STUDY ON THE HERITABILITY (h^2) OF LITTER SIZE AND BODY WEIGHT AT BIRTH OF SIRES IN SWINE BREEDING FARMS, SRI LANKA

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Abstract: Aim of the study was to estimate the heritability (h^2) of litter size and body weight at birth of sires in swine breeding farm of Sri Lanka. Breeding herds of two farms were selected for the study. 15 sires and 45 sows from three breeds (Large white, Landrace and Duroc) were nested according to 'Nested full sib, half sib design' and data for litter size on 117 litters and body weight from 1084 piglets were collected for three consecutive litters from each dam. Main objective was to estimate the heritability for litter size and body weight at birth. Selection accuracy, additive component variance and dominant component variance were estimated further. Estimated heritability values for litter size in farm A were 0.07, 0.08 and 0.08 in Duroc, Landrace and Large white respectively. It is in farm B were 0.07, 0.08 and 0.07 in Duroc, Landrace and Large white respectively. Heritability values for birth weight in Farm A were 0.22, 0.21, 0.23 and 0.16, 0.12, 0.16 in Farm B for Duroc, Landrace and Large white respectively. Selection accuracy for litter size in Farm A is 0.113, 0.135 and 0.127 in Duroc, Landrace and Large white respectively and it is 0.155, 0.086 and 0.132 in Farm B for above three breeds respectively. Estimated values were lower than international standards thus imply the need of upgrading existing breeding herds in Sri Lanka.

Keywords: Swine, Heritability, Litter size, Birth weight, Selection Accuracy.

Introduction: Swine industry plays a major role in world livestock industry and the pork is the most widely eaten meat in the world accounting for over 36% of the world meat intake. It is followed by poultry and beef with about 33% and 24% respectively. Swine industry of Sri Lanka is currently at developing stage. The total swine population in Sri Lanka is estimated to be 91,977 heads, producing about 14,000 metric tons of pork annually. Average per capita pork consumption is 0.6 kg per year, which is about 1/10th of the total meat consumption by an average Sri Lankan [2]. Poor breeding herd due to underutilization of genetic resource or genetic potential of animal is one of a major problem for current status of swine industry. Lots of economically important trait are being considering by swine breeders when selecting animals for breeding herd and litter size and weight at birth are two important traits among them. These traits are also known as early selective criterions.

Most of the selecting programs use phenotypic characters for selecting parents instead of considering genetic potential of animal. Selecting animal that has high additive genetic component related to focusing trait is very effective and high additive component indicate the high genetic potential of animal as a parent. Heritability is a common parameter that indicates the genetic potential of animal as a breeder. The proportion of total phenotypic variation in a population due to genetic factors is known as "Heritability" [10]. Information on the genetic potential of breeders, specifically heritability estimates of livestock, is prerequisites for genetic improvements for programs, since the genetic progress depends on accurate estimates of variances and heritability for traits of selection. Although numerous estimates of heritability and phenotypic correlations are available for swine in the world, estimates of these are less for Sri Lankan swine population. Thus this study focused on the estimation of heritability two important traits of swine (i.e.: Litter size and Birth weight) and selection accuracy in two large scale swine breeding farms in Sri Lanka.

Methodology:

Data Collection: 15 sires and 45 sows from three breeds (large white, landrace and duroc) in two large scale swine breeding farms were selected for the study. Average litter size, farrowing interval and culling age of animals in both farms were collected. Dams were nested within sires. Data for litter size on 117 litters and body weight from 1084 piglets were collected from three consecutive litters of each dam.

Statistical Analysis:

Total variation was calculated by substituting sire, dam and individual effects to following model.

$Yijk=\mu+si+dij+£ijk$

Yijk = Phenotypic value of kth pig ling within jth dam and ith sire

μ = Overall mean

si = Effect of ith sire

dij = Effect of jth dam within ith sire

£ijk = Total effect

Variance of sire component, dam component and error component were calculated using ANOVA.

Heritability and other genetic components were estimated using following formulas.

