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FARROWING AND WEANING PERFORMANCE OF BLACK TIAONG AND KALINGA NATIVE PIG BREEDS AT A CONSERVATION FARM, PHILIPPINES

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ABSTRACT

Data from 159 Black Tiaong litters and 81 Kalinga litters born from 2011 to 2015 at the native pig conservation farm of the National Swine and Poultry Research and Development Center, Bureau of Animal Industry, Department of Agriculture, Tiaong, Quezon, Philippines were analyzed to establish breed standards for farrowing and weaning performance. Average parity per sow, farrowing interval, and litter size at birth were not significantly different (P>0.05) between breeds. Black Tiaong sows were significantly older at first farrowing (P<0.01), had significantly heavier pig weight at birth (P<0.05), had piglets weaned at a younger age (P<0.01), and had heavier piglets at weaning (P<0.05) with higher pre-weaning average daily gain (PreADG) (P<0.01) than Kalinga sows. While litter size at weaning was slightly higher in Black Tiaong than Kalinga, farrowing index (FI) and sow productivity index (SPI) were lower in Black Tiaong than Kalinga sows. Litter size at birth and at weaning, weaning age, pig weight at birth and at weaning, PreADG, FI, and SPI in Black Tiaong and Kalinga native breeds were all inferior than the 2012 average performance of commercial swine farms in the Philippines. The only advantage of native breeds over commercial breeds was the lower number of mummified piglets, stillbirths, and piglet mortality before weaning.

Key words: Black Tiaong, Kalinga, reproductive performance, swine

INTRODUCTION

Native (or local) pig breeds have long been the basis of livelihoods in smallholder livestock production systems in the Philippines, albeit no structured animal breeding program exists to improve their genetic traits. Native pigs have descended from their wild ancestors and are raised in small numbers using traditional production techniques by most village households (Bondoc, 2008). Native pig breeds are socially and culturally acceptable. They are believed to have adapted to a broad range of environments as a result of their evolution to produce under harsh environments, including disease challenges (e.g., ICAR, 2000).

Recently, local pig breeds are actively sought to provide the adapted livestock requirements of the slowly but steadily growing organic sector (Bondoc, 2014). Native pig breeds are preferred by smallholder farmers whose husbandry practices are closer to organic farming systems, although largely by default, since they traditionally use few external inputs, such as allopathic medicines and antibiotics, and follow grazing-based extensive or semi-intensive production systems. However, productivity of local breeds used in organic smallholder livestock production systems should be improved (Bondoc, 2015). While genetic variation may exist in productivity within these breeds for most traits

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of importance since they are already adapted to local conditions, the potential for their sustainable use and genetic improvement has so far only been exploited to a very limited degree.

While the design of swine breeding (conservation) programs may be oriented towards a breeding plan that should be able to ensure farm profitability, safeguard animal health and welfare, focus on conserving genetic diversity and promote human health, technical knowledge of genetic parameters for economically important traits determined under Philippine conditions will be required. For example, data on farrowing and weaning traits, as reported for native pig breeds are rare in scientific literature. Although weighted mean estimates of genetic parameters from a meta-analysis may be used, the significant effects of breed, data origin, estimation method, data age and location of study as reported by Akanno *et al*. (2013), imply the relevance of having local, population-specific genetic parameter estimates.

In this regard, the objective of the study was to establish breed standards for farrowing and weaning performance of Black Tiaong and Kalinga native pig breeds kept at the native pig conservation farm of the National Swine and Poultry Research and Development Center (NSPRDC), Bureau of Animal Industry, Department of Agriculture (BAI-DA), Tiaong, Quezon, in comparison with the average performance of commercial swine farms in the Philippines (e.g, Calud *et al*., 2012). Such new information may help promote native pig production not only to contribute to rural development, but also to the conservation of valuable animal genetic resources owned by smallholder farmers.

