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CLUSTER ANALYSIS AS A TOOL TO ASSESS LITTER SIZE IN CONJUNCTION WITH THE AMOUNT OF EMBRYONIC AND FETAL LOSSES IN PIGS

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Abstract: High numbers of live born and vital piglets are required for an effective piglet production. It has been reported that embryonic losses in swine can be as high as 20 to 50%. Generally, up to 30% of embryonic losses are considered within the normal biological range. The aim of our study was first to determine embryonic and fetal losses in sows of the German Landrace breed, and second to identify sows, which are able to realize high numbers of intact embryos and fetuses in combination with low rates of embryonic and fetal losses. This study was conducted on a commercial farrow-finish operation and involved 64 gilts. Gilts were synchronized for ovulation and inseminated artificially (AI) twice at fixed times. Pregnant gilts were slaughtered on Day 30 (n=34) and Day 80 (n=30) after second AI. Corpora lutea (CL) and embryos/fetuses (E/F) were counted. The length of uterine horns was measured. Based on the difference between the number of CL and the number of E/F, embryonic and fetal losses were 36.9 and 37.9%, respectively. The results obtained regarding the number of CL, the number E/F (intact and total), the rate of embryonic or fetal losses and uterine space per E/F underwent a cluster analysis. The results show that several gilts are able to realize high numbers of intact E/F in combination with low rates of losses and limited uterine space per E/F. Numbers of 15 to 20 intact fetuses on day 80 of pregnancy are considered as a minimum for an adequate litter size at the end of pregnancy. In this study only 35% of gilts at Day 30 and 37% of gilts at Day 80 demonstrate this potential. Cluster analysis is a useful mathematical tool which helps to assess results of embryonic and fetal losses and to group gilts according to their performance. As a consequence cluster analysis provides clues which gilts or family structures should be analyzed more intensively.

Key words: embryonic and fetal losses, uterine space per embryo and fetus, cluster analysis, German Landrace, gilts

Introduction

A high number of live born and vital piglets are the basic condition to achieve a high number of weaned piglets at the end of suckling period. To reach such an optimal number of piglets it is necessary to exhaust the genetic potential of reproduction of the sows. There are a few very strong impact factors. The amount of embryonic and fetal mortality reduces the number of piglets as well as the uterus capacity of the sow. In consequence the realized fertility is always less than the potential one. In literature the amount of embryonic and fetal losses is described in a range between 20 to 50% of all fertilized oocytes. In general an amount of 30% of losses during gestation is considered to be caused biologically *(Almid and Blichfeldt, 1982; van der Lende et al., 1999; Edwards, 2002, Wessels et al. 2008)*. It is interesting to identify sows which are able to realize an optimal number of piglets in combination with a low amount of losses during gestation and which are able to use the uterine space very efficient. Aim of this investigation is to find these sows with the help of a cluster analysis.

Materials and Methods

The experiment was conducted in a commercial farrow-finish operation on two biologically important dates of gestation; at day 30 of gestation (the end of implementation) and at day 80 of gestation (beginning of fetal final maturation). In total 64 gilts were involved, 34 gilts at day 30 of gestation and 30 gilts at day 80 of gestation. The gilts were integrated in the normal scheme of the farm. All of them were synchronized in ovulation and inseminated at pre-determined times. At the age of 220 days the gilts got Regumate® for a duration of 15 days. 850 IE of PMSG was injected 24 hours after the last Regumate® application and 50µg Gonavet® was injected 56 hours after PMSG. Artificial insemination (AI) was done twice after Gonavet®. All gilts got slaughtered at the required days. Corpora Lutea (CL) and embryos/fetuses (E/F) were counted, gross-morphologically assessed and weighed. Fetuses were also measured for crown rump length.

The parameters number of CL, uterine space per E/F and number of intact E/F at day 30 and 80 of gestation were used for a cluster analysis. This is a statistical method which examines data in terms of structure. All gilts get assigned to a cluster on the basis of similarity of their results. There are two aims of a cluster analysis. First gilts of one cluster should have very similar results and second the data of different cluster should be very different.

