weaning mortality records were collected for each sow and data analysed to determine if there were any differences in performance between huts with and without fans. Subsequent farrowing performance was also determined.

It was originally planned that the number of “smalls” at weaning would be assessed for each treatment group. Unfortunately this data was not able to be accurately captured and therefore was not included in the project.

The fan specifications were:

- 4 inch fan
- 6V USB powered, individual switch, metal mesh, 1.2m cable
- Adjustable fan position.

The solar panel specifications were:

- 3.5w 6v Solar Panel (145mm x 145mm) with USB output port
- Material: Polycrystalline
- Max Power: 3.5W
- Working Voltage: 6V
- Max Current: 500mA
- Short Circuit Current: 6.5A
- Open Circuit Voltage: 7.2V

Figure 4. Example of solar powered fan that was fitted to the farrowing huts

Statistical Analysis:

Data were analysed by analysis of variance, adjusted for parity and total number born as the covariates and blocked by batch (Genstat 20th Edition, VSN International Ltd). Data were considered significant if $P \leq 0.050$; a trend if $P > 0.05$ and < 0.100 and not significant if $P \geq 0.100$.

Impact of Covid-19 Restrictions:

For the most part the impact of travel restrictions relating to the Covid-19 Global pandemic were minimal.

The fans were fitted to the huts for the final batch of sows began on 20 March 2020 (regional travel restrictions occurred from 31 March 2020). The main effects were that the fans for the final batch of sows could not be checked one week after installation to determine/rectify equipment failures and some of the temperature loggers could not be located and retrieved by other staff.

Results and Discussion:

Table 2. Comparison of farrowing and pre-weaning records for litters farrowed into huts fitted with solar powered fans or control huts (without fans)

	Fan (n=80) Average	Control (n=83) Average	sed	P-value		
				Treatment	Parity	Total born
Parity	3.0	2.5	0.232	**0.023**		
Total number born	12.7	11.7	0.478	**0.046**	**<0.001**	
Number born alive	10.95	11.17	0.206	0.294	**<0.001**	**<0.001**
Number born dead	1.20	0.94	0.194	0.176	0.724	**<0.001**
% Born dead	11.1	6.5	2.02	**0.023**	0.521	0.721
% Born alive	88.6	93.0	2.08	**0.037**	0.587	0.515
Pre wean mortality (number)	1.15	0.95	0.215	0.346	**0.002**	0.154
Pre wean mortality (%)	11.3	9.82	2.37	0.532	**0.042**	**<0.001**

There was a significant difference in the average parity of sows between the treatment and control groups ($P < 0.05$). Parity can be related to litter size where total born tends to be higher for sows at parity 3 and 4 compared to sows at parity 1 and 2 (Lavery et al., 2019). Therefore parity was considered as a covariate in the remainder of the statistical analyses.

Total number born was significantly higher, by 1 pig/litter, for sows in the fan treatment ($P < 0.05$), with parity also contributing as a significant factor. Even though analysis indicates that the effect of the fan treatment was statistically significant on total number born it is likely the difference is explained by parity because the fans were introduced very late in gestation so the number of piglets would be established and any that may have died in utero during the experimental pre farrowing period would still be present as mummified or stillborn. The numbers of mummified piglets recovered was very low across all batches therefore the data is not included in this report. Total number born was also used as a covariate throughout the remainder of the analyses because it is established that as litter size increases the percentage of still births, particularly for piglets born later in the birth order, increases (Langendijk and Plush, 2019).

The total number born alive did not differ between fan and control groups ($P > 0.100$), though there was a significant effect of parity and total number born ($P < 0.05$).

The total number born dead was higher for sows in the fan treatment group (an average of 1.20 vs 0.94 piglets/litter) and this was explained by the higher total number born ($P < 0.05$). This difference was also reflected in the percentages of the litter born alive and born dead.

Further analyses indicated that there was no effect of farrowing hut type (metal vs wooden) on born alive and born dead ($P > 0.100$; $P = > 0.100$ respectively).

Pre-weaning mortality was related to parity ($P < 0.05$) but there was no impact of the hut treatment ($P > 0.100$).

The records from the subsequent farrowing of sows that remained in the sow herd were examined. As expected, the average parity of sows differed between treatment groups ($P < 0.05$) (Table 3.) where average parity was higher for the sows that were previously in the fan group. Total pigs born in the subsequent litter was higher for sows that had been in the control group ($P < 0.05$) and the number born alive was higher for the sows previously from the fan group. Analysis indicated that these differences were explained by the total number born ($P < 0.05$). Sows previously from the fan group had a significantly lower number of piglets born dead ($P < 0.05$) and this was again explained by the total number born. There was no influence of parity on the total number of pigs born dead, born alive or the percentages of these ($P > 0.100$).

Table 3. Subsequent farrowing records for sows that were included in the experiment (all sows farrowed in standard huts)

Subsequent Farrowing	Fan (n=59) Average	Control (n=63) Average	sed	P-value		
				Treatment	Parity	Total born
Parity	4.1	3.4	0.276	**0.027**		
Total Born	11.2	13.2	0.674	**0.005**	0.631	
Born alive	11.1	10.3	0.580	0.158	0.397	<0.001
Born dead	1.29	2.09	0.583	**0.177**	0.455	<0.001
% Born alive	90.2	84.9	4.07	**0.199**	0.627	0.006
% Born dead	9.8	15.1	4.07	**0.199**	0.627	0.006

Environmental Temperature:
Temperature records were collected for the duration of the experiment. Maximum daily temperatures recorded from the nearest weather station (Porongorup) and the external environmental temperature as recorded by a logger on the exterior of a wooden farrowing hut (attached to the west facing wall), and temperature loggers located inside control and fan huts (metal box huts, Figure 5; wooden angle huts Figure 6). In general, the temperatures recorded on location were higher than those reported by the weather station. Internal hut daily maximum temperatures tended to be lower than the external ambient daily maximum temperature for the metal box huts but occasionally higher for the wooden angle huts (the black surface likely to absorb the radiant heat more than the reflective surface of the box huts). There were minimal temperature differences between the control huts and huts with fans.

Between 30 January and 22 April, daily maximum temperatures (as reported by the weather station) exceeded the 27°C UCT for lactating sows on 15 out of 85 days (~18% of the time). Maximum daily temperatures recorded inside the farrowing huts exceeded the 27°C UCT for over half the days during the same period: 45 and 51 days out of 85 for control and fan huts, respectively.

As expected, the temperature records indicate that the pregnant and lactating free range sows (located in the Albany region) are exposed to significant levels of heat stress during the summer period. Continuing the search for a practical solution that improves the comfort of the free range sow during summer may create benefits in farrowing performance and piglet survivability.

Durability:
The quality of the low-cost solar fans was variable with several fans needing to be replaced as they did not work when tested prior to installation. During the trial period it was found that the fans had failed on 13 occasions. These were replaced or repaired during the trial as soon as practical. The failures were due to the solar panels and/or the wiring to the fan. Other issues were related to birds damaging the wiring (connecting the solar panel to the fan) or sows damaging the fans if they were installed too low or if the amount of bedding added to the hut was higher than expected. The force of the air coming from different fans (of the same size and brand) was variable and in several cases the air movement generated by the fan may not have been intense enough to provide benefit to the sow. In this study the average cost of the fans was $26/fan.