MATERIALS AND METHODS

Data were obtained from 240 litters belonging to the Black Tiaong (N=159) and Kalinga (N=81) native pig breeds born from 2011 to 2015 at the NSPRDC, BAI-DA, Lagalag, Tiaong, Quezon, Philippines (13° 56′ 37.0″ N, 121° 22′ 23.0″ E). A total of 26 boars and 92 sows (i.e. 1:3.6 boar-sow ratio) were used in the native pig conservation farm (Table 1). In particular, Black Tiaong litters were born from 54 sows bred to 14 boars (i.e. 1:3.9 boar-sow ratio), while Kalinga litters were produced by 38 sows mated to 12 boars (i.e. 1:3.2 boar-sow ratio).

Farrowing data consisted of the sow's parity number, farrowing interval, and age of the sow at farrowing. Other litter data included litter size born alive (i.e. number of males, females, and total), number of mummified and still birth pigs, number of pigs that

Table 1. Number and distribution of boars and sows, and boar-sow ratio at National Swine and Poultry Research and Development Center, Bureau of Animal Industry-Department of Agriculture (2011-2015).

	Black Tiaong	Kalinga	Total
No. of litters produced	159	81	240
No. of piglets produced	908	429	1,337
No. of boars	14	12	26
No. of sows	54	38	92
Total breeding animals	68	50	118
Boar- Sow ratio	1: 3.9	1: 3.2	1: 3.6

die before weaning, and age at weaning. Other weaning data included average pig weight at birth, at weaning, at 30 days old, and at 45 days old and average daily gain or ADG pre-weaning, 0-30 days old, 0-45 days old, and 30-45 days old. Average farrowing index (i.e. number of litters produced by a sow in one year) and average sow productivity index (i.e. number of pigs weaned per sow per year) for each breed were then computed and compared with the average performance of commercial swine farms in the Philippines (e.g., Calud *et al*., 2012).

The "Black Tiaong" and "Kalinga" pigs belong to native black breeds whose foundation stocks were acquired by the NSPRDC, BAI-DA starting in 2010 from farmers in Tiaong, Quezon and Kalinga province, respectively. The native pigs are raised following an organic (extensive) production system, with a 2.5m x 2.5m space provided for each sow in a specially-designed pen constructed out of wood, iron pipes, and bamboo and litter floor composed of layered stones, sand, coconut husks, and sawdust, while allowing access to pasture or open-air exercise areas. The regular diet consists of rice bran, vegetables and soya by-products, and various forage/fiber crops such as "madre de agua" (*Trichantera gigantea*), "kulape" (*Paspalum conjugatum*), and water fern (*Azolla filiculoides*) fed *ad libitum*.

For the statistical analysis of each trait, the individual litter was considered as an experimental unit.

Simple descriptive statistics were determined for the various farrowing and weaning performance of the Black Tiaong and Kalinga breeds using the MEANS procedure of SAS (2009) and are given in Table 2. The Pearson product-moment correlation coefficients were then computed to measure linear relationships among the traits of a particular breed (Table 3 and 4) using the CORR procedure of SAS (2009).

The general least squares procedures for unbalanced data were used to examine the principal sources of variation affecting each trait. The following linear "fixed effects" model was used to determine, using an F-test, the appropriate model that would best describe each trait:

$$\mathbf{y}_{ijklmno} = \boldsymbol{\mu} + \mathbf{Breed}_i + \mathbf{FYear(Breed)}_{ij} + \mathbf{FMonth(Breed)}_{ik} + \mathbf{WYear(Breed)}_{il} + \mathbf{WMonth(Breed)}_{im} + \boldsymbol{\beta}_n\mathbf{Covariates}_n + \mathbf{e}_{ijklmno}$$

where:

$\mathbf{y}_{ijklmno}$ is the dependent variable (i.e. farrowing and weaning performance associated with each litter),

$\boldsymbol{\mu}$ is the overall mean,

$\mathbf{Breed}_i$ is the i^{th} breed of the sow (i.e. Black Tiaong and Kalinga),