Results and Discussion

In table 1 the results of all gilts are demonstrated (tab.1). The number of CL differs not between gilts investigated at day 30 of gestation and at day 80 of gestation. In contrast the gilts vary significantly in number of embryos and fetuses in total ($p<0.05$). The numbers of intact embryos and fetuses are comparable. The difference between both groups of gilts is only 1.7.

Table 1. Number of CL, embryos and fetuses and the amount of embryonic and fetal losses at the 30th and 80th day of gestation (DOG)

Parameter	DOG 30	DOG 80
number of gilts (n)	34	30
CL (m ± sd)	22.8 ± 8.8	20.5 ± 6.6
embryos/fetuses$_{total}$(m ± sd)	17.0 ± 4.5[a]	12.3 ± 3.5[b]
embryos/fetuses$_{intakt}$ (m ± sd)	13.5 ± 4.3	11.8 ± 3.6
embryonic/fetal mortality in %	21 ± 19	36 ± 23
embryonic/fetal losses in %	37 ± 20	38 ± 24

[a,b] $p<0.05$

Depending on the number of CL and number of E/F in total the amount of mortality gets estimated. If you consider the number of CL and the number of intact E/F you can calculate a much more important parameter - the amount of losses. There are no differences between gilts of both groups. At day 30 the rate of embryonic losses is 37%. The rate of fetal losses is calculated as the difference between the amount of losses at day 80 and day 30 of gestation. So you can estimate fetal losses of approximately 1%.

In general all results show a very high standard deviation. This is the starting point for the cluster analysis to identify gilts, which are able to realize high numbers of intact E/F in combination with low rates of losses.

Cluster analysis at day 30 of gestation. The result of the cluster analysis shows 4 groups (cluster) of gilts. The data of each cluster is shown in table 2 (tab. 2). The distribution of the gilts in cluster is not equal. This depends only on the data of the gilts. It is no personal decision. 73% of all gilts are in cluster 1 or 3. The highest number of CL (38.0) is reached by gilts in cluster 4. The lowest numbers (16.0) are achieved by gilts of cluster 2. Those gilts also show the lowest results for the parameter of the number of embryos in total and number of intact embryos. Gilts of the first cluster achieve the best results with 21.3 embryos in total and 17.7 intact embryos.

Table 2. Data according cluster analysis at day 30 of gestation

	Cluster			
Parameter	**1**	**2**	**3**	**4**
number of gilts (n)	12	5	13	4
CL (m ± sd)	25.9 ± 6.6	16.0 ± 4.2	17.8 ± 4.0	38.0 ± 8.6
embryos $_{total}$ (m ± sd)	21.3 ± 3.3	10.6 ± 0.5	15.5 ± 2.4	16.5 ± 2.6
embryos $_{intact}$ (m ± sd)	17.7 ± 2.3	6.8 ± 2.2	12.3 ± 2.4	13.3 ± 2.1
uterine space (cm)/embryo $_{total}$ (m ± sd)	18.8 ± 4.0	37.0 ± 3.7	26.5 ± 3.3	26.3 ± 4.6
rate of losses (m ± sd)	29.4 ± 12.2	57.2 ± 10.7	27.7 ± 18.8	64.8 ± 3.9

Gilts of cluster 2 use the most uterine space/embryo $_{total}$ (37.0cm), gilts of cluster 1 need only 18.8cm. The rates of embryonic losses are very high for the gilts in cluster 2 and cluster 4. Those results are higher than described in literature (*Schnurrbusch*, 2002). The lowest rates of 29.4% and 27.7% could be realized by gilts of cluster 1 and 3. This is seen to be a biological caused level (*Kolb*, 1980; *Blichfeldt und Almid*, 1982; *van der Lende et al*., 1999).

Cluster analysis at day 80 of gestation. As result 3 clusters are formed (tab.3). The number of animals in each cluster is nearly equal. The highest number of CL (26.1) is achieved by gilts in cluster 2. The lowest number of CL (14.6) is reached by gilts in cluster 3. Despite that gilts of cluster 1 realize the highest numbers of fetuses in total and the highest numbers of intact fetuses as well.

