Relative Superiority Analysis of Garut Dam and Its Crossbred

I. INOUNU[1], SUBANDRIYO[1], B. TIESNAMURTI[1], N. HIDAJATI[1] and LA ODE NAFIU[2]

[1]*Balai Penelitian Ternak, PO Box 221, Bogor 16002*
[2]*Fakultas Pertanian Universitas Haluoleo, Jl. Abunawas III No 1, Kendari 93117*

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ABSTRAK

INOUNU, I., SUBANDRIYO, B. TIESNAMURTI, N. HIDAJATI dan L. O. NAFIU. 2005. Analisis keunggulan relatif domba Garut induk dan persilangannya. *JITV* 10(1): 17-26.

Untuk meningkatkan produktivitas domba Garut pada 1995, Balai Penelitian Ternak telah menyilangkan domba Garut (GG) dengan domba *St. Croix* (HH) yang mempunyai ukuran tubuh yang besar dan daya tahan terhadap cuaca panas dan lembab; dan dengan *Moulton Charollais* (MM) pada tahun 1996, yang mempunyai daya tumbuh yang tinggi dan produksi susu yang cukup untuk memelihara anak kembar. Penelitian ini bertujuan mengevaluasi produktivitas induk domba Garut dan persilangan dengan *St. Croix* dan *M. Charollais*. Penelitian dilaksanakan di Stasiun Penelitian Ternak, Bogor mulai tahun 1995 sampai 2002. Persilangan dilakukan menