Philipp J Vet Anim Sci 2017 43 (2): 67-72

PHENOTYPIC TREND AND ESTIMATES OF GENETIC PARAMETERS FOR GROWTH TRAITS OF PHILIPPINE SWAMP BUFFALOES IN A NUCLEUS HERD, CAGAYAN PROVINCE, PHILIPPINES

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ABSTRACT

The Philippine Carabao Center (PCC) at Piat, Cagayan, Philippines established a breeding program to improve growth rates of Philippine swamp buffaloes. A total of 1,322 growth records from 220 animals taken at birth, 6, 9, 12 and 18 mos from 2002 to 2014 were analyzed in multi-trait genetic animal models that included additive direct effects only or both additive direct and maternal effects using ASReml 3.0 program to estimate variance components. Growth rates improved across the years but the response was most evident at 12 and 18 months as breeder bulls were selected based on weight at these two age categories. Improvement at weaning and pre-weaning weights (<12 mos.) did not follow the same trend as weights at 12 and 18 mos. This may be due to the fact that while direct heritability was moderate for weight at 18 mos. at 0.19, it was low for pre-weaning and weaning weights. Maternal heritability was higher for these traits at 0.21 for weight at 9 mos thus, selection for replacement breeders should include weights at 9 and 6 mos especially for the heifers. When the data set has increased, animals should be ranked and selected based on direct and maternal breeding values for growth traits.

Key Words: average daily gain, genetic correlations, growth traits, heritability, swamp buffalo

INTRODUCTION

The Philippine Carabao Center (PCC) is mandated to conserve, propagate and promote the Philippine carabao for milk, meat, draft and hide among others. In response, the PCC put in the ground a breeding program for the Philippine swamp buffalo. One component is the establishment of a nucleus herd in Piat, Cagayan wherein growth traits are the primary interest. The selection is expected to produce future generation bulls with excellent genetic potential for growth that can be disseminated through the population for the benefit of thousands of farmers with carabaos. Effectively disseminating the bulls' superiority through the population by mating with several or even hundreds of females is best done through artificial insemination. Sires have a very large impact on the resulting progeny and these choices also affect the performance of later generations of the population. Thus, the frozen semen of selected bulls for breeding is being made available by PCC to buffalo farmers to achieve genetic improvement in the population.

Identifying genetically superior individuals for breeding requires recording weights and comparing among contemporaries based on weights at different growth stages. However, fair comparison requires accounting for the effects of environment and management among others. In recent years, genetic evaluation models can account for

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the systematic environment effects and enable the identification of genetically superior individuals. Aside from accounting for systematic environment effects, genetic evaluation requires the estimation of genetic parameters and (co)variance components using a suitable genetic model for the traits of interest. For increasing the rate of growth in beef cattle, traits of interest include body weight at different stages of growth such as 120D, 180D, 360D, 600D adjusted weights (de Oliviera Menezes *et al*., 2013; Diop *et al*., 1998) analysed using a multi-trait animal model. Recent developments include the use of random regression models wherein the weights at different growth stages are used directly to estimate the growth curve for each individual rather than being treated as separate traits.

For the Philippine swamp buffaloes, current selection is mainly based on body weight at 12 and 18 mos. However, similar approach as what is being done in beef cattle can be applied on genetic evaluation in order to select bulls for breeding to improve the growth rate of the population. The preliminary estimates of genetic parameters for growth traits and the average body weights at different stages of growth across years are presented in this study.

MATERIALS AND METHOD

Birth weight, body weights and average daily gain at 3, 6, 9, 12, 18, 24, 36 and 60 mos of age were the available performance records of swamp buffaloes from a PCC herd in Piat, Cagayan. There were 1,322 records of 220 animals from 2002 to 2014 available for analysis. However, in the pedigree file used for generating the numerator relationship matrix (NRM), there were 280 animals extending three generations with 90 dams and 12 sires, sixty (60) of which are without phenotype. The genetic animal model used for analysis is given as:

$$\mathbf{y_i = X_i b_i + Z_i u_i} + \mathbf{e_i},$$

where the vector $\mathbf{y_1}$ represents the $\mathbf{n_1}$ observations for trait 1 and $\mathbf{y_2}$ represents $\mathbf{n_2}$ observations for trait two, and so on and there are $\mathbf{p_i}$ fixed effects associated with trait **i** so that $\mathbf{X_i}$ is an $\mathbf{n_i}$ x $\mathbf{p_i}$ matrix and $\mathbf{b_i}$ is a $\mathbf{p_i}$ x **1** dimensional column, vector $\mathbf{u_i}$ is the vector with random effects. $\mathbf{X_i}$ and $\mathbf{Z_i}$ are incidence matrices for fixed effects and random effects for trait **i**, respectively.

Analysis for two-, three- and four-trait models were done wherein only additive direct effects for growth traits was fitted (multiple trait animal model) as well as models fitting both additive and maternal effects (maternal effects model). Fixed effects in the genetic models included year-season of calving (Jan-Apr, May-Aug, Sept-Dec), test-date (month of weighing) and sex. Average Information Residual Maximum Likelihood (ASREML 3.0) software (Gilmour *et al*., 2009) was used for variance component estimation. Direct and maternal heritability estimates, phenotypic and genetic correlations were obtained.

Table 1. Average body weight of Philippine swamp buffaloes at PCC herd in Piat, Cagayan at different age categories born at different seasons.

Age category	Season A[1]			Season B[1]			Season C[1]			Overall average	
	n	Wt.	ADG	n	Wt.	ADG	n	Wt.	ADG	Wt.	ADG
Birth	77	30.2		41	29.5		102	29.3		29.7	
3Mo	70	92.2	0.59	29	79.9	0.47	82	86.1	0.53	87.5	0.54
6Mo	67	133.5	0.52	31	112.2	0.41	81	117.2	0.44	122.4	0.47
9Mo	65	166.3	0.47	31	133.5	0.34	73	150.2	0.42	153.3	0.42
12Mo	61	186.4	0.28	30	163.1	0.28	61	170.2	0.27	175.3	0.28
18Mo	45	221.9	0.34	23	195.0	0.29	52	204.0	0.30	209.0	0.31
24Mo	50	243.6	0.30	18	252.0	0.29	35	238.1	0.28	243.2	0.29
36Mo	30	337.9	0.28	17	338.4	0.28	25	339.8	0.28	338.7	0.28
48Mo	24	399.2	0.25	12	397.2	0.25	13	414.5	0.26	402.8	0.25
60Mo	12	438.5	0.22	11	440.2	0.22	10	427.6	0.22	435.7	0.22

[1] Season of calving, A = Jan – Apr, B = May – Aug, C = Sep – Dec

RESULTS AND DISCUSSION

Average body weight and average daily gain at different stages of growth of calves born at different seasons is shown in Table 1. There are more calves bon in season C (Sep – Dec) season followed by season A (Jan – Apr) and least in season B (May – Aug). There was steady increase in body weight with age whereas the average daily gain (ADG) decreased with age. However, calves born in season A are generally heavier compared to calves born in other season up to 18 mos of age. There were no appreciable differences in average weight with older animals. While there was steady and appreciable increase in body weight up to about 24 mos, increase in height starts to taper off quite early at about 9 – 12 mos. Thus, the increase in weight after one year was due largely to lateral rather than vertical growth (Figure 1). The decrease in ADG with increasing age is to be expected due largely to tapering of growth (body weight and height) after 12 mos of age.

The average body weight at 12 - 36 mos increased across the years compared to 2004 when the first four bulls were selected for breeding (Figure 2). The positive trend was quite evident especially at 18 and 24 mos of age. There was a 39% and 38% increase in average body weight at 18 and 24 mos in 2013 relative to 2004. The positive trend was less evident with younger age. There was no appreciable improvement in average body weight at 3mos (WT3) and birth (BW) across the years. Selection for breeding bulls was based on body weight at 12 (WT12) and 18 (WT18) months and would account for the most weight gain. However, it is also expected that there would be a correlated increase as it is assumed that growth traits are positively correlated (Glaze & Schalles, 1994).

