Resour Sci Res, 2023, 5(1):26-31
https://doi.org/10.52346/rsr.2023.5.1.26

자원과학연구 (Resources Science Research)
pISSN: 2713-7872 eISSN: 2799-3442

ARTICLE

Importance of Thermoregulation in Farrowing Houses for Improving Pig Production Efficiency in Korea

Jin-Ki Park[1], Kwanghyun Cho[1], Joon Mo Yeo[1], Dong-Wook Kim[1], Pilnam Seong[2], Won-Young Lee[1]

[1]Department of Livestock, Korea National University of Agricultures and Fisheries, Jeonju 54874, Republic of Korea
[2]Animal Nutrition & Physiology Division, National Institute of Animal Science, RDA, Wanju 55365, Republic of Korea

Received: April 12, 2023
Revised: June 08, 2023
Accepted: June 08, 2023

*Corresponding author :
Won-Young Lee
Department of Livestock,
Korea National University of
Agricultures and Fisheries,
Jeonju 54874, Republic of Korea
Tel : +82-63-7238-9214
E-mail : leewy81@korea.kr

ORCID
Park, Jin-Ki
https://orcid.org/0000-0002-8423-5848
Yeo, Joon Mo
https://orcid.org/0000-0002-1617-2195
Cho, Kwanghyun
https://orcid.org/0000-0003-1564-5656
Kim, Dong-Wook
https://orcid.org/0000-0003-2647-2690
Seong, Pilnam
https://orcid.org/0000-0003-2915-1059
Lee, Won-Young
https://orcid.org/0000-0003-0291-5581

Abstract

South Korean summers are hot and humid, negatively affecting the pig industry. This study investigated the effects of season on farrowing rate, litter size, litter per sow per year, and piglets per sow per year on pig farms. The data were collected from local pig farms in Jeongeup-si, South Korea. The four seasons were classified as spring (March-May), summer (June-August), fall (September-November), and winter (December-February). The temperatures of the farrowing houses in summer differed for each of the four pig farms analyzed. Farm 1 and farm 2 regulated their temperatures. In contrast, farm 3 and farm 4 did not control their temperatures. Consequently, the pig production efficiency of farm 1 and farm 2 did not differ between the four seasons. Although the farrowing rate and litter size did not differ with the season, the number of weaning piglets was significantly reduced in the summer on farm 3 and farm 4. In farm 3, the farrowing interval was significantly increased, and the litter per sow per year was the highest in winter. In addition, the litter per sow per year was significantly lower in the summer at farm 4. Furthermore, the number of piglets per sow per year was significantly reduced in the summer at farm 3 and farm 4. These data indicate that the thermoregulation of farrowing houses during the summer is important for efficient pig production in Korea.

Keywords

Pig, Season, Heat stress, Piglets per sow per year

Ⅰ. Introduction

Global warming has accelerated over the past few years. Heat stress is not limited to tropical regions, as temperate countries are also affected during the summer (Renaudeau *et al.*, 2012). According to the Ministry of Environment in Korea, the average annual temperature has risen around 0.18℃ every ten years for the past century, which is faster than the global warming trend (Ministry of Environment, 2023). As a result, extreme weather events, including heat and cold waves, are becoming increasingly frequent. In particular, the weather in Korea is hot and humid during the summer.

Heat stress is a major environmental problem that negatively affects animal welfare and production efficiency in most farm animal industries (Baumgard and Rhoads, 2013). In the pig industry, the economic losses associated with heat stress include reduced growth, decreased feed efficiency, poor sow performance, decreased carcass quality, and increased mortality. The reduced reproductive performance in sows is characterized by anestrus, increased wean-to-estrus intervals, decreased farrowing rates, and reduced litter size (Ross *et al.*, 2015).