Variance of Additive Component [V (A)] = $\sigma s2 * 4$

Variance of Dominance Component [V (D)] = σd2 - [1/4V (A)]
Variance of Phenotype [V (P)] = σe2 + σd2 + σs2
Sum of Variance of Epistatic [V(I)] & Environment [V(E)]= V(P) – [V(A) + V(D)]
Heritability (h2) = V (A) /V (P)
Standard error,
SE = 4√(2(n.-1) ⟦(1-t)⟧^2 [1+(k-1)t]^2)/(k^2 (n-s)(s-1))
S= number of sires
n. = total number of progeny
t = interclass correlation
K= Coefficient of K
Selection Accuracy = √h2/2 x 100 [5]

Results and Discussion: Breeding herd of farm A consists with 4 duroc, 4 large white, 3 landrace sires and 10 duroc, 35 large white and 20 landrace sires. Farm A practises artificial insemination and the average farrowing interval is about 152 days. Weaning age in farm A is at about 1 month and culling age is 2-2.5 years for sires and 2.5- 3 years for dams.

Breeding herd of farm B is with 18 duroc, 15 large white, 14 landrace sires and 21 duroc, 25 large white and 24 landrace sows. Farm B follows natural breeding and average farrowing interval in farm B is about 160 days. Culling age for sires is 3- 3.5 years and it is 2.5- 3 years for dams in farm B.

Estimated heritability values for litter size: Estimated heritability values for litter size of Duroc, Landrace and Large white in farm A were 0.07, 0.08 and 0.08 respectively. It was 0.07, 0.08 and 0.07 respectively for above three breeds in farm B. Table 3.1 gives the estimated values for heritability, additive genetic variance, dominant variance, standard error for the heritability and selection accuracy for litter size in both farms. Revelle and Robison [7] reported that the heritability values for most reproductive traits are low.

A heritability of zero indicates a lack of additive genetic influence on the differences observed among animals. A heritability of one indicates that all differences among animals are due to additive genetic causes. Findings of the study agreed with previous statements due to the lower additive genetic variance of the studied traits. The heritability of a trait may be low due to small additive genetic variance, excessive environmental variability, negative correlations between direct genetic and maternal effects or negative genetic correlations between components of the trait [7].

I a. Estimated values for litter size in farm A and farm B

Breeding herd	Breed	h^2	V(A)	V(D)
Farm A	Duroc	0.07	0.115	0.023
	Landrace	0.08	0.198	0.108
	Large white	0.08	0.165	0.051
Farm B	Duroc	0.07	0.115	0.026
	Landrace	0.08	0.279	0.01
	Large white	0.07	0.23	0.174

I b. Estimated values for litter size in farm A and farm B

Breeding herd	Breed	V(E)+V(I)	V(P)	SA %
Farm A	Duroc	1.49	1.634	13.27
	Landrace	2.151	2.457	14.17
	Large white	2.151	2.547	12.71
Farm B	Duroc	1.369	1.51	13.83
	Landrace	3.187	3.477	14.18
	Large white	2.777	3.181	13.45

Environmental and epistatic variances are high for the studied traits (Table I a & I b). Rothschild *et al* [8] stated that litter size differences between first and later parities may reflect that genetic differences for litter size in older and more physiologically similar females are reduced or masks by environmental effects such as nutritional effects and stress related to larger first litters.

Size in order and more physiologically similar females are reduced or masks by environmental effects and stress related to larger first litters.

Estimated heritability values for Body weight at birth: This study was able to estimate the heritability of body weight at birth. Selection for sow ability to give birth to a higher number of piglets has led to an increased within litter variation in piglet birth weight.

The critical birth weight of a piglet is 950 grams. Average birth weight for Duroc, Landrace and Large white piglets in farm A are 1.3 Kg, 1.2 Kg and 1.2 kg respectively. It is 1.2 kg, 1.2 kg and 1.3 kg in farm B.

II a. Estimated values for birth weight in farm A and farm B				
Breeding herd	Breed	h^2	V(A)	V(D)
Farm A	Duroc	0.22	0.002	0.006
	Landrace	0.21	0.003	0.013
	Large white	0.23	0.006	0.046
Farm B	Duroc	0.16	0.176	0.335
	Landrace	0.12	0.001	0.005
	Large white	0.16	0.002	0.004

II b. Estimated values for birth weight in farm A and farm B				
Breeding herd	Breed	V(E)+V(I)	V(P)	SA%
Farm A	Duroc	0.001	0.009	23.93
	Landrace	0.002	0.014	23.7
	Large white	0.026	0.028	24.48
Farm B	Duroc	0.581	1.093	20.06
	Landrace	0.004	0.012	17.42
	Large white	0.003	0.015	20.08

Birth weight is an important trait in pig production [6]. Low birth weight results from intrauterine growth retardation during gestation. Small piglets form a lower total number of skeletal muscle fibres during prenatal development compared with their larger littermates [3].

The results of a study by Quiniou *et a*l. [6] demonstrated that the average piglet body weight may decrease and the percentage of piglets with low birth weight may increase with increasing litter size.

The birth weight of piglet is 1 % from its slaughter weight. The piglets with birth weight higher than 1.2 kg are considered to be viable and reach the maximum of its production efficiency [9]. Birth weight variation within litters affects piglet survival and weight gain. Parity and litter size are some of the factors affecting birth weight.

Milligan *et al.* [4] indicated that parity influences birth weight and generally, sows in first parity have lower birth weight yields than sows in other parities. There is a negative correlation between litter size and birth weight, hence increase in litter size yields reduced birth weight [1]. Birth weight and litter size affect weaned numbers and weight.

Table IIa and IIb gives the estimated values for heritability, additive genetic variance, dominant variance, standard error for the heritability and selection accuracy for birth weight in both farms.

Heritability of individual birth weight is low and therefore potential for genetic selection is likely nominal. Based on the higher maternal heritability compared to direct heritability, it appears the genetic aspects of the uterine environment (nutrition, space, etc.) contribute a larger portion of the phenotypic variation than the fetus' or individual pig's contribution. Consequently, the potential for genetic selection for an individual's increased birth weight due their genetic merit is minimal. Even so, there is still the potential, if desired, to impact individual birth weight through direct selection.

Accuracy of selection: The selection accuracy is defined as the correlation between true breeding value and estimated breeding value (EBV). Heritability and accuracy are related together. Phenotypic variance depends on Genetic variance and Environment variance. Thus selecting animals completely based on phenotypic variance will reduce the accuracy of selection. Accuracy of selection for litter size of Duroc, Large white and Landrace in farm A is 13.27%, 12.71%, 14.17% respectively. It is in farm B is 13.83%, 14.18% and 13.45% for above breeds respectively. Finding of this study shows the effect of dominance variation, epistatic variation and environmental variation of the litter size is comparatively high. This may be a reason for lower selection accuracy. Selection accuracy for the trait body weight at birth in farm A and B are mentioned in table 3.2. *Vaclavkova et al* [9] describes environmental factors affect on body weight at birth thus convincing environmental effects for the trait

birth weight is higher than the genotypic effect.

Conclusion: The findings of the present study demonstrate the status of gene pool for selected traits of swine in Sri Lanka. Heritability values for litter size and birth weight ranged from 0.07-0.23 in both farms for three studied breeds. Selection Accuracy for selection against litter size ranged from 12.71% to 14.18% in both farms. Accuracy of selection against birth weight is ranged from 17.42% to 24.48%. The results reveal the need of well designed breeding programme for Swine breeding farms in Sri Lanka. Future studies can be deployed to implement breeding plans to existing farms in Sri Lanka.

References:

1. Damgaard, L.H., L. Rydhmer, P. Lovendahl and K. Grandinson, 2003, Genetic parameters for within litter variation in piglet birth weight and change in within litter variation during suckling. J. Anim. Sci., 81: 604-610
2. Department of Animal Production & Health, 2010, Sri Lanka
3. Gondret F., Lefaucheur L., Juin H., Louveau I., Lebret B. (2006), Low birth weight is associated with enlarged muscle fiber area and impaired meat tenderness of the longissimus muscle in pigs. J. Anim. Sci, 84, 93-103
4. Milligan, B.N., D. Fraser and D.L. Kramer, 2002, Within litter birth weight variation in the domestic pig and its relation to pre-weaning survival, weight gain and variation in weaning weights. Livest. Prod. Sci., 76: 181-191
5. Mukherjee D.P., Banerjee G.C., 1980, Genetics and Breeding of Farm Animals, Oxford & IBH Publishing Co Pvt Ltd, India
6. Quiniou N., Dagorn J., Gaudre D. (2002). Variation of piglets' birth weight and consequences on subsequent performance, Li. Prod. Sci., 78, 63-70.
7. Revelle, T. J., and O. W. Robison. 1973. An explanation for the low heritability of litter size in swine. J. Anim. Sci. 37:668.
8. Rothschild, M. F., C. R. Henderson, and R. L. Quaas. 1979. Effects of selection on variances and covariances of simulated first and second lactations. J. Dairy Sci. 62:996.
9. Vaclavkova E., Danek P., Rozkot M., 2012, The influence of piglet birth weight on growth performance, Research in pig breeding, 6, (1)
10. William, S. K., Cumming M, R. and Spences C. A., 2010, Essential of Genetics, 6th edition, Benjamin Cummings.

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