$\mathbf{FYear(Breed)}_{ij}$, $\mathbf{FMonth(Breed)}_{ik}$, $WYear(Breed)_{il}$, and $WMonth(Breed)_{im}$ are fixed effects for the j^{th} year of farrowing, k^{th} month of farrowing, l^{th} year of weaning, and m^{th} month of weaning nested within the i^{th} breed of the sow, respectively,

$\boldsymbol{\beta}_n$ is the regression coefficient for $\mathbf{Covariates}_n$ which are random covariate effects of n^{th} age of sow at farrowing, farrowing interval, litter size, average pig weight, average daily gain, and weaning age, and

$\mathbf{e}_{ijklmno}$ is the error term assumed to be normally distributed with variance of errors as constant across observations.

Only those significant ($P<0.05$) fixed effects and covariates including the main effect of the breed of sow were included in the final linear models. The list of linear models, regression coefficient (no intercept model), and their coefficients of variation (CV) are presented in Table 5. The least square means and their standard errors were then computed and compared between breeds to represent the "breed standard" for each trait.

Table 2. Simple descriptive statistics of various farrowing and weaning traits in the Black Tiaong and Kalinga native pigs.

Trait	Black Tiaong			Kalinga		
	N	Ave. ± S.D.	Range	N	Ave. ± S.D.	Range
Parity number	159	2.5 ± 1.6	1-9	81	2.3 ± 1.8	1-8
Age of sow, days						
- at 1st farrowing	22	591.4 ± 322.4	322-1595	24	484.6 ± 155.7	258-814
- at 2nd farrowing	15	748.7 ± 192.8	497-1159	14	642.9 ± 189.9	326-931
- at 3rd farrowing	13	935.8 ± 171.4	588-1248	6	964.5 ± 124.1	831-1095
- at 4th farrowing	11	1076.4 ± 126.7	880-1269	3	1092 ± 160.3	989-1277
- at 5th farrowing	1	1370.0 ± 0.0	-	1	1155.0 ± 0.0	-
- at 6th farrowing	-	-	-	1	1338.0 ± 0.0	-
Farr. interval, days	97	239.3 ± 108.1	115-642	42	208.1 ± 1.6	134-844
Litter size at birth						
- males	159	2.9 ± 1.7	0-7	81	2.9 ± 1.6	0-7
- females	159	2.8 ± 1.7	0-9	81	2.4 ± 1.6	0-7
- total	159	5.7 ± 2.3	1-13	81	5.3 ± 2.3	1-13
Mummified pigs	159	0.01 ± 0.11	0-1	81	0.00 ± 0.00	-
Stillbirths	159	0.13 ± 0.45	0-3	81	0.05 ±0.31	0-2
Piglet mortality	159	0.27 ± 0.64	0-3	81	0.07 ± 0.38	0-3
Weaning age, d	159	40.2 ± 8.3	20-63	81	43.4 ± 7.1	31-69
Ave. pig wt., kg						
- at birth,	159	0.80 ± 0.17	0.30-1.20	81	0.67 ± 0.16	0.30-1.00
- at weaning	27	4.43 ± 1.37	2.22-7.72	21	3.77 ± 0.69	2.24-5.17
- at 30 days old	131	3.76 ± 0.89	1.65-5.85	47	3.60 ± 0.74	2.24-5.35
- at 45 days old	112	5.01 ± 1.13	2.74-8.25	62	4.03 ± 0.93	2.00-6.55
ADG, kg/day						
- Pre-weaning	27	0.089 ± 0.029	0.040-0.149	21	0.067 ± 0.016	0.029-0.097
- 0-30 days old	131	0.098 ± 0.030	0.033-0.168	47	0.097 ± 0.024	0.050-0.157
- 0-45 days old	112	0.093 ± 0.024	0.046-0.163	62	0.075 ± 0.020	0.031-0.131
- 30-45 days old	85	0.075 ± 0.043	-0.03-0.200	39	0.055 ± 0.029	0.000-0.133

Table 3. Significant correlations among farrowing and weaning traits in the Black Tiaong native pigs.

