Influence of Age, Body Weight, and Average Daily Gain at First Insemination of Topigs Norsvin TN70 Gilts on the Litter Size

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Preface

This is the final part of my Bachelor Animal Science thesis “Influence of age, body weight, and average daily gain at first insemination of Topigs Norsvin TN70 Gilts on the litter size”. The reason to conduct this thesis is to find out the optimal insemination criteria for the farm to improve reproductive performance.

I would like to thank my coach Marrit Van Engen for guiding me to finish this thesis and support from farm manager Jan for providing the data and related farm information and teacher Honk for SPSS analyses teaching, as well as the assistance and suggestion from consultant teams of Topigs Norsvin.

Abstract

The objective of the present study was to investigate the influence of age, body weight, and the average daily gain at first insemination on the litter's size of Topigs Norsvin TN70 gilts. This research was implemented in a specific pathogen-free (SPF) commercial swine farm which is located in the eastern part of Germany. Data was exported from the data system of the farm, TN 70 gilts were inseminated and farrowed from 1st May 2019 to 30th May 2020, the gilt without BW information and litter's size data were filtered out from the sample. This study found out that the age at first inseminating had negative correlation with TB ($P \leq 0.002$, R^2=0.009) and BA ($P<0.0001$, R^2=0.011). ADG at first inseminating had positively correlation with TB ($P=0.01$, R^2= 0.004) and BA ($P = 0.0069$, R^2= 0.005). There is no correlation between inseminating body weight with litter size ($P=0.949$) for TB and BA ($P= 0.894$). Gilts inseminated between 240-249 day' age had the highest TB (14.89 ± 2.97) and BA (14.38 ± 2.95). Gilts inseminated between 260-269 had the second-highest TB (14.65 ± 2.92) and BA (14.08 ± 3.06). Gilts with ADG 661-699 g/d had the optimal TB (14.58 ± 3.10) and BA (13.97 ± 3.17), no big difference from other groups with over 600 g/d, but had significantly higher number than group < 600 g/d TB (13.74 ± 3.15) and BA (13.08 ± 3.45). In conclusion, Gilts inseminating between 240- 249 days' age and 260-269 days' age with ADG 661-699 have the corresponding the body weight range: 167- 181 kg might have an optimal litter size. For the field particle, it is recommended to inseminated gilts from 240 days' age to 270 days' age with an optimal ADG 600-700 g/d and a body weight between 165-180 kg.

Key words: TN70, litter size, age, body weight, average daily gain.

Contents

1. Introduction

Gilts are the future of commercial swine farm, gilt's herd take up 20~25% of the total female swineherd in reproduction (Roongsitthichai et al., 2013). At the commercial sow herds, the average annual replacement rate is approximately 40% to 50%. (Engblom et al., 2007). Therefore, the gilts play an important role in the farm because the herd reproductive performance is made up of those 20-25% animals.

A lot of previous researches were conducted to improve the gilts' reproductive performance. They have found out that various factors that can influence the farrowing results, such as feed nutrition, outdoor temperature, living space, inseminating age, and body weight (Koketsu et al., 2017). In the field, it is good to develop the quantification of the standard operating procedure as a management criterion to be easily carried out by the employees (Kaneko et al., 2012). Therefore, it is necessary to have an optimal quantification of Age, body weight, and average daily gain as a standard to inseminate the gilts to increase the potential of reproductive performance such as litter size.

Age is a major criterion for all the genetic types of gilts at first insemination as well. Gilts reach puberty at an average of 6 to 7 months age (P. Tummaruk et al., 2000). Meanwhile, Age of gilts at first insemination is an element in connection with reproductive performance (Saito et al., 2010). The age of puberty in gilts is normally defined as the time of the first oestrus and ovulation with a continuation of regular oestrous cycles, a study found that age at first insemination of the gilts delayed for 10 days, 0.1 piglet would increase in the first litter (P. Tummaruk et al., 2001a). In addition, previous study discovered gilts showed the first estrus at age 181-200 days had 1.5 piglets more than those gilts showed first estrus at age 201 to 220 days (P Tummaruk et al., 2007). Furthermore, a study concluded that because of housing and feed costs of gilts from birth to the first gestation is expensive, the optimal economic age for the first gestation is about 200 to 220 days (Schukken et al., 1994).

Body weight (BW) of gilts is an important factor for improving the reproductive performance and longevity of the female animals at insemination (Strathe et al., 2019). BW is related to the average daily gain which is significantly related to the feeding strategy for gilts during the rearing period, higher growth rate resulted in heavier gilts at first estrus and insemination. (George Foxcroft, 2001). Gilt's growth rate and body composition are influenced by altering amino acid density (Díaz et al., 2017). Growth rate of the gilts indicates animal health and feed intake during the rearing period. Also, (Tummaruk et al., 2009) recommended to

do not inseminate gilts with a body weight below 130 kg, because this might lead to a lower litter size and shorter sow longevity. Base on the research result of (GR Foxcroft, 2002), body weight of gilts must be a very important criteria in determining the time of the first insemination, higher GR value consumed more feed had a better nutritional status which might result in higher litter size comparing with gilts with lower GR. Another Tummaruk's research found that the gilts' body weight and growth rate were correlated with the number of ovulations and every 10 kg increase in body weight lead to an increase of 1.1 corpora lutea (Padet Tummaruk et al., 2015). Furthermore, the litter size of gilts increased when GR of gilts greater than 700g/d was also observed (Amaral Filha et al., 2010). Gilts with GR between 350–450 g/day have a smaller litter size as sows than gilts having a GR of 500–550 g/day (P. Tummaruk et al., 2001a). A research conducted in China revealed that Yorkshire and Landrace sows might have better performance by inseminating before 230 days age (Bin et al., 2016).

Litter size is determined by ovulation rate, fertilization rate, and prenatal survival rate. (Van der Lende et al., 1990), total born (TB) and born alive (BA), it is a part of the reproductive performance of gilts in field. Ovulation rate is determined by the number of larger follicles that released from atresia, female pigs might ovulate 15 to 30 follicles in one oestrus period (Soede et al., 2011). There is a research conducted in Thailand discovered that TB and BA in the first three parities were highest in gilts that had first observed oestrus between 181 and 200 days of age with 110.1 -120 kg body weight, the body weight at first insemination is related to the total piglets born per litter and the total piglets born alive(P Tummaruk et al., 2007).

An old research found that the average number of born alive piglets is positively correlated with the older age of the first conception of gilts (Schukken et al., 1994). In more recent research of PIC genetics, (Karolina Szulc, 2015) found in their research that the age of the gilts has a significant effect on litter size. On the other hand, the age and body weight at first insemination did not affect the farrowing result of first litter (Roongsitthichai et al., 2013).

Genetic selection for improving litter size has been researching for many years, changes the physiological response of gilts to management or environmental factors, gilts might feel stressful and become more anxious as a result increase standing behaviour (Yang et al., 2019). To archive the better performance of the breeding animals, the breeding management need to be optimized according to the accurate mating weight and age (SuHyup Lee, 2019). However, the different farms have different situations, and reproductive traits are very important for the economic efficiency of pig production, it depends on numerous environmental and genetic elements (Amaral Filha et al., 2010).

The age and BW at insemination are always the first targets of various swine genetic companies, Topigs recommended inseminating TN70 gilts at age of 240-250 days with 150-160 kg BW, 600- 660g ADG (Topigs Norsvin, 2015).

There are a lot of present studies regarding relationship of Age, BW at first inseminating with litter size that have conducted, however, the different sow herds are always have different managements, this study aimed to investigate the influence of the BW and age of TN70 gilts at first service on the litter size under the filed large-scale commercial sow farm. To achieve the best economic benefits at commercial sow herd, it is necessary to have a better performance of litter size by an optimal BW and age at first insemination of replacement gilts.

Therefore, the main question of this thesis is **whether the age, body weight, and average daily gain at first insemination effect the litter size of TN 70 gilts** and what is the optimal range of body weight, age, and average daily gain at the first inseminating to have a greater litter size.

In the end, the research result will be compared with the recommended TN 70 inseminating standard of Topigs Norsvin and discuss with farm's management side and Topigs' consultant to have the optimal inseminating standard as a guideline for employees at the farm.

2. Material and methods

2.1. Animals and management

To learn more about the influence of body weight, age, and the average daily gain at first insemination on the following litter's size in TN70 gilts. This research was implemented in a specific pathogen-free (SPF) commercial swine farm which is located in the eastern part of Germany. Data was exported from the data system (PigExpert ® AgriSyst, Netherlands) by the farm, TN 70 gilts were inseminated and farrowed from 1st May 2019 to 30th May 2020, and gilts without BW information and litter's size data were filtered out. Therefore, the sample size in this research was 1471 heads. The gilts were divided into groups according to their BW at first insemination: <160 kg (n=186, BW I), 160-169kg (n=389, BW II), 170-179kg (n=519, BW III), 180-189kg (n=326, BW V) and ≥190kg (n=51, BW VI). The insemination age groups were distinguished as: 240-249 days (n=167, GE I), 250-259 days (n=318, GE II), 260-269 days (n=504, GE III), 270-279 days (n=339, GE V), ≥280 days (n=129, GE VI). For ADG, the gilts were divided into 5 groups

as well, <600 (n=227, DG I), 600-630(n=309, DG II), 631-660 (n=377, DG III), 661-699（n=404, DG V）and ≥700 (n=149, DG VI).