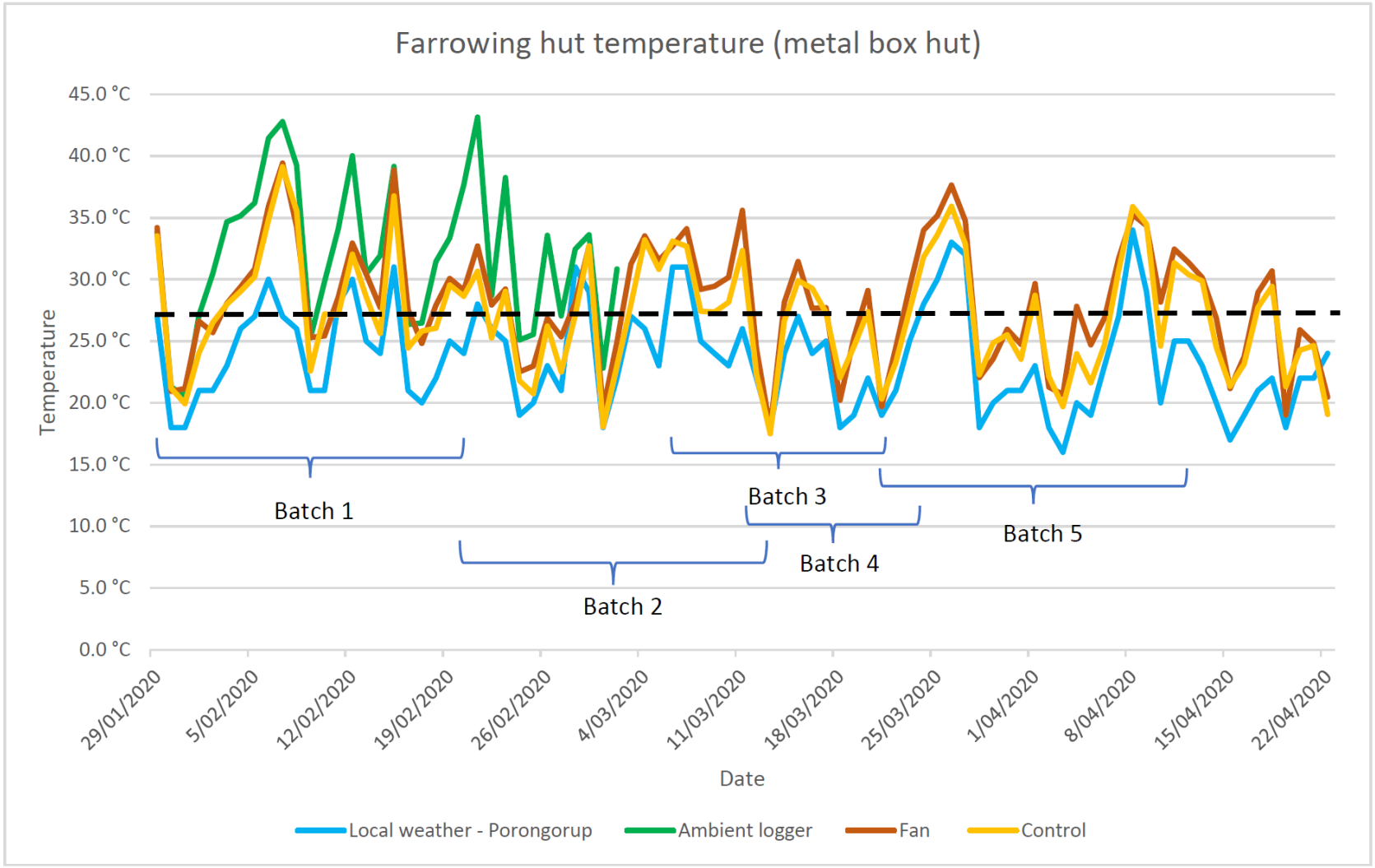

Figure 5. Maximum daily temperature records during the farrowing hut experiment for metal box huts
The dashed black line indicates 27°C, identified as the upper critical temperature for a lactating sow.
Technical issues with the Ambient logger (temperature external to the hut, indicated by the green line) meant data was only available to 03/03/2020.