Traits	Correlation coefficient (r_{xy})	P level	N
1. Parity – Age of sow at farrowing	0.65	**	62
2. Parity – APW at birth	0.28	**	159
3. Parity – Pre-weaning ADG	-0.42	*	27
4. Parity – ADG 0-45 days old	-0.22	*	112
5. Age of sow at farrowing – Litter size at birth	0.30	*	62
6. Age of sow at farrowing – APW at birth	0.28	*	159
7. Age of sow at farrowing – Weaning age	0.37	**	97
8. Litter size at birth (total) – Weaning age	-0.26	**	159
9. Mummified piglets – Stillbirths	-0.22	**	159
10. Stillbirths – APW	-0.22	**	159
11. APW at birth – APW at 45 days old	0.27	**	112
12. APW at birth – ADG 30-45 days old	0.37	**	85
13. Weaning age – APW at weaning	0.54	**	27
14. APW at weaning – APW at 30 days old	0.68	**	32
15. APW at weaning – APW at 45 days old	0.78	**	32
16. APW at weaning – Pre-weaning ADG	0.89	**	48
17. APW at weaning – ADG 0-30 days old	0.68	**	32
18. APW at weaning – ADG 0-45 days old	0.78	**	32
19. APW at 30 days old – APW at 45 days old	0.81	**	84
20. APW at 30 days old – Pre-weaning ADG	0.83	**	22
21. APW at 30 days old – ADG 0-30 days old	0.98	**	131
22. APW at 30 days old – ADG 0-45 days old	0.82	**	84
23. APW at 45 days old – Pre-weaning ADG	0.87	**	21
24. APW at 45 days old – ADG 0-30 days old	0.74	**	84
25. APW at 45 days old – ADG 0-45 days old	0.98	**	112
26. APW at 45 days old – ADG 30-45 days old	0.71	**	85
27. Pre-weaning ADG – ADG 0-30 days old	0.83	**	22
28. Pre-weaning ADG – ADG 0-45 days old	0.90	**	21
29. ADG 0-30 days old – ADG 0-45 days old	0.78	**	84
30. ADG 0-45 days old – ADG 30-45 days old	0.68	**	85

Note: N is number of paired observations.
* correlation coefficient (r_{xy}) is significantly different from zero, P<0.05.
** correlation coefficient (r_{xy}) is highly significantly different from zero, P<0.01.

Table 4. Significant correlations among farrowing and weaning traits in the Kalinga native pigs.

Traits	Correlation coefficient (r_{xy})	P level	N
1. Parity – Age of sow at farrowing	0.81	**	49
2. Litter size at birth – APW at 30 days old	-0.38	**	47
3. Litter size at birth – ADG 0-30 days old	-0.41	**	47
4. APW at birth – Weaning age	0.28	*	81
5. APW at birth – APW at 30 days old	0.31	*	47
6. APW at birth – APW at 45 days old	0.32	*	62
7. APW at weaning – APW at 45 days old	0.71	*	10
8. APW at weaning – Pre-weaning ADG	0.97	**	21
9. APW at weaning – ADG 0-45 days old	0.70	*	10
10. APW at 30 days old – APW at 45 days old	0.85	**	39
11. APW at 30 days old – ADG 0-30 days old	0.98	**	47
12. APW at 30 days old – ADG 0-45 days old	0.71	**	39
13. APW at 45 days old – Pre-weaning ADG	0.70	*	10
14. APW at 45 days old – ADG 0-45 days old	0.95	**	62
15. Pre-weaning ADG – ADG 0-45 days old	0.70	*	10
16. ADG 0-30 days old – ADG 0-45 days old	0.71	**	39
17. ADG 0-45 days old – ADG 30-45 days old	0.40	*	39

Note: N is number of paired observations.
* correlation coefficient (r_{xy}) is significantly different from zero, P<0.05.
** correlation coefficient (r_{xy}) is highly significantly different from zero, P<0.01.

RESULTS AND DISCUSSION

Breed standards for farrowing and weaning traits are summarized in Table 6, including the estimates of average farrowing index (FI) and average sow productivity index (SPI), and the 2012 average production performance of commercial swine farms in the Philippines (Calud *et al.*, 2012).

Parity, Age of Sow at Farrowing, Farrowing Interval

Black Tiaong sows had farrowing records of up to the fifth parity, while Kalinga sows had litters up to the sixth parity. The average parity number of 2.1±0.1 per sow was not significantly different (P>0.05, CV=39.0%) between the native pig breeds. Parity was positively correlated to age of sow at farrowing in the Black Tiaong (r=0.65) and Kalinga (r=0.81). Parity in the Black Tiaong was also positively correlated to average pig weight at birth (r=0.28), but negatively correlated to pre-weaning ADG (r=-0.42). This means that heavier pig weight at birth in Black Tiaong litters is expected in the later parities, although pre-weaning ADG will also be lower.

Age of sow at farrowing was significantly different (P<0.05, CV=22.7%) between the native breeds in the first and second litters, but not in the succeeding litters. Black Tiaong sows had their first farrowing at an older age (21.6±1.3 months) than Kalinga

Table 5. Mean square F tests for the effects of the independent variables on farrowing and weaning performance of native pigs.

Traits	Independent variables						Covariates (regression coefficient)	Coeff. of Var
	Breed	Factors nested within the breed						
		Parity	Farrowing		Weaning			
			Year	Month	Year	Month		
Parity number	ns	-	ns	ns	ns	ns	AFF** (b=0.24±0.06)	39.0
Age at first farrowing	*	-	ns	*	ns	ns	-	-
Ave. age at farrowing, days	ns	**	ns	**	ns	ns	-	22.7
Farr. interval, days	ns	**	ns	ns	ns	ns	AFF** (b=0.24±0.06)	33.8
Litter size at birth								
- males	ns	ns	ns	ns	-	-	-	57.4
- females	ns	ns	*	ns	-	-	-	63.4
- total	ns	ns	ns	ns	-	-	-	41.7
Mummified pigs	-	-	-	-	-	-	-	-
Stillbirths	-	-	-	-	-	-	-	-
Piglet mortality	-	-	-	-	-	-	-	-
Weaning age, days	**	ns	ns	**	ns	**	-	14.5
Ave. pig weight (APW), kg								
- at birth	**	ns	**	ns	-	-	-	15.8
- at weaning	*	ns	-	ns	-	ns	-	27.2
- at 30 days old	ns	ns	ns	ns	**	ns	LSB** (b=-0.08±0.03)	21.4
- at 45 days old	**	ns	ns	ns	ns	ns	-	22.8
ADG, kg/day								
- Pre-weaning	**	ns	-	ns	-	ns	-	30.5
- 0-30 days old	**	ns	ns	ns	-	ns	APW30d** (b=0.03±0.00)	6.0
- 0-45 days old	*	ns	ns	ns	ns	ns	APW45d** (b=0.02±0.00)	5.7
- 30-45 days old	ns	ns	ns	ns	-	ns	APW30d** (b=-0.07±0.00) APW45d** (b=0.07±0.00)	0.5

Note: "- " means non-estimable; ns - not significantly different (P>0.05); * - significantly different (P<0.05); ** - highly significant differencs(P<0.01).
AFF = age at farrowing; LSB = litter size at birth; APW30d = average pig weight at 30 days old; APW45 = average pig weight at 45 days old.

Table 6. Breed standards (LSM ± SE) for farrowing and weaning traits in Black Tiaong and Kalinga native pig breeds.

Trait	Black Tiaong	Kalinga	Commercial swine farm average
	LSM ± SE	LSM ± SE	
Parity number ns	2.1 ± 0.1	2.1 ± 0.1	4.0 – 8.0 t
- at first farrowing *	647.8 ± 39.5	475.3 ± 42.4	384.0 t
- at second farrowing *	862.7 ± 50.2	641.2 ± 50.2	539.0 t
- at third farrowing ns	999.4 ± 52.6	999.9 ± 90.3	694.0 t
- at fourth farrowing ns	1154.8 ± 55.8	1095.4 ± 115.0	849.0 t
- at fifth farrowing ns	1398.4 ± 184.6	1187.7 ± 183.8	1004.0 t
- at sixth farrowing	-	1346.5 ± 184.5	1159.0 t
Farrowing interval, days ns	183.0 ± 21.9	141.5 ± 24.8	167.5
Litter size at birth			
- males ns	2.91 ± 0.14	2.50 ± 0.30	na
- females ns	2.80 ± 0.14	2.62 ± 0.29	na
- total ns	5.71 ± 0.19	5.11 ± 0.41	9.69
Mummified pigs §	0.01 ± 0.011	0.00 ± 0.00	0.28
Stillbirths §	0.13 ± 0.45	0.05 ± 0.31	0.46
Piglet mortality §	0.27 ± 0.64	0.07 ± 0.38	0.92
Weaning age, days **	38.5 ± 0.7	44.0 ± 1.0	28.4
Ave. pig weight (APW), kg			
- at birth **	0.82 ± 0.01	0.56 ± 0.02	1.46
- at weaning *	4.43 ± 0.22	3.77 ± 0.25	7.30
- at 30 days old ns	3.80 ± 0.07	3.56 ± 0.22	7.76
- at 45 days old **	5.01 ± 0.10	4.03 ± 0.14	na
Ave. daily gain (ADG), kg/day			
- Pre-weaning **	0.089 ± 0.005	0.067 ± 0.005	0.206
- 0-30 days old **	0.097 ± 0.001	0.101 ± 0.001	0.210
- 0-45 days old *	0.086 ± 0.000	0.088 ± 0.001	na
- 30-45 days old ns	0.069 ± 0.000	0.069 ± 0.000	na
Litter size at weaning	5.44	5.04	8.77
Farrowing index (FI)	1.99	2.58	2.18
Sow productivity index (SPI)	10.83	13.00	19.33

ns No significant difference between breeds (P>0.05),* Significant difference between breeds (P<0.05),
** Highly significant difference between breeds (P<0.01)
§ Not subjected to statistical analysis (i.e. LSM ± SE are actually unadjusted means ± std.dev.)
For commercial farm average (2012): "na" means not available; "t" means target.

Note: Litter size at weaning = Litter size born alive - Piglet mortality before weaning
Farrowing index (FI) = 365 ÷ Farrowing interval
Sow productivity index (SPI) = Litter size at weaning x Farrowing index

sows (15.8±1.4 months), or a difference of about half a year. However, the age of sow at farrowing in the native pig breeds were both older compared to the commercial swine farms' target of 384 days (or 12.8 months) only. Among the Black Tiaong litters, age of sow at farrowing was found to be positively correlated with litter size at birth (r=0.30), with average pig weight at birth (r=0.28), and with weaning age (r=0.37). On the other hand, age of Kalinga sows at farrowing was not correlated with the weaning traits.

Farrowing interval was not significantly different between breeds (P>0.05, CV=33.8%), although numerically was shorter in Kalinga (141.5±24.8 days) than Black Tiaong (183.0± 21.9 days). Farrowing interval in the native pig breeds was comparable to the 2012 average farrowing interval (167.5 days) in commercial swine farms in the Philippines (Calud *et al.*, 2012). Furthermore, farrowing interval was not related to any farrowing or weaning trait in both native pig breeds.

Litter Size and Average Pig Weight at Birth

Average litter size at birth (also litter size born alive) was slightly higher for Black Tiaong sows (5.71±0.19) than Kalinga sows' (5.11±0.41), although the difference was not statistically significant (P>0.05). While there was no significant difference in sex of the piglet in either breed, about 51.0% of the piglets born alive were males in the Black Tiaong, while Kalinga piglets born alive were mostly females (51.3%). Litter size in the native pig breeds were lower than the 2012 average of 9.69 piglets born in commercial hog farms in the Philippines (Calud *et al.*, 2012).

The average pig weight at birth was, however, significantly heavier (P<0.05, CV=41.7%) in Black Tiaong (0.82±0.01 kg) than Kalinga (0.56±0.2 kg) – both certainly lower than the 2012 average birth weight (1.46 kg) of commercial swine breeds (Calud *et al.*, 2012).

Litter size at birth was positively correlated with age of sow at farrowing (r=0.30) in the Black Tiaong breed. Similar phenotypic correlation (r=0.19) was reported by Akanno *et al.* (2013) based on the results their meta-analysis of reproduction and growth traits of pigs in the tropics. On the other hand, litter size at birth was negatively correlated with average pig weight at 30 days old (r=-0.38) and ADG from 0-30 days old (r=-0.41) in the Kalinga breed.

Mummified Piglets, Stillbirths, and Piglet Mortality Before Weaning

Only two mummified piglets (in Black Tiaong only) and 25 stillbirths were reported from among the 240 litters considered in the analysis. There were also 50 piglet deaths before weaning, mostly in Black Tiaong litters born during the first three years (i.e. 2011 - 2013) of establishing the native pig conservation farm at NSPRDC, BAI-DA, Tiaong, Quezon. Piglet mortality was due to crushing and weak, small size. These are equivalent to a maximum of 0.01 mummified pigs, 0.13 stillbirths, and 0.27 piglet deaths before weaning per litter. By contrast, the 2012 average number of mummified piglets (n=0.28), still births (n=0.46), and mortality before weaning (n=0.92 piglets) per litter in commercial swine farms (Calud *et al.*, 2012) were higher.

Since the number of mummified and still birth pigs, and number of pigs that die before weaning were small compared to the number of piglets born alive (i.e. 0.2%, 1.9%, and 3.7% of total piglets born alive, respectively), no statistical analysis was applied on them. The breed standards for these traits were thus estimated from their simple average and standard deviations.

Such breed standards were considered in determining the recommended age at weaning for the native pig breeds, which could be between 5 and 8 weeks of age (e.g., Akanno *et al.*, 2013). In addition to the average pig weight at different ages, the weaning age for native pigs should be at least 45 days. By comparison, the 2012 average weaning age (28.4 days) in commercial swine farms was lower (Calud *et al*, 2012).

Average Pig Weight (APW) and Average Daily Gain (ADG)

In general, average pig weights (APW) at different ages are positively correlated with one another, resembling the results presented by Akanno *et al*. (2013). APW is also positively correlated with ADG.

Average pig weights are generally heavier in Black Tiaong than Kalinga litters. Except for average pig weight (APW) at 30 days old, significant breed differences were also found for APW at weaning (P<0.05, CV=21.4%), and for ADG at 45 days old (P<0.01, CV=22.8%). The average pig weight at 30 days for the Black Tiaong breed (3.80±0.07 kg) and Kalinga breed (3.56±0.22 kg) are both lower than the 2012 average weaning weight at 30 days (7.76 kg) in commercial swine breeds (Calud *et al*., 2012).

Pre-weaning ADG for the Black Tiaong pigs (89 ± 5 g/day) was significantly higher (P<0.01, CV=30.5%) than Kalinga pigs (56 ± 5 g/day). This is also lower than the 2012 average pre-weaning ADG of 206 g/day in commercial swine farms (Calud *et al*., 2012). Significant breed differences (although with smaller CV values) were also noted surprisingly in favor of the Kalinga breed for ADG 0-30 days old (P<0.01, CV=6.0%), and for ADG 0-45 days old (P<0.05, CV=5.7%). No significant differences between breeds (P>0.05, CV=0.5%) were found for ADG 30-45 days old, which is about 6.9 g/day only.