This farm is equipped with a liquid feed system and a fermentation feed system. The total number of sows on the farm is approximately 5300 sows including 10% of pure breed herds from Topigs and this farm replaces 2500 gilts annually which means there are around 50 gilts are serviced every week. This study group includes 1471 TN70 gilts which are F1 crossbreed gilts based on Norsvin Landrace and Z-line (Large White). All of the young gilts were bred internal at the farm. Weaned female piglets were brought from the farrowing room into Gilts Development Unit (GDU) directly on average 23 days of age. Those female piglets were raised in a nursery stall for around 7 weeks, after the nursery, the gilts were moved into rearing barn till approximately 240 days of age. Then the gilts were moved into individual crates in the insemination stall. There was no boar exposure before service while gilts were in the rearing period at pens because the farm administrates the altrenogest (Altresyn® Ceva Santé Animal, France) to gilts for consecutive 18 days to have synchronization of estrus to reduce the working in the barn and improve the working efficiency. All of the gilts were artificial inseminated with semen from the Topigs boar stud. In this farm, gilts receive 6 vaccinations from 35 days of age to 3 weeks before farrowing for Porcine Circovirus Type 2, Swine influenza, and Porcine Parvovirus. All the gilts were inseminated in the individual crates at the insemination room of GDU; Serviced animals were placed into a waiting room for the first 30th days of gestation. After the gestation check by an ultrasound machine, the pregnant gilts were moved into a group pen with gestating gilts till loading the farrowing rooms.

Due to the labour cost of boar exposure, the estrus recording and teaser boar was not implemented and there was no boar contacting with rearing gilts in the group pen of GDU before moving gilts into the insemination area.

All the animals were fed with liquid feed. During the growing period in GDU, there were two types of feed for different stages' animals. Feed type 1 was nursery feed and Feed type 2 was rearing feed.

2.2. Body weight measurement

In this research, gilts were weighted individually when moving from regumate crates to inseminating crates, around 4-5 days before the inseminating. To conveniently recording the weighing information of the gilts, the weighing data was rounded number instead of a real number by the scale because not inseminated gilts were not tagged with animal ID, but with obviousness tattoo number, checking the tattoo number while weighing cost time. For example, a gilt with 153 kilograms

(kg) on the scales' screen was rounded to 155 kg or 152 kg was rounded to 150 kg. The scale is a big scale for group weight with an electric screen (MS Easy Scale Pro Group® MS Schipper, Netherlands).

2.3. Statistical analyses

Gilts information such as birthday, insemination date, and semen information and farrowing results were recorded in the date system (PigExpert ® AgriSyst, Netherlands). The information of the age of gilts was inputted into the data system when gilts came into GDU from the farrowing barn. BW information was uploaded to the data system immediately after weighing. The average daily gain of gilts in this study was the average daily gain from birth to weighing at first insemination, it was calculated by this formula: [ADG (g/day) = (Body weight at first insemination/ age at weighing of the first insemination) x 1000].

Farrowing performance results such as born alive, still born, mummy, and total born of each litter, were inputted into system when parturition finished. Sample size was exported from the Pigexpert data system and filtered out the gilts with incomplete data by Excel.

Data were analysed by the Statistic Analysis System (SPSS® IBM, U.S.A). Age, BW, and ADG at the first insemination were calculated by using the basic descriptive statistics for data of quantitative and frequency. To find out the association, the One-way ANOVA was applied to analyse the influences of age, BW, and ADG on the total born piglets (TB) and born alive piglets (BA). Dunken and LSD were used to do the Post Hoc Multiple Comparisons, besides linear regression was implemented to analyse the association between variate (Age, BW, ADG) and dependent (TB, BA).

In this analyse module, the value with $P < 0.05$ were considered as statistically significant, $P < 0.01$was considered as extremely significant.

3. What factors impacted the litter size

3.1. Descriptive statistics

In this section, 4 tables and 3 figures are illustrated the analyse result by SPSS software. *Table 1* is the descriptive data of the reproductive performance of TN70 gilts. *Table 2, 3,4* is the descriptive data of total born and born alive at different groups of age, bodyweight and average daily gain at first insemination. *Figure 1, 2, 3* shown the percentage of gilts in different groups of age, body weight and average daily gain from study samples.

Table 1.
Descriptive data of the reproductive performance of TN70 gilts (n=1471).

Reproductive paramete	N	Means ± S.D.	Range
TN 70 Gilts at FI			
Age at FI (days)	1471	264.1 ± 12.8	224-318
BW at FI (kg)	1471	170.5 ± 11.0	150-200
ADG at FI (g)	1471	645.9 ± 43.5	487-784
TB	1471	14.3 ± 3.1	1-22
BA	1471	13.8 ± 3.2	0-21
SB （%）	1471	5.1	
MM（%）	1471	3.7	

FI: first insemination; BW: body weight; ADG: average daily gain TB: total born;
BA: born alive; SB: stillborn MM: mummy;
S.D.: standard deviation;

The reproduction data is described in Table 1. The average age of gilts at first insemination was 264.1 ± 12.8 days. The average body weight of gilts at insemination was 170.5 ± 11.0 kg, the average daily gain of gilts at first insemination was 645.9 ± 43.5 g. The number of totals born was 14.3 ± 3.1 piglets in the first litter of the gilts, born alive was 13.8 ± 3.2 piglets. The percentage of stillborn and mummies was 5.1% and 3.7% from 1471 litters.

For the litter size at birth, the average total born was 14.3 ± 3.1 piglets per litter, average BA was 13.8 ± 3.2; Average percentage of stillborn and MM was 5.1% and 3.7%.

The following Figure 1-3 illustrate the distribution of age, bodyweight, and average daily gain of TN 70 gilts at first insemination from researching sample.