Pork is one of the most widely consumed farm animals in the world. China accounts for approximately half of pork production (49%). European countries are the second largest in pig production (25%), followed by North American countries (11%) (Mayorga *et al.*, 2019). According to the Ministry of Agriculture, Food, and Rural Affairs, the pork industry in Korea accounts for 15% of the total agricultural products (KASS, 2023). Several studies have investigated the effects of heat stress on pig production. The reduced farrowing rate of domestic sows mated in summer remains a major issue in the pig industry. The recently published Australian commercial farrowing rates of sows mated in summer range from 64 to 83%, which are lower than those in cooler months (89%) (Liu *et al.*, 2020). Boar fertility contributed to the lower farrowing rate of summer-mated sows. The effects of hot conditions on boar fertility include reduced sperm concentrations, increased percentages of abnormal sperm, and decreased sperm motility (Zasiadczyk *et al.*, 2015). In addition, a climate-controlled study found that heat stress during lactation reduced follicle size from 6.7 to 5.8 mm and prolonged the estrus to ovulation interval from 1 to 2.5 days (Cabezón *et al.*, 2017).

This study examined pig production efficiency from two different farm groups between 2021 and 2022, including the number of the sow, farrowing rate, farrowing interval, litter size, number of weaning piglets, litter per sow per year (LSY), and piglets per sow per year (PSY),. We also compared the production efficiency results for each of the four seasons to investigate the relationship between heat stress and pig production efficiency.

Ⅱ. Material and Methods

Data collection

The four seasons were classified as spring (March–May), summer (June–August), fall (September–November), and winter (December–February). Temperature data were obtained from the Korea Meteorological Administration Weather Data Service (Table 1). The temperatures of the farrowing houses on each farm were collected every 10 min from June to August using the Real Farm Corporation farm manager program (Anseong, Korea) (Table 2). Data on the number of sows,

Table 1. The seasonal temperature in Jeongeup-si, South Korea, between 2021–2022

Year	Season	Average temperature (℃)	Lowest temperature (℃)	Highest temperature (℃)
2021	Fall	15.6	11.1	21
2021	Winter	0.7	-3.6	5.5
2022	Spring	13	7.2	19.5
2022	Summer	25.1	21.6	29.5

Table 2. The summer temperature of the farrowing houses from 4 different pig farms

Year	Average temperature (℃±SD)	Lowest temperature (℃)	Highest temperature (℃)
Farm 1	26.2±1.77	22.3	28.6
Farm 2	25.9±1.56	24.6	26.5
Farm 3	26.8±2.12	23.7	31.3
Farm 4	27.5±2.35	23.5	33

farrowing rate, farrowing interval, litter size, number of weaning piglets, LSY, and PSY were collected from four local farms in Jeongeup-si, Korea, between September 2021 and August 2022. The four farms were enclosed house and numbers of sow was described in Table 3 and 4. The room temprature was set at 22 to 23℃, according to the farm protocol and targeted 32 to 35℃ for the temperature of the mat. The production efficiency data were classified and analyzed by month and season.

Statistical analysis

A one-way analysis of variance (ANOVA) was used to compare the average farrowing rate, farrowing interval, litter size, number of weaning piglets, LSY, and PSY data using the Statistical Analysis System (SAS) software (version 9.4; Cary, USA). Duncan's multiple comparison test was used to compare the groups. All data are expressed as mean ± standard deviation (SD). The null hypothesis was rejected when the probability was $p<0.05$.

Ⅲ. Results

The temperatures during the four seasons in Jeongeup-si are listed in Table 1. In summer, the highest temperature was 29.5℃. The summer temperatures of the farrowing houses on each farm are shown in Table 2. Farm 1 and farm 2 efficiently regulated the temperature of their farrowing houses. In contrast, farm 3 and farm 4 did not control their temperatures, which were over 30℃. Good

Table 3. The seasonal average pig production efficiency from two different farm 1 and farm 2, between 2021−2022

Farm 1	Spring	Summer	Fall	Winter
Number of sows	902	899	902	906
Farrowing rate (%)	91.27±1.86	88.2±6.26	85.4±4.13	85.6±4.86
Farrowing interval (day)	142.07±0.84	142.5±1.2	142.13±0.15	144.7±0.2
Litter size (total)	15.4	14.8±0.2	14.43±0.25	14.47±0.46
Litter size (alive)	13.87±0.12	13.6±0.17	13.4±0.26	13.3±0.35
Number of weaning piglets	12.17±0.06	12.13±0.32	12.07±0.32	11.9±0.35
LSY[1)]	2.44±0.21	2.43±0.01	2.45±0.08	2.52±0.02
PSY[2)]	29.63±0.21	29.43±0.67	29.7±1.15	29.93±0.59
Farm 2	**Spring**	**Summer**	**Fall**	**Winter**
Number of sows	964	969	933	963
Farrowing rate (%)	79.8±5.51	86.8±3.28	81.27±6.69	85.7±1.48
Farrowing interval (day)	153.13±0.45	151.5±2.35	154.8±1.74	153.33±0.55
Litter number (total)	12.53±0.4	12±0.1	12.2±0.2	12.33±0.42
Litter number (alive)	12.3±0.26	11.8±0.17	11.9±0.2	12.23±0.4
Number of weaning piglets	10.87±0.21	10.47±0.57	10.17±0.68	11.03±0.21
LSY	2.31±0.1	2.33±0.05	2.3±0.03	2.29±0.02
PSY	25.2±0.1	24.43±1.46	23.4±1.65	25.3±0.2

Abbreviations: [1)] LSY, litter per sow per year; [2)] PSY, piglets per sow per year.

Table 4. The seasonal average pig production efficiency from farm 3 and farm 4 between 2021–2022

Farm 3	Spring	Summer	Fall	Winter
Number of sows	964	856	911	933
Farrowing rate (%)	91.67±0.91	81.53±16.79	86.27±2.35	92.47±1.12
Farrowing interval (day)	151.23±2.22[ab]	149.67±2.57[a]	148.6±1.30[a]	154.37±1.79[b]
Litter size (total)	15.93±0.64	14.37±1.27	15.4±0.61	15.07±0.51
Litter size (alive)	14.2±0.46	13.13±1.01	13.73±0.32	13.8±0.61
Number of weaning piglets	12.07±0.21[a]	9.47±3.33[b]	11.77±0.49[a]	11.83±0.042[a]
LSY[1)]	2.22±0.15[b]	2.34±0.22[b]	2.39±0.05[b]	2.42±0.03[a]
PSY[2)]	26.7±1.49[a]	21.97±7.39[b]	28.03±1.30[a]	28.57±0.76[a]
Farm 4	**Spring**	**Summer**	**Fall**	**Winter**
Number of sows	160	159	159	161
Farrowing rate (%)	86.1±2.91	86.83±6.14	79.67±14.28	85.83±9.59
Farrowing interval (day)	152.93±1.16	150.77±3.21	155.27±6.27	152.83±7.32
Litter number (total)	12.63±1.42	12.77±0.50	12.7±1.68	13.23±0.51
Litter number (alive)	12.1±1.21	12.47±0.40	11.7±1.97	12.4±0.70
Number of weaning piglets	10.27±0.87[a]	9.17±0.45[b]	10.63±0.64[a]	10.73±0.35[a]
LSY	2.28±0.04[a]	2.21±0.01[b]	2.3±0.12[a]	2.34±0.06[a]
PSY	23.47±1.95[a]	20.17±1.00[b]	24.57±2.78[a]	25.17±1.16[a]

Abbreviations: [1)] LSY, litter per sow per year; [2)] PSY, piglets per sow per year.

thermo-controlled farms showed no difference in each economic indicator during the different seasons (Table 3). The farrowing rate and litter size did not differ between seasons in the two poorly thermo controlled farms. However, the number of weaning piglets was significantly reduced in the summer on farm 3 and farm 4. In farm 3, the farrowing interval was significantly increased in the winter compared to summer and fall. The LSY was significantly higher in winter compared with other seasons (2.42±0.03, $p<0.05$). The LSY did not significantly differ in summer compared to spring and fall (2.34±0.22, $p<0.05$). In addition, the LSY was the lowest in summer compared with other seasons in farm 4 (2.21±0.01). Furthermore, the PSY was significantly lowered in farm 3 and farm 4 during summer (Table 4).

Ⅳ. Discussion

The PSY is an important factor for measuring the efficiency of pig farms and the reproductive performance of sows. PSY is closely related to the number of weaned piglets per litter, farrowing rate, non-productive days, and other production factors (Bell *et al*., 2015). Therefore, PSY has been used as a target for reproductive performance and productivity in breeding herds (King *et al*.., 1998). Commonly, pig production rate was decreased in summer season that was related with heat stress induced by high temperatrue and moisture. Recently, themoregulater was outstanding developed in farrowing house their pig production efficency was increased. In this study, the farrowing rate and litter size did not differ between seasons. In contrast, the number of weaning piglets of poorly thermo regulated farm was significantly reduced in the summer. These data indicate that heat stress is related to the lactating piglet's fate but not the fetal stage. A previous report found that heat stress did not affect litter size or offspring body weight. However, heat stress has decreased litter body weight gain due to a reduction in sow milk production (Guo *et al.*, 2018). This result was complete coincied with our present study.

Ambient temperatures above the critical evaporative temperature of lactating sows reduce food intake, milk yield, reproductive performance, and the growth rate of piglets. The direct effect of high temperatures on milk yield may result from the redirection of blood flow to the skin and away from other tissues, including the mammary glands (Black *et al.*, 1993). Another sdudy descrived it is concluded that the free-feeding system or increased dietary energy dendity leads to improved sow performance during hot ambient temperature (Kim *et al.*, 2020).

Sows can potentially produce approximately 60–70 weaned piglets per year. Therefore, if the annual parity is calculated to be 2.27, the average PSY should exceed 26. However, our data showed that the average PSY in the summer of farm 3 and farm 4 (poorly thermo regulated farm) were 21.97 and 20.17, respectively, indicating a lack of more than four piglets per sow per year. Therefore, it is possible to improve pig farm productivity in South Korea by regulating the temperature of the farrowing houses in the summer. Our study demonstrates that the thermoregulation of farrowing houses is important for efficient pig production in Korea in the summer. Especilly, management of air ciculation system and using cooling pad is important for impove pig production in the summer.

V. References

1. Baumgard LH, Rhoads RPJr. 2013. Effects of heat stress on postabsorptive metabolism and energetics. Annu Rev Anim Biosci. 1:311–337.
2. Bell W, Urioste JI, Barlocco N, Vadell A, Clariget RP. 2015. Genetic and environmental factors affecting reproductive traits in sows in an outdoor production system. Livest Sci. 182:101–107.
3. Black JL, Mullan, BP, Lorschy ML, Giles LR. 1993. Lactation in the sow during heat stress. Livest Sci. 35:153–170.
4. Cabezón FA, Stewart KR, Schinckel AP, Richert BT. 2017. Effects of betaine and heat stress on lactation and postweaning reproductive performance of sows. Prof Anim Sci. 33:241–253.
5. Guo Z, Lv L, Liu D, Fu B. 2018. Effects of heat stress on piglet production/performance parameters. Trop Anim Health Prod. 50:1203–1208.
6. Kim KY, Choi YH, Hosseindoust A, Kim MJ, Moturi J, Kim TG, Song CH, Lee JH, Chae BJ. 2020. Effects of free feeding time system and energy level to improve the reproductive performance of lactating sows during summer. J Anim Sci Technol. 62:356–364.
7. King VL, Koketsu Y, Reeves D, Xue JL, Dial GD. 1998. Management factors associated with swine breeding-herd productivity in the United States. Prev Vet Med. 35:255–264.
8. Liu F, Ford EM, Morrison RS, Brewster CJ, Henman DJ, Smits RJ, Zhao W, Cottrell JJ, Leury BJ, Dunshea FR, Bell AW. 2020. The greater proportion of born-light progeny from sows mated in summer contributes to increased carcass fatness observed in spring. Animals (Basel). 10:2080.

9. Mayorga EJ, Renaudeau D, Ramirez BC, Ross JW, Baumgard LH. 2019. Heat stress adaptations in pigs. Anim Front. 9:54–61.
10. Ministry of Agriculture Food and Rural Affairs in Korea, Korea Agricultural Statistics Service (KASS). 2023. https://kass.mafra.go.kr/
11. Ministry of Environment in Korea. Topics. Cimate Change. 2023. https://eng.me.go.kr/
12. Renaudeau D, Collin A, Yahav S, de Basilio V, Gourdine JL, Collier RJ. 2012. Adaptation to hot climate and strategies to alleviate heat stress in livestock production. Animal. 6:707–728.
13. Ross JW, Hale BJ., Gabler NK, Rhoads RP, Keating AF, Baumgard LH. 2015. Physiological consequences of heat stress in pigs. Anim Prod Sci. 55:1381–1390.
14. Zasiadczyk L, Fraser L, Kordan W, Wasilewska K. 2015. Individual and seasonal variations in the quality of fractionated boar ejaculates. Theriogenology. 83:1287–1303.