Table 3. Data according cluster analysis at day 80 of gestation

	Cluster		
Parameter	**1**	**2**	**3**
number of gilts (n)	11	9	10
CL (m ± sd)	21.3 ± 3.8	26.1 ± 7.0	14.6 ± 2.2
fetus $_{total}$ (m ± sd)	15.5 ± 1.5	9.2 ± 3.7	11.6 ± 1.6
fetus $_{intact}$ (m ± sd)	15.2 ± 1.4	8.3 ± 3.5	11.2 ± 1.5
uterine space (cm)/ fetus $_{total}$ (m ± sd)	35.9 ± 7.4	52.0 ± 20.3	46.0 ± 6.2
rate of losses (m ± sd)	26.9 ± 13.4	68.7 ± 8.8	22.2 ± 13.3

The differences between the number of fetuses in total and intact fetuses are very low. This indicates low rates of fetal losses. The uterine space/fetus total is the highest for gilts in cluster 2 (52.0cm) and the lowest for gilts in cluster 1

(35.9cm). Because of the difference between the high number of CL and the low number of intact fetuses gilts of cluster 2 show the highest rates of losses during gestation. Gilts of cluster 3 achieve better results with 22.2% of losses.

Aim is to realize a litter size of 14 piglets born alive per litter. At day 30 and at day 80 of gestation only gilts of cluster 1 are able to realize this performance. The number of intact embryos or fetuses is too low for gilts of the other clusters. Those results are very interesting from the point of view of breeding. The gilts of cluster 1 achieve the highest number of intact embryos/fetuses in combination with little uterine space/embryo or fetus and comparable low rates of losses in general.

Cluster analysis is a very helpful tool to asses litter size in conjunction with the amount of embryonic and fetal losses in pigs. Differences between gilts get visible how they manage a specific number of fetuses until the end of gestation. Those results provide new aspects for further research especially the family structure of the gilts of cluster 1.

Klaster analiza kao instrument za ocenu veličine legla u vezi sa gubitkom embriona i fetusa svinja

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Rezime

Za efikasnu proizvodnju prasadi potrebno je ostvariti veliki broj živo rođenih i vitalnih prasadi. U literaturi se navode gubici embriona kod svinja u opsegu od 20 do 50%. Generalno, smatra se da je do 30% gubitaka embriona normalno i u okviru biološkog opsega. Cilj našeg istraživanja je bio prvo da se odredi kvantitativno gubitak embriona i fetusa kod krmača rase nemački landras, i drugo, identifikovati krmače koje mogu da ostvare veliki broj dobrih/netaknutih embriona i fetusa uz mali procenat njihovog gubitka. Ispitivanje je urađeno u komercijalnom zapatu, gde postoji i odgoj i tov svinja, na 64 nazimice. Kod nazimica je urađena sinhronizacija ovulacije i one su veštački osemenjene (VO) dva puta i to u unapred određenim terminima. Gravidne nazimice su zaklane 30. (n=34) odnosno 80. (n=30) dana nakon drugog VO. *Corpora lutea* (CL) i embrioni/fetusi (E/F) su izbrojani. Dužina rogova materice je takođe izmerena. Na osnovu razlike između broja CL i broja E/F, gubici embriona i fetusa su bili 36,9 i 37,9%, respektivno. Rezultati koji se odnose na broj CL, broj E/F (netaknutih i ukupno), procenat gubitaka embriona i fetusa su zatim podvrgnuti klaster analizi. Rezultati pokazuju da je nekoliko nazimica pokazalo odn. ostvarilo visok broj netaknutih E/F u kombinaciji sa malim procentom gubitaka i ograničenim

prostorom u materici po svakom E/F. Broj od 15 do 20 netaknutih fetusa 80. dana gestacije se smatra minimumom za adekvatnu veličinu legla na kraju gestacije. U ovom ispitivanju samo 35% nazimica 30. dana i 37% nazimica 80. dana je pokazalo ovakav potencijal. Klaster analiza je korisno matematičko sredstvo/instrument koji se koristi za ocenu rezultata koji se odnose na gubitke fetusa i embriona, i za grupisanje nazimica prema njihovim reproduktivnim rezultatima. Klaster analiza daje signale/znake koje nazimice ili strukture treba da budu podvrgnute intenzivnijoj analizi.

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