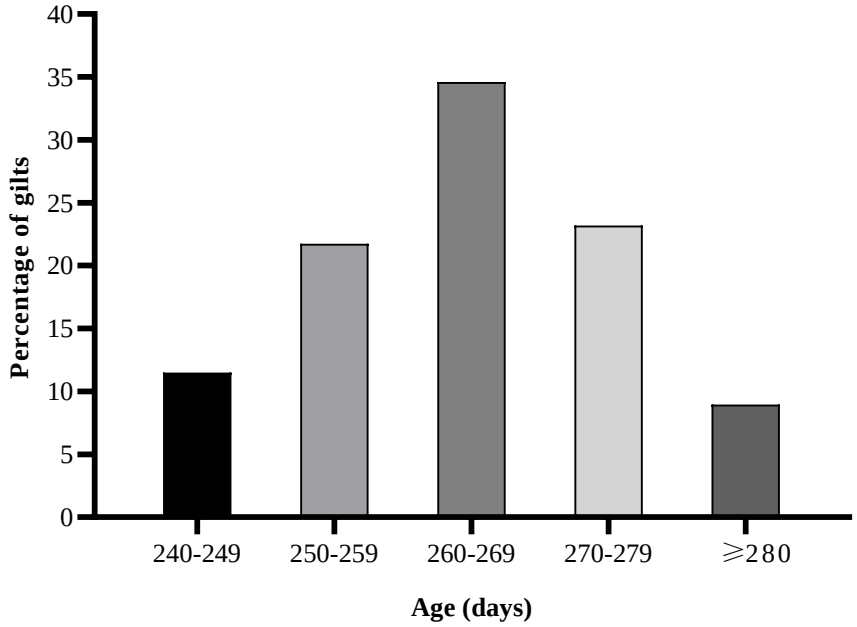

Figure 1. The distribution of age of gilts at the first insemination (n=1462).

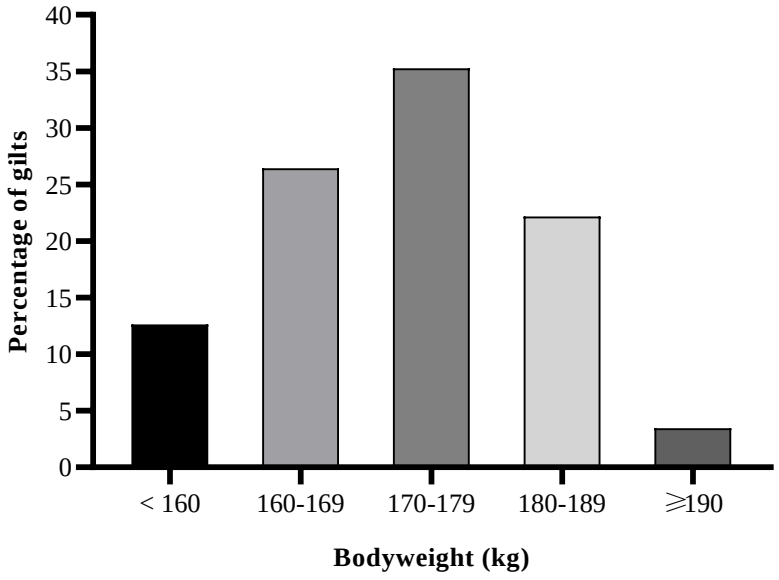

Figure 2. The distribution of body weight of TN70 gilts at first insemination (n=1471).

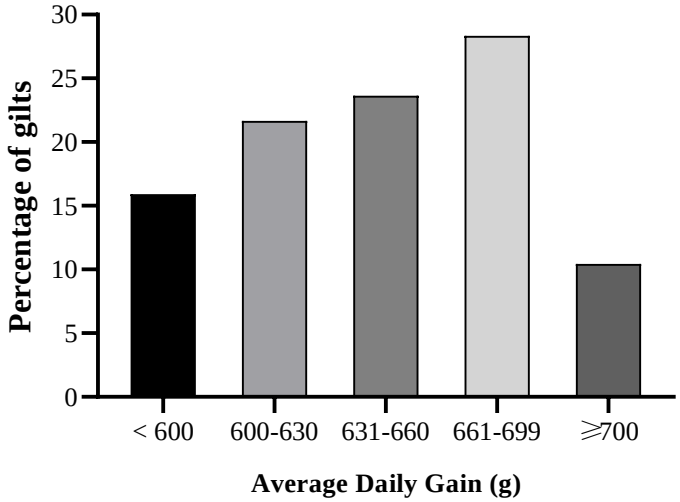

*Figure 3. The d*istribution of average daily gain of TN70 gilts at first insemination (n=1466)

Base on the Figure 1, 32% of the gilts were inseminated at older than 270 days age. Figure 2 demonstrated that 12.6% of the gilts were lower than 160kg at first insemination (FI), over 25.6% of gilts were heavier than 180 kg at first insemination. Furthermore, it was found 15% of gilts' ADG lower than 600 grams, 10% of gilts had over 700 grams ADG at first insemination.

