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# HERITABILITY AND REPEATABILITY ESTIMATES OF REPRODUCTION TRAITS IN PUREBRED PIGS

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**Abstract:** Research was performed on four farms, on 2434 highly fertile females Landrace and Yorkshire, and 28 boars of Danish origin, or 7684 consecutive parities, in period 2009 - 2012. Study of genetic parameters of conventional breeds Landrace and Yorkshire were conducted on 3964 females who mated with 49 males or 15764 litters in the same period. Estimates of genetic parameters for litter size show the same tendency as the legality of the purebred sows that produce 11-14 weaned piglets less per sow per year. Environmental factors, HYS, food technology and management expressed no significant effect on traits. Heritability and repeatability of live and still born piglets, litter size and the live at day 5 after birth and the number of piglets weaned in category of low hereditary traits whose values vary within the limits of 0.07 to 0.12 for the heritability and from 0.15 to 0.19 for the repeatability. There was tendency of lower values of genetic parameters in the conventional compared to highly fertile sows, which is considered to be the effect of selection on gene frequency for the observed traits.

**Key words:** genetic parameters, reproduction traits, pigs

## Introduction

The genetic parameters are used by producers and breeders, primarily to study the natural action of genes, namely additive ones. Also that can be used for modelling of selection criteria, and selection direction of breeding. The nucleus of the farms is genetically superior material, completely healthy and used to produce desirable effects in the selection of pure breed and hybrid animals of both sexes. The current strategy of selection and crossbreeding showed significant improvement when talking about litter size at birth and weaning. This is obtained by selecting Landrace and Yorkshire pigs, particularly those originating from Denmark, which produce 11-14 more weaned piglets per sow per year over the existing selection. The selection in our conditions showed almost identical pattern. A similar trend was also observed in hybrid sows. We analysed the value of population genetic parameters in sows that were highly fertile sows and the same breed, national - conventional selection, which produce significantly less piglets per unit of time.

The purpose of study is to estimate and compare values of genetic parameters for traits like: litter size and weight at birth and weaning in female with such a high level of fertility compared to the conventional local selection of the same breed.

## Materials and methods

Research was performed on 2434 female Landrace and Yorkshire animals, and 28 boars of Danish origin, born locally, or 7684 consecutive parities, in the period 2009 - 2012. Study of the genetic parameters of conventional Landrace and Yorkshire breeds were conducted on 3964 females who mated with 49 boars and produced 15764 litters in the same period.

Mixed model equations (MME) was used to analyse available data, the model 1.

$$\mathbf{Y_{ijkl} = \mu + K_i + GS_{ij} + P_{ijk} * E_{ijkl}}$$

$Y_{ijkl}$ – the observed traits;
$\mu$ - general mean value;
$K_i$ – random sire effect;
$GS_{ij}$ – fixed effect of differences between farms, years and seasons;
$P_{ijk}$ – effect of farrowing (parity);
$E_{ijkl}$ – random error.

Analysed traits are: age of sows at first farrowing, number of live and still born pigs, live born piglets five days after birth, litter size and weight at weaning. Duration of lactation was 28 days. Diet of lactating sows was ad libitum and determined within the efficient technology, according to stage of lactation and production. Technology diet was the same at all stages of production.

## Results and Discussion

The results are shown in Tables 1-9. Age of sows at first farrowing was 366 in Landrace and 372 days in Yorkshire breed. Sows conventional Landrace and Yorkshire were younger 32 and 42 days compared to highly fertile animals. Indirectly, conventional sows were lighter before the insemination and farrowing for 29-32 kg body weight (Table 1).

**Table 1. Age at 1st farrowing, body weight at insemination and farrowing of prolificacy and conventional selection of Landrace and Yorkshire**

| Traits | Prolificacy | | Conventional | |
|---|---|---|---|---|
| | Landrace | Yorkshire | Landrace | Yorkshire |
| Age at 1st farrowing | 366 | 372 | 334 | 330 |
| Weight at insemination | 138 | 142 | 109 | 110 |
| Weight at farrowing | 188 | 195 | 156 | 163 |

Litter size at farrowing and weaning did not differ significantly in some farrowings between the two breeds, but within the breed with the expected trend, and therefore have identical criteria for selection. There were no differences in weight or the number of piglets at weaning. Number of piglets five days after birth was less than the number of live born to 0.7. These differences are small pigs, which are the result of high selection pressure by increasing the genotype of this traits, i.e., more piglets at farrowing, and the possibility of optimal nutrition in piglets to be uniform on born. Also, this is partly a consequence of the lack of milk for such a large number of piglets born. These two traits are important and open questions for future work of breeders and nutritionists (Table 2 and 3). Almost the same is the case in conventional breeds. However, the highly fertile breed, in average, has higher values of genetic parameters for all analysed properties which is considered the contribution of selection.