The estimates of heritability obtained from running a multi-trait analysis of growth traits (BW, WT9, WT12, WT18) that included only additive direct effects in the genetic

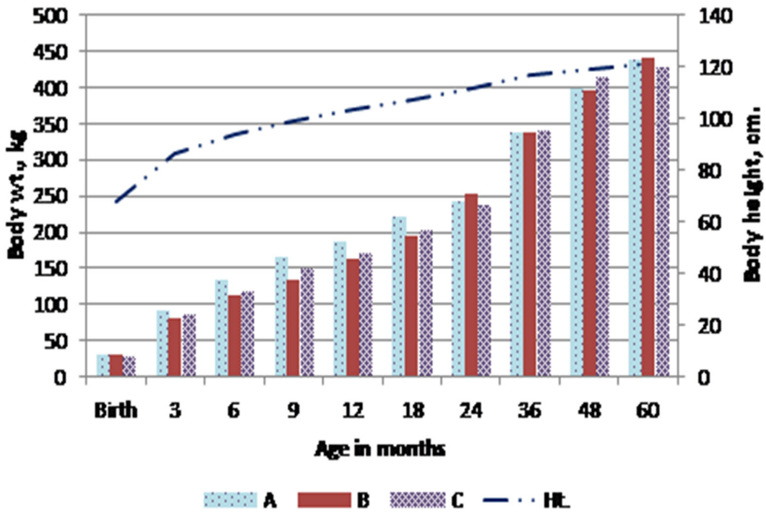

Fig. 1. Average body weight and height of Philippie swamp buffaloes calved at different seasons. Season A=Jan - Apr, Season B= May - Aug, Season C= Sept - Dec.

model resulted in heritability estimates that were moderately high ranging from 0.48 for BW, and 0.64 for WT18 (Table 2). The high heritability for WT18 might account for the best response to selection among the different age categories. The genetic correlations among the four traits were high and positive but the response to pre-weaning, weaning (WT9) and birth weight (BW) did not follow the same trend as that of yearling weight (WT12). This was because weaning and pre-weaning weights were not included in the selection criteria. There was also no selection on the dam line to account for rearing ability of the dams.

Table 2. Heritability (diagonal), genetic correlations (lower off-diagonal) and phenotypic correlations (upper off-diagonal) for growth traits of Philippine swamp buffalo herd of PCC CSU estimated from running a multi-trait analysis with only additive direct effects in the genetic model.

TRAIT	BW	WT9	WT12	WT18
BW	0.48 ± 0.21	0.42	0.3395	0.42
WT9	0.84	0.56 ± 0.12	0.8636	0.79
WT12	0.85	0.98	0.54 ± 0.12	0.80
WT18	0.69	0.85	0.90	0.64 ± 0.13

Running the same data set using a multi-trait genetic model that included both direct and maternal effects resulted in a lower direct heritability estimates for birth and pre-weaning growth traits (Table 3). A large proportion of the genetic variance estimated previously were re-distributed to maternal variance with the inclusion of direct and maternal effects in the genetic model. Still, WT18 had the highest direct heritability at 0.21 followed by BW at 0.11. Direct heritability for weaning (WT9) and yearling weight (WT12) were very low. Nevertheless, the genetic correlation of WT12 with WT18 was very high hence, there will be correlated response to selection on WT18 and this would probably

Table 3. Additive direct and maternal heritability (diagonal), genetic correlations (lower off-diagonal) for growth traits of Philippine swamp buffalo herd of PCC estimated from running a multi-trait analysis with a genetic model fitting both additive direct and maternal effects.