There are 3 tables showing descriptive data of total born and born alive of age groups, body weight groups and average daily gain groups. Mean and Standard deviation is calculated into the tables.

Table 2.

Descriptive data of total born and born alive at different groups of age at first insemination.

Group of age (days)	N	TB Mean±S.D.	BA Mean ± S.D.
240-249	168	14.89 ± 2.97	14.38 ± 2.95
250-259	318	14.25 ± 3.15	13.87 ± 3.20
260-269	506	14.65 ± 2.92	14.08 ± 3.06
270-279	339	13.86 ±3.23	13.33 ± 3.41
≥280	131	13.74 ± 3.32	13.12 ± 3.28

FI: first insemination; BW: body weight; ADG: average daily gain TB: total born;

BA: born alive; SB: stillborn MM: mummy;

S.D.: standard deviation;

It is found that gilts first inseminated at 240-249 days age had the highest average total born piglets and born alive piglets which were 14.89 and 14.38 respectively in 5 groups. Gilts older than 280 days age had the lowest average TB 13.74 and BA 13.12. However, the total number of samples of these two groups was 299, it took only 20.5% in the total group. Gilts inseminated between 260-269 days had an average TB 14.65, BA 14.08 from 506 gilts. In addition, 318 gilts inseminated at 250-259 days age had 14.25 average TB, BA 13.87. Gilts inseminated at 270-279 days age had 13.86 average TB, 13.33 BA. This descriptive data show that the gilts inseminated after 270 days of age had a lower litter size from table 2.

Table 3.

Descriptive data of total born and born alive at different groups of bodyweights at first insemination

Group of BW (kg)	N	TB Mean ± S.D.	BA Mean ± S.D.
＜160	186	14.03 ± 2.89	13.54 ± 3.11
160-169	389	14.25 ± 3.05	13.75 ± 3.17
170-179	519	14.61 ± 3.03	14.12 ± 3.10
180-189	326	14.13 ± 3.30	13.56 ± 3.33
≥190	51	14.18 ± 3.91	13.63 ± 3.90

FI: first insemination; BW: body weight; ADG: average daily gain TB: total born;

BA: born alive; SB: stillborn MM: mummy;

S.D.: standard deviation;

In this descriptive of average TB and BA at different groups' BW, gilts inseminated with 170-179 kg had the highest average TB 14.61 and 14.12 BA. Gilts inseminated with lower 160 kg had the lowest average TB 14.03 and BA 13.54, but the difference is not very high, only average 0.58 piglets TB per litter. More than 908 gilts (62%) were inseminated at body weight between 160 kg to 179 kg from table 3.

Table 4.
Descriptive data of Average TB at different groups of ADG at FI

Group of ADG (g)	N	TB Mean ± S.D.	BA Mean ± S.D.
< 600	227	13.74 ± 3.15	13.08 ± 3.45
600-630	309	14.35 ± 3.01	13.95 ± 3.09
631-660	377	14.36 ± 2.99	13.90 ± 3.00
661-699	404	14.58 ± 3.10	13.97 ± 3.17
≥ 700	149	14.34 ± 3.57	13.91 ± 3.59

FI: first insemination; BW: body weight; ADG: average daily gain TB: total born;
BA: born alive; SB: stillborn MM: mummy;
S.D.: standard deviation;

In table 4, it was found that gilts had average 14.58 TB, 13.97 BA with ADG 661-699. The gilts with ADG less than 600 g had the lowest average TB, 13.74, and BA 13.08. From figure 6, it illustrates that the average TB increased when ADG is increasing, but it is going down when ADG is greater than 700 g. There are no big differences of gilts with ADG between 600-700, the average TB was 14.35 to 14.58, average BA was 13.95 to 13.97.

3.2. Correlation between age, body weight, average daily gain and litter size

Correlation between the age, body weight, average daily gain at first insemination and litter size of TN70 gilts.

Figure 7 is the graph of regression, this regression analyses have shown relations between the Age, BW, ADG of gilts at first insemination on total born piglets and born alive piglets of the first litter. There are 6 graphs, A, B, C, D, E, F.

The age of gilts at FI was negatively significantly associated with the TB ($P \leq 0.0002$) and BA ($P=0.01$) in Figure 7 A and D. The ADG of gilts at FI was positively significantly associated with the TB ($P = 0.01$) and BA($P=0.0069$) as well by graph C and F from Figure7. Furthermore, TB($P=0.094$) and BA ($P=0.894$) were not influenced by BW at FI as observed from *Figure 7 B, E*.

According to the graph and data, it illustrates that there were associations between Age at FI and total born piglets, born alive piglets, as well as ADG at FI with TB, BA. However, the correlations with total born piglets were very weak of both factors Age(R^2=0.009), ADG(R^2=0.004). For born alive piglets, the correlations were very weak either, Age(R^2=0.011), ADG(R^2=0.011).