**Table 2. Litter size of prolificacy and conventional selection of Landrace**

| Farrowing | **Prolificacy** | | | **Conventional** | | |
|---|---|---|---|---|---|---|
| | Alive born | Still born | Weaned | Alive born | Still born | Weaned |
| 1. | 13.8 | 2.3 | 13.1 | 10.8 | 0.9 | 9.3 |
| 2. | 14.3 | 2.4 | 13.6 | 11.3 | 1.3 | 10.6 |
| 3. | 15.0 | 2.8 | 13.8 | 11.6 | 1.3 | 10.8 |
| 4. | 14.4 | 2.7 | 13.6 | 11.9 | 1.7 | 11.0 |
| 5. | 14.1 | 2.6 | 13.4 | 12.1 | 1.9 | 11.1 |
| 1+2+3+4+5 | 14.4 | 2.5 | 13.6 | 11.4 | 1.6 | 10.9 |

**Table 3. Litter size of prolificacy and conventional selection of Yorkshire**

| Farrowing | Prolificacy | | | Conventional | | |
|---|---|---|---|---|---|---|
| | Alive born | Still born | Weaned | Alive born | Still born | Weaned |
| 1. | 13.6 | 2.4 | 12.9 | 10.0 | 0.9 | 9.0 |
| 2. | 14.3 | 2.4 | 13.7 | 10.2 | 1.3 | 10.0 |
| 3. | 14.9 | 2.6 | 13.9 | 11.1 | 1.6 | 10.3 |
| 4. | 14.0 | 2.3 | 13.5 | 11.3 | 1.8 | 10.6 |
| 5. | 14.8 | 2.8 | 13.8 | 11.1 | 2.4 | 10.4 |
| 1+2+3+4+5 | 14.5 | 2.5 | 13.5 | 10.6 | 1.9 | 10.2 |

All the factors (sire, FYS and farrowing) have a significant influence on observed traits. Similar results have been reported by (*Vidovic et al*., 2011a; *Vincek* 2005; *Radojkovic et al*., 2005: *Vidovic,* 1976). This indicator shows that despite the modern conditions of keeping pigs in a farm where automatic control of production parameters such as light, humidity and temperature, are not balanced with females genome, which means that research is needed to improve the environment. Farrowing had a significant impact on the observed traits of both conventional as and highly fertile sows meaning that further studies are needed to stabilize the genome of these breeds.

**Table 4. The heritability of litter size of prolificacy Landrace**

| Farrowing | Age at farrowing | | | | | |
|---|---|---|---|---|---|---|
| | | Alive born | Still born | $5^{th}$ day | | Weaned |
| 1. | 0.15 | 0.12 | 0.05 | 0.10 | | 0.11 |
| 2. | - | 0.11 | 0.02 | 0.09 | | 0.10 |
| 3. | - | 0.09 | 0.05 | 0.08 | | 0.10 |
| 4. | - | 0.09 | 0.03 | 0.08 | | 0.09 |
| 5. | - | 0.09 | 0.04 | 0.10 | | 0.08 |
| 1+2+3+4+5 | - | 0.10 | 0.03 | 0.09 | | 0.10 |

Heritability and repeatability were not significantly different compared to conventional selection of breeds which have much lower genetic potential (*Vidovic* et al., 2011b; *Vidovic et al*., 2011c; *Tretinjak et al*., 2009; *Chen et al*., 2003; *Lucia et al*., 2002; *Crump et al*., 1997; *Gordon 1997*; *Hue et al.,* 1993, *Petrovic et al.*,*1991*). This justifies the use of new knowledge in the area optimization of environment, optimization technology feeding sows and age with weight the introducing of the reproduction.

**Table 5. The heritability of litter size at conventional selection of Landrace**

| Farrowing | Age at farrowing | Born | | | | |
|---|---|---|---|---|---|---|
| | | Alive born | Still born | $5^{th}$ day | | Weaned |
| 1. | 0.12 | 0.10 | 0.05 | 0.11 | | 0.10 |
| 2. | - | 0.09 | 0.02 | 0.09 | | 0.10 |
| 3. | - | 0.09 | 0.02 | 0.09 | | 0.09 |
| 4. | - | 0.08 | 0.04 | 0.11 | | 0.11 |
| 5. | - | 0.07 | 0.05 | 0.10 | | 0.11 |
| 1+2+3+4+5 | - | 0.10 | 0.04 | 0.11 | | 0.11 |

**Table 6. The heritability of litter size of prolificacy Yorkshire**

| Farrowing | Age at farrowing | Born | | | | |
|---|---|---|---|---|---|---|
| | | Alive born | Still born | $5^{th}$ day | | Weaned |
| 1. | 0.21 | 0.12 | 0.03 | 0.07 | | 0.10 |
| 2. | - | 0.09 | 0.02 | 0.08 | | 0.10 |
| 3. | - | 0.10 | 0.04 | 0.09 | | 0.12 |
| 4. | - | 0.09 | 0.03 | 0.09 | | 0.08 |
| 5. | - | 0.09 | 0.02 | 0.07 | | 0.11 |
| 1+2+3+4+5 | - | 0.11 | 0.03 | 0.08 | | 0.11 |