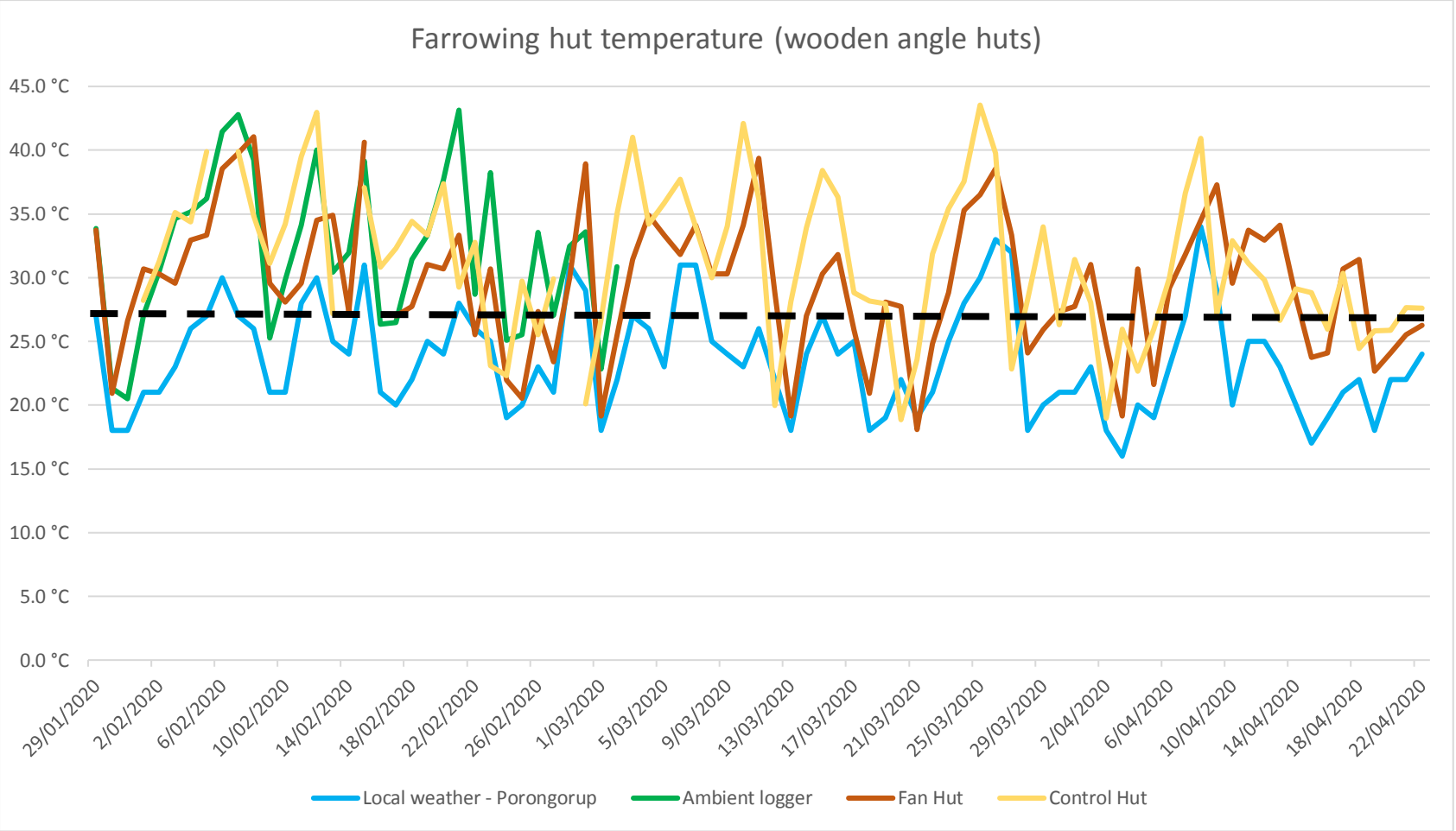

Figure 6. Maximum daily temperature records during the farrowing hut experiment for wooden angle huts
The dashed black line indicates 27°C, identified as the upper critical temperature for a lactating sow.
Technical issues with the Ambient logger (temperature external to the hut, indicated by the green line) meant data was only available to 03/03/2020.

Conclusion:

No direct benefits were observed from having the small solar powered fans in free range farrowing huts, in fact the differences between treatment groups were primarily explained by parity of the sows or the total litter size.

Sows in the fan group had a higher average parity (3.0 vs 2.5 for control group) and this was related to the total number of piglets born/litter which was significantly higher, by 1 pig/litter. compared to sows that farrowed in the control huts. However, the total number born alive did not differ between fan and control groups. Total number born dead was significantly higher for litters born in huts with fans (0.5 pig/litter) but this was because as litter size increases the percentage of still births, particularly piglets born later in the birth order, also increases (Langendijk and Plush, 2019).

The low-cost solar fans were not robust enough for the production environment with numerous equipment failures. In some cases the air movement generated by the fans may not have been intense enough to benefit the sow. Improved equipment, more robustly and purpose designed (but also likely to be more expensive) is likely to have a greater impact on the internal hut environment (pre-farrowing) and may result in outcomes that were closer to what was hypothesised.

As expected, the temperature records indicate that the pregnant and lactating free range sows located in the Albany region are exposed to significant levels of heat stress during the summer period. Continuing the search for a practical solution to improve the comfort of the free range sow during summer may result benefits to farrowing performance and piglet survivability.

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Appendix 1. Fans in operation in farrowing huts: Pre farrowing and post farrowing