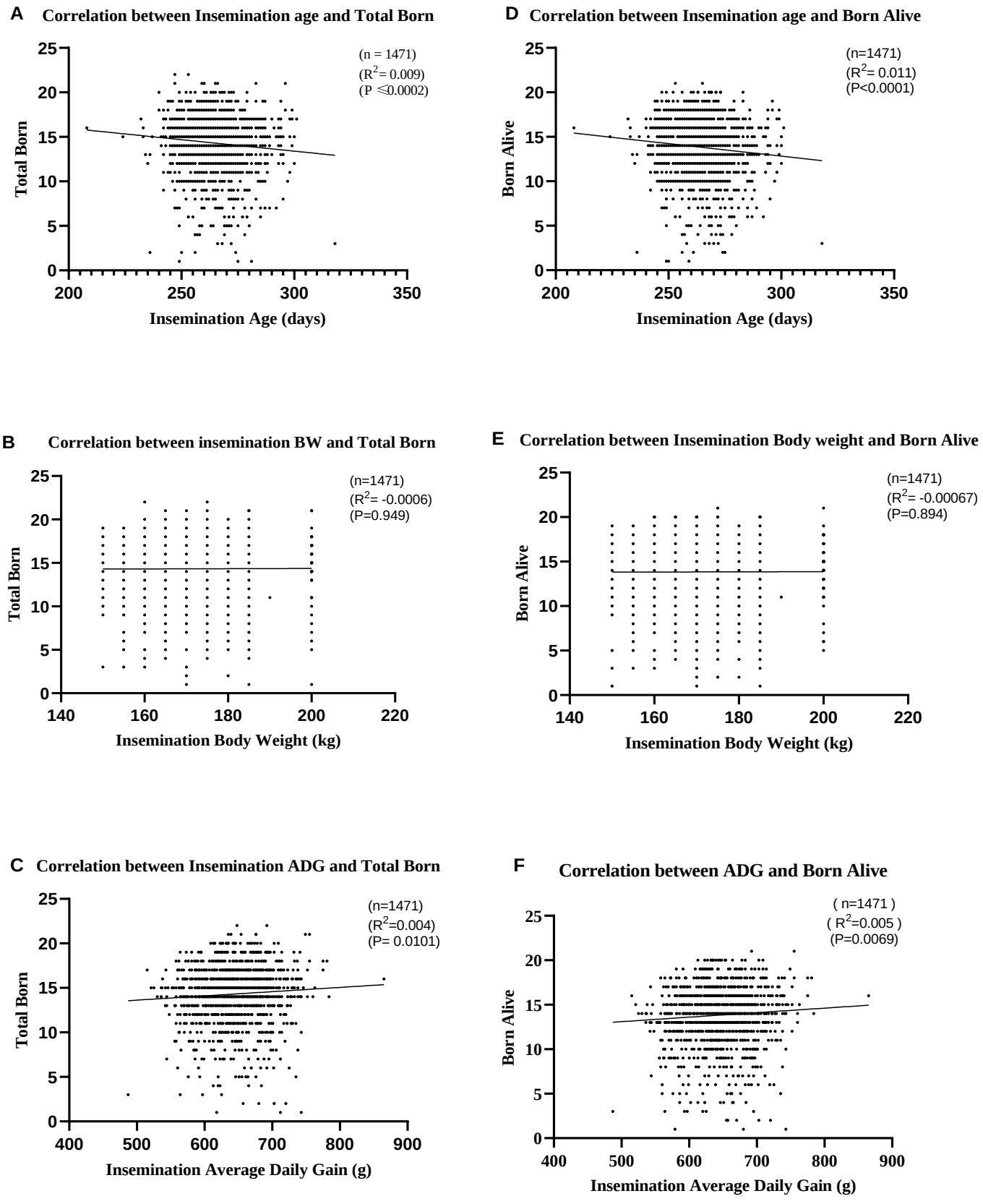

Figure 7. Correlation between Age, BW, ADG and TB, BA

3.3. The effect of first inseminated age, body weight and average daily gain on the litter size.

The significant differences between groups of Age, Bodyweight, and Average Daily Gain on total born and born alive is founded and illustrated on the *Figure 8.*

Figure 8A and *8B* demonstrated that Age Group I (240-249) and Age Group III (260-269) had no significant between each other by total born (P = 0.36) and born alive (P = 1), however, gilts inseminated at 240-249 days of age (Age Group I) had an extremely significant higher number of total born than gilts inseminated at 270-279 days of age (P=0.001), and gilt inseminated age older than 280 days (P=0.002). In *Figure 8B*, gilts inseminated between 240 to 249 days age had extreme significant higher number of born alive piglets than gilts older than 270 days age (P=0.0001).

It is shown in *Figure 8C* that inseminated gilts with bodyweight between 170 to 179 kg had a significant higher number of total born piglets than other 4 Body weight Groups' gilts (I, II, V, VI). In *Figure 8D*, gilts with bodyweight 170-179kg had an extremely higher born alive piglets than gilts with 180-189 kg, and significant larger born alive piglets than gilts which were lower than 160 kg.

From *Figure 8E* and *8F*, there was a significant difference total born piglets between gilts with lower than 600-gram average daily gain and those had over 600 grams ADG at first insemination. Meanwhile, the gilts with lower than 600-gram average daily gain had an extremely significant lower number of born alive piglets ($P<0.01$) than other four groups (ADG>600) as well from *Figure 8F*.

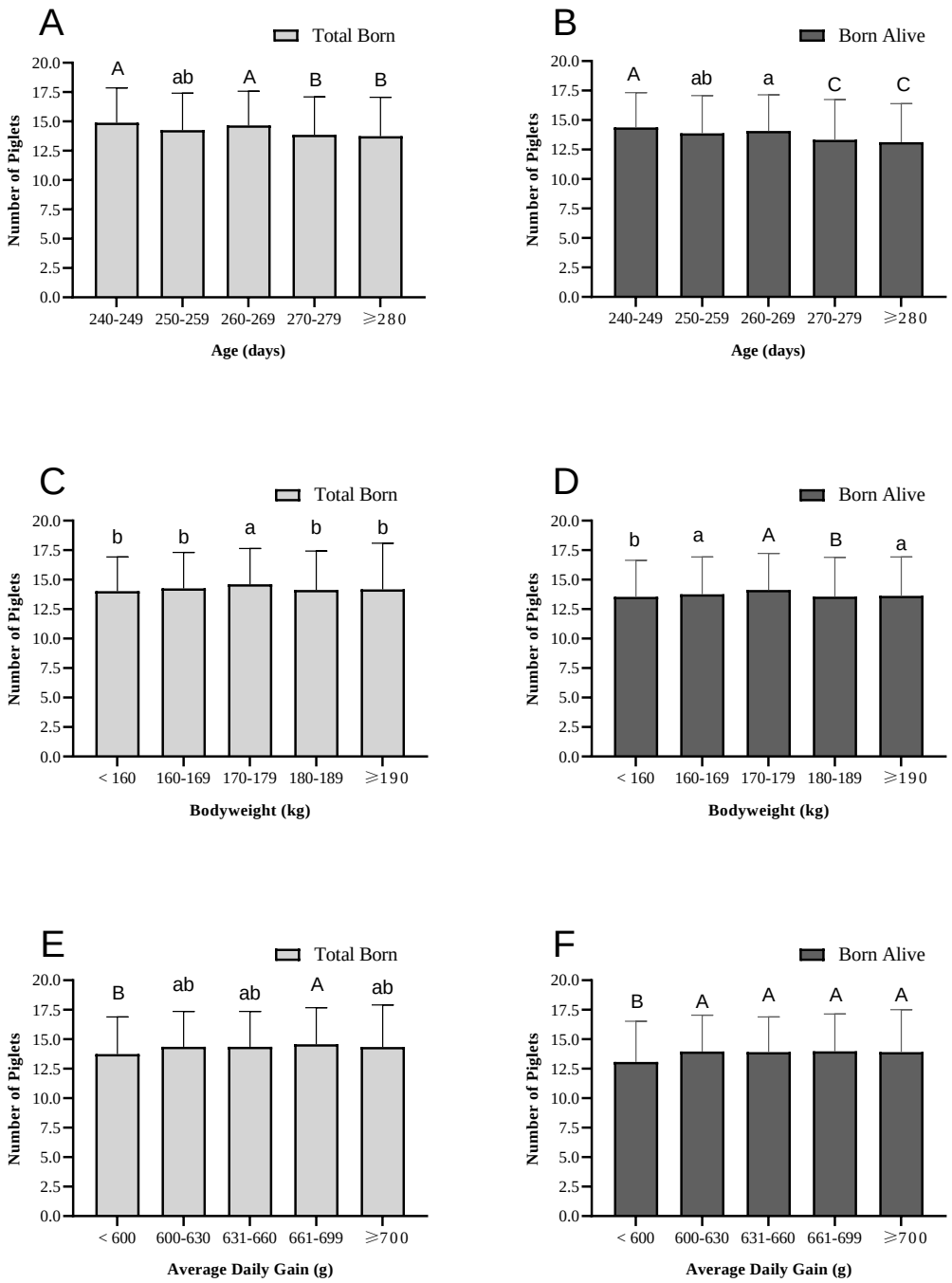

Figure 8. The significant difference between groups of Age, Bodyweight, Average Daily Gain on total born and born alive.

Different lowercase letters within columns differ significantly (P< 0.05)

Different capital letters within columns extreme differ significantly (P <0.01)

4. Discussion

Nowadays, age, body weight, and average daily gain are the main criteria of insemination of gilts, whether these three factors impact the litter size of Topigs Norsvin TN70 and the optimal age, body weight and average daily gain of Topig Norsvin TN70 gilts at first insemination need to find out.

This research was implemented in a specific pathogen-free (SPF) commercial swine farm which is located in the eastern part of Germany. 1471 TN 70 gilts were weighted, inseminated and farrowed from 1st May 2019 to 30th May 2020.

To have the result, the method of this research was using the statistical analyses software SPSS to analyses the correlation and variance between age, bodyweight, average daily gain and litter size.

The analysis results are as following:

4.1. Age at first insemination

The present study found out that age at first inseminating was negatively correlated with the total born piglets ($P \leq 0.0002$) and born alive piglets ($P=0.01$) of the TN 70 gilts, but the correlation was very weak ($R^2=0.009$) for total born piglets, ($R^2= 0.01$) for born alive piglets. The age of gilts at first inseminating is connected with the reproductive performance (Saito, 2010). On the other hand, it does not show that the older age would increase the litter size, because we found that gilts inseminated with older than 270 days age had lower total born piglets and born alive piglets than gilt inseminated between age 240 to 269 days as observed from Table 2. It is opposite with the Danish researchers recommended inseminating gilts at an older age to increase the litter size (Nielsen et al., 2018). Therefore, the age at first inseminating of TN 70 gilts is a factor that could impact the total born piglets and born alive piglets, it should be one of the inseminating standards when making the inseminating decision.

Based on the analysis, it is shown that the gilts inseminated between 240-249 days age had the highest total born piglets (14.89) and born alive piglets (14.38), this inseminating age is the same as the recommendation by Topigs Norsvin (Topigs Norsvin, 2015). The followed group is age between 260-269 with 14.65 total born piglets and 14.08 born alive piglets, but gilts inseminated with older than 270 days age had lower TB and BA.

4.2. Bodyweight at first insemination

By the research result from previous study, (Karolina Szulc, 2015) found the body weight at first inseminating significantly impacted on the litter size of PIC gilts. For TN 70, there is no correlation between inseminating body weight with litter size (P=0.949) for TB and BA (P= 0.894). Thus, the body weight at first inseminating is not significantly correlated with the litter size, it is not recommended to use the body weight as the insemination criteria, but it can be a reference base on other two factors, according to the Figure 8C and 8D, the BW group between 170- 179 kg had higher TB (14.61) and BA (14.12) than other groups.

As it was mentioned before, the body weight data was not the real body weight data because of rounded number, the minimal interval of the BW data was 5 kilo grams in the rounded calculation, gilts with 168 kg or 169 kg and so on might rounded into 170 kg, it could impact the group's sample size. As to the impact level, it is unknown.

4.3. Average daily gain at first insemination

In the present study, Figure 7C and 7F indicated that the ADG at first insemination of TN 70 gilts positively correlated with the litter size, TB (P=0.01), BA(P=0.006), it was the same result with (P. Tummaruk et al., 2001b), but the correlation is very weak as well(R^2= 0.004) for TB and (R^2= 0.005). It also indicated that higher ADG might have higher TB and BA, group 661-699 had 14.58 TB and 13.97 BA on average, but there were no significant differences between group II, III, VI but the group I (<600) was significant lower TB(13.74) and BA(13.08) on average than other groups.

For the BA, the difference in Group II, III, V, VI was not significant. Therefore, gilts inseminated with 630 g/d had almost the same BA comparing with gilts with over 700 g/d. It indicated that the gilts with higher ADG might have higher total born, but the number of still born piglets might be higher because BA is almost the same,(Filha et al., 2010) found ADG higher than 770 g/d result in higher still born. This could happen in present sample size; it needs more further research.

From the above, ADG should be one of the necessary inseminating criteria, it is recommended inseminating the TN 70 gilts with over 600 g/d. This range accord with the Topigs' recommendation 600- 660 g/d (Topigs Norsvin, 2015). Therefore, gilts with lower than 600 g/d ADG should not be inseminated.

4.4. Deficiency and questions

As mentioned above, the data of body weight was not the actual number, it was rounded off number, this might affect the analyse result. It is good to have the actual number while measuring to minimize the mistake of analyse.

The sample size from age group 240-249 days' age only 11.35% from the total sample size. The factors that can influence on the litter size are more than age and ADG at first mating (Koketsu et al., 2017). For example, the environment of the barn, feed nutrition, management, and stress. It is also correlated with the puberty of the gilts, boar contact can boost the gilts puberty at a younger age, in the field, the boar contacting was not implemented before inseminating because the farm administrates the regumate management. However, it is still a question that whether the regumate impacted the litter size, this is not known yet, it would be better to have a research to find out the influence of regumate on TN70 gilts.

The litter size is just one of the indexes of reproductive performance of sow herds, whether the age and average daily gain at first insemination impact on the subsequent parity of sows that is also not known.

5. Conclusions

In this study, age and average daily gain at first inseminating impacted the litter size, but not the body weight. The optimal age of TN70 gilt for first insemination is 240-249 days' age, and 260-270 days' age and not older than 270 days. The accept average daily gain at first insemination is from 600 to 700 g/d, the ADG between 661-699 g/d is optimal base on the result. The body weight is dependent on the age and ADG, therefore, the body weight can be calculated by the optimal age and ADG. Gilts inseminating between 240- 249 days' age and 260-269 with ADG 661-699 have the corresponding the body weight range: 167- 181 kg might have an optimal litter size.

However, in the field, considering the farm use 3 weeks batch system to produce the gilts, therefore there are 7 days age differences of inseminated gilts between inseminating weeks, it is recommended to start administrate the regumate for the gilts at age 220-245 days, with an optimal ADG 600-700 g/d and a body weight between 165-180 kg as am operation standard for inseminating TN 70 gilts for this commercial farm that may reach an optimal litter size.

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