TRAIT	BW	WT9	WT12	WT18
Additive direct				
BW	0.11 ± 0.34			
WT9	-0.98	1.01 ± 0.04		
WT12	-0.20	0.24	1.01 ± 0.06	
WT18	-0.20	0.24	0.99	0.19 ± 0.12
Maternal				
BW	0.10 ± 0.14			
WT9	0.98	0.21 ± 0.09		
WT12	0.95	0.97	0.16 ± 0.10	
WT18	0.95	0.95	0.88	0.11 ± 0.11

account for the similar trend across the years seen in Figure 2. The small improvement in pre-weaning might be explained by the fact that while genetic correlations were positive between pre-weaning and yearling weights, the maternal heritability is higher than direct heritability for growth traits hence, the dam's ability to rear and provide milk for its calf is very important influence for pre-weaning weight as well as birth weight. On the other hand, birth weight remained essentially the same across the years despite the improvement in growth rates due to the negative genetic correlations with post-weaning weights. The estimates of direct heritability for growth traits obtained in this study was very similar to those reported for Brazilian buffaloes for the same age categories (Malhado

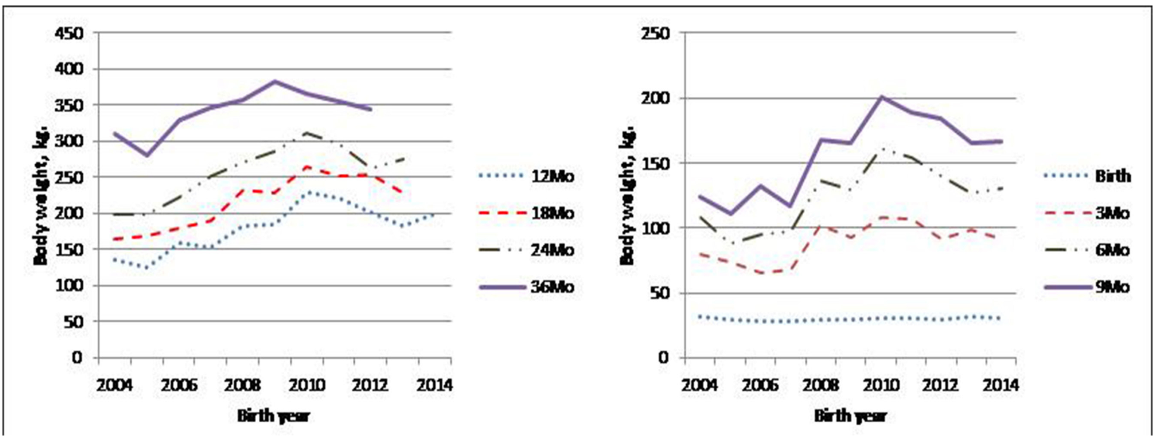

Fig. 2. Average body weight at different age categories of Philippine swamp buffaloes at PCC herd across the year.

et al., 2007) but the same authors reported lower maternal heritability. Nevertheless, the study by Glaze & Schalles (1994) reported very similar estimates and supports the finding of this study.

The standard errors for all genetic parameters estimated reflect the small data set available. With a larger data set in the future, it is expected that the estimates may change and the standard error to become smaller. However, the pattern for the partitioning of the direct and maternal variances may remain the same. Due to the high standard errors obtained, the use of breeding values or ranking and selecting replacement animals may not be appropriate at the moment but selection criteria should include pre-weaning weights aside from weight at 12 and 18 months especially for identifying replacement females.

Research showed that calves are born the most during the cool months of September to December followed by the months of January to April and the least in the hot months of May to August. Calves born in the months of January to April were on the average heavier up to about the age of 18 months. Selection of breeder bulls based on body weight at 12 and 18 months resulted in positive phenotypic trend for growth and a general improvement in growth rates for the herd. However, the result also indicated the need to include pre-weaning and weaning weights in the selection criteria especially on the female breeders to increase the growth rates at pre-weaning and weaning age.

ACKNOWLEDGMENTS

The author wishes to acknowledge the technical staff and Director of PCC at CSU for providing the data and implementing the breeding program for the herd of Philippine swamp buffaloes.

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