**Table 7. The heritability of litter size of conventional selection of Yorkshire**

| Farrowing | Age at farrowing | Born | | | | |
|---|---|---|---|---|---|---|
| | | A Live born | Still born | $5^{th}$ day | | Weaned |
| 1. | 0.14 | 0.12 | 0.04 | 0.10 | | 0.10 |
| 2. | - | 0.08 | 0.05 | 0.08 | | 0.08 |
| 3. | - | 0.09 | 0.02 | 0.09 | | 0.09 |
| 4. | - | 0.09 | 0.03 | 0.07 | | 0.07 |
| 5. | - | 0.11 | 0.03 | 0.07 | | 0.09 |
| 1+2+3+4+5 | - | 0.10 | 0.03 | 0.08 | | 0.09 |

**Table 8. The repeatability of litter size of prolificacy Landrace**

| Farrowing | Age at farrowing | | | | | |
|---|---|---|---|---|---|---|
| | | Alive born | Still born | $5^{th}$ day | | Weaned |
| 1. | 0.20 | 0.16 | 0.09 | 0.17 | | 0.18 |
| 2. | - | 0.16 | 0.08 | 0.15 | | 0.18 |
| 3. | - | 0.18 | 0.09 | 0.16 | | 0.17 |
| 4. | - | 0.18 | 0.07 | 0.18 | | 0.17 |
| 5. | - | 0.18 | 0.08 | 0.17 | | 0.16 |
| 1+2+3+4+5 | - | 0.17 | 0.09 | 0.17 | | 0.17 |

**Table 9. The repeatability of litter size of conventional selection of Landrace**

| Farrowing | Age at farrowing | Born | | | | |
|---|---|---|---|---|---|---|
| | | Alive born | Still born | $5^{th}$ day | | Weaned |
| 1. | 0.19 | 0.18 | 0.07 | 0.16 | | 0.16 |
| 2. | - | 0.16 | 0.08 | 0.16 | | 0.15 |
| 3. | - | 0.17 | 0.08 | 0.17 | | 0.16 |
| 4. | - | 0.17 | 0.07 | 0.15 | | 0.18 |
| 5. | - | 0.18 | 0.07 | 0.15 | | 0.20 |
| 1+2+3+4+5 | - | 0.18 | 0.07 | 0.16 | | 0.19 |

# Conclusion

There are statistically significant differences for number of alive, still born and weaned piglets between prolificacy and conventional Landrace and Yorkshire breeds. No differences within prolificacy are for the same traits. Prolificacy's L and Y gilts were heavier at the entrance to the production, which guarantees the continuity of a stable production of pigs and optimal replacement. Conventional selection of the same L and Y breeds were, by selection criteria and technology, at least one month younger and with smaller size. These indicate shorter life production and smaller litter size. Genetic parameters indicate that reproduction belong to low hereditary traits regardless of the level of genetic potential and significantly larger litters than the conventional selection of these breeds in our conditions. Even statistically significant differences on phenotypic level, the estimation of genetic parameters for both indicated they are belonging to low heritage group of traits. Knowing that ovulation rate belong to middle heritage trait ($h^2$ – 0.40) it is necessarily to use different management in feeding regime of females and age with weight of gilts. Research justifies the use of new information technologies in the area of feeding sows, and optimization of production conditions, e.g. humidity, air velocity, temperature and light, which significantly affect the development of the genome. A particularly important aspect is the adaptation of modern management aspects in production management at the farm. As expected evaluations the repeatability values were significantly higher than heritability. The differences between genetic parameters of prolificacy and conventional purebred L and Y belong to selection efficiency during generation.

# Heritabilnost i ponovljivost reprodukcijskih svojstava svinja čistih rasa

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# Rezime

Istraživanja su izvedena na 4 farme na kojima su krmače podeljene u dve grupe: visokoplodne i konvencionalne sa znatno nižom plodnošću. Broj visokoplodnih iznosio je 2.434 krmača rase landras i jorkšir koje su parene sa 28 nerastova,svi Danskog porekla ili, 7.684 legla iz prvih 5 prašenja a u periodu 2009. – 2012. Uporedo su izvedena i istraživanja na plotkinjama koje su odabirane koristeći konvencionalne selekcsijske kriterijume, rasa landras i jorkšir, koja su obuhvatila 3.964 krmače parene sa 49 nerastova, i koje su proizvele 15.764 legla u istom periodu. Na obe selekcije, visokoplodne i konvencionalne, primenjeni su različiti kriterijumi selekcije (danski i srpski) tokom godina proizvodnje sa očekivanim efektima. Za korekciju uticaja sistematskih i slučajnih faktora korišćen je mešoviti model ocene. Razlika u broju zalučene prasadi između visokoplodnih i konvencionalnih selekcija bila je signifikantna, a varirala je u granicama 11-14 zalučene prasadi na godišnjem nivou. Ocene heritabilnosti varirale su u granicama 0.07 – 0.12 dok su vrednosti koefcijent ponovljivosi bile veće i to za nivo dodatnih informacija iz modela. Varirale su u granicama 15 – 19 procenata. Selekcijski kriterijumi u konvencionalnih selekcija nisu bili efikasni prema očekivanju. Bili su pristrasni. Visokoplodne životinje pokazale su genetsku superiornost ali je udeo aditivnih gena bio gotovo identičan kao u konvencionalni selekcija obe rase.

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