Average Farrowing Index and Average Sow Productivity Index

Due to a longer farrowing interval in Black Tiaong than Kalinga, average farrowing index (FI) was lower in Black Tiaong (FI=1.99) than the Kalinga breed (FI=2.58). As a consequence, average sow productivity index (SPI) was lower in Black Tiaong (SPI=10.83) than Kalinga (SPI=13.00), despite the higher litter size at weaning in Black Tiaong (5.44 piglets) than Kalinga (5.04 piglets). Higher litter size at weaning (8.77 piglets), average FI (2.18 farrowing per sow per year), and average SPI (19.33 piglets weaned per sow per year) were reported in 2012 in commercial swine farms in the Philippines (Calud *et al*., 2012).

Data on farrowing and weaning performance including sow productivity index of native pig breeds reported here are important contributions to the limited technical information on native pig production in organic (extensive) husbandry systems in the Philippines. In particular, this study highlights the only advantage of the native pig breeds over the commercial breeds, which was the lower number of mummified piglets, stillbirths, and piglet mortality before weaning – an indication of the desirable adaptive characteristics of native pig breeds. Such information may be especially useful for local pig farmers targeting the high-end retail sector with increasing demand for organic livestock food products. For example, farrowing and weaning traits which are not significantly affected by breed differences may be improved by reducing environmental variation, e.g., development of new organic farm management technologies related to proper feeds and feeding, effective reproductive programs and animal health/welfare.

In relation to the NSPRDC's mission towards the promotion and use of native breeds to be raised in organic livestock farms, native pig breeds must be continuously raised in local organic (extensive) production systems to maintain their unique adaptive traits and natural behavior, and consequently justify their conservation, sustainable use and genetic improvement. Black Tiaong and Kalinga breeds may be maintained in closed herds, i.e. breeding replacements should be produced on the farm, so as to minimize the risk of importing diseases from elsewhere. Breed diversity in the native pig conservation farm can also be maintained, while allowing selection for desirable traits in each breed. Furthermore, a local regional marketing strategy should be developed to promote the special quality of pork products derived from the local pig breeds and protect their designations of origin or geographical indications (e.g., Bondoc, 2014).

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REFERENCES

Akanno EC, Schenkel FS, Quinton VM, Friendship RM and Robinson JAB. 2013. Meta-analysis of genetic parameter estimates for reproduction, growth and carcass traits of pigs in the tropics. *Livest Prod Sci* 152: 101-113.

Bondoc OL. 2008. *Animal Breeding: Principles and Practice in the Philippine Context*. University of the Philippines Press, Diliman, Quezon City. 386 pp.

Bondoc OL. 2014. Improvement of local breeds of smallholder livestock farmers in Southeast Asia. Book of Abstracts. *2nd International Conference on Agricultural and Rural Development in Southeast Asia*. 12-13 November 2014. Makati Shangri-La, Manila.

Bondoc OL. 2015. *Organic Livestock Farming and Breeding toward Food Security of Smallholder Farmers in the Tropics*. SEARCA Agriculture & Development Discussion Paper Series No. 2015-2. Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA), Los Baños. College, Laguna 4031 Philippines. 91 pp.

Calud AT, Apo LT, Villar EC and Guico AMB. 2012. Range of Performance of Swine in the Philippines 2012. In: *2012 Swine Production Performance in the Philippines*. Philippine Swine Industry Research and Development Foundation, Inc. (PSIRDFI) and PCAARD-DOST. Accessed on 01 July 2016 from http://www.swinefoundation.com.ph/production.

International Committee for Animal Recording (ICAR). 2000. Developing breeding strategies for lower input animal production environments. *Proceedings of a workshop held at Bella, Italy*. 22-25 September 1999. ICAR Technical Series 3. ICAR, Rome, Italy. 570 pp.

SAS Institute Inc. 2009. SAS/STAT ® 9.2 User’s Guide, second edition.