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Relation between ovulation rate and embryonic survival and development in crossbred gilts at 35 days of pregnancy

C.L.A. Da Silva[1], M.L.W.J. Broekhuijse[2], B.F.A. Laurenssen[1], E.F. Knol[2], B. Kemp[1], N.M. Soede[1]*[1]*Adaptation Physiology Group, Wageningen University and Research, Wageningen, The Netherlands;*[2]*Topigs Norsvin, Schoenaker, Beuningen, The Netherlands.*

Introduction In modern crossbred multiparous sows, an increase in ovulation rate (OR) is related with a relatively small increase in the number of vital embryos at 35 days of pregnancy, which is mainly due to an increase in early embryonic mortality (Da Silva et al., 2016). Early embryonic mortality, i.e. mortality before uterine implantation at 13 days of pregnancy, increases with the increase in OR probably due to an increase in heterogeneity in the pool of ovulatory follicles and oocytes, increasing also embryonic heterogeneity and thereby embryonic mortality at the time of implantation (Pope et al, 1986; Geisert et al., 1982). An increase in OR was also related with a decrease in implantation and placental length of the vital embryos in multiparous sows at 35 days of pregnancy (Da Silva et al., 2016), indicating uterine crowding already at this stage of pregnancy. This might subsequently lead to a higher foetal mortality, but might also compromise foetal growth, leading to lower piglet birth weight and birth weight uniformity; associated with a higher piglet mortality after birth (Milligan et al., 2002). Gilts have a lower OR (Belstra, 2003), which could imply different relationships between OR and embryonic survival and development. Thus, crossbred gilts available from an insemination trial with semen stored for different durations were slaughtered at 35 days of pregnancy and the relationship between OR and embryonic survival and development was investigated.
Material and Methods Yorkshire x Landrace gilts (Topigs Norsvin, Vught, The Netherlands) were inseminated at 253±11 days of age (231 to 292), with semen stored for 3-5 days (SS1, n=36); 6-7 days (SS2, n=93) and 8-10 days (SS3, n=85) at 17°C. In total, 214 gilts were slaughtered at 34.7±0.9 days of pregnancy, in 14 weekly batches. After slaughter, OR was assessed by dissection of the corpora lutea from both ovaries. Embryos were classified as vital (VE) by visual appearance and after separation of the embryonic-placental units from the uterine wall, the length of the uterine implantation site of the vital embryos was measured and the average (VIL) and the SD of the length per gilt calculated (SDVIL). Early embryonic mortality (EEM) was estimated as the difference between OR and the number of vital + non-vital embryos. In a subset of 76 gilts, VE were individually weighed (batches 7 to 14) and the average (Vg) and the SD of the VE weight (SDVg) per gilt calculated. Analyses were done using Proc Mixed in SAS 9.3 (SAS Inst. Inc. Cary, NC). Embryonic characteristics per gilt were assessed as the dependent variables and the independent variables included the fixed class effect of semen storage duration [SS1, SS2 and SS3], and the linear and quadratic terms of OR. Batch was included as a random effect. Linear equations are presented when the quadratic term is not significant. Results are considered significant at $P \leq 0.05$.
Results and Discussion Average OR was 20.3±2.9 (8 up to 30), VE was 15.2±3.9, and EEM was 3.8±3.9. Average and SD of VIL was 21.1±3.7 cm and 5.4±1.3 cm; and the average and SD of

Vg was 4.0±.7g and 0.4±0.1g. A quadratic relationship of OR (*P≤0.05*) was found with VE, which specifies that VE increased with the increase in OR up to a maximum of 19.5±1.4 for SS1, 18.2±1.3 for SS2, and 16.8±1.3 for SS3 gilts at 29 ovulations [1.7(±0.6)*OR – 0.03(±0.01)*OR^2 + C: -7.8±9.1 (SS1), -6.8±8.1 (SS2), -7.4±6.2 (SS3)]. A quadratic relationship of OR (*P≤0.05*) was also found for EEM, with a minimum EEM of 1.08±0.9 for SS1, 1.79±0.7 for SS2 and 3.75±0.8 for SS3 at 14 ovulations [(0.03 (±0.01)*OR -0.9 (±0.6)*OR^2 + C: 7.8±6.8 (SS1), 8.5±6.6 (SS2), 10.4±6.1 (SS3)]. VIL and Vg were not related with OR, but the SDVIL and SDVg had a positive linear relationship (P≤0.05) with OR [SDVL: 0.11(±0.03)*OR + 2.9(±0.6); and SDVg: 0.01(±0.01)*OR + 0.12(±0.1)]. Results show that the number of VE at 35 days of pregnancy increases with an increase in OR, but the significance of the quadratic term indicates a smaller increase at a higher OR and a limit for the number of VE achieved, which is due to an increase in EEM. The higher EEM seen in gilts with a higher OR might be explained by an increased follicular/oocyte heterogeneity, thereby increasing the heterogeneity in conceptuses elongation at 11 days of pregnancy (Pope et al., 1986). When pig conceptuses elongate they produce oestrogens and more developed conceptuses will start this earlier, changing the uterine environment in detriment of the less developed ones (Pope et al., 1986). The VE show an increased variation in uterine implantation length and in embryonic weight with an increase in OR. This also indicates a higher embryonic heterogeneity in gilts with higher OR, as the length of conceptus elongation determines the length of their uterine implantation site (Geisert et al., 1982), and because the variation in vital embryo weight was correlated with the variation of the uterine implantation length (r=0.38, *P=0.001*, results not shown). Thus, gilts with a higher OR have a small increase in the number of vital embryos, due to higher early embryonic mortality, similar to what was previously observed in sows. There was also an increase in variation in uterine implantation length and in embryo weight with the increase in OR in gilts at 35 days of pregnancy; which was not observed in sows, indicating that the relationship between OR and embryonic development is indeed different between gilts and sows. The increase in the variation in uterine implantation length and in embryonic weight at early pregnancy might lead to higher foetal mortality and piglet birth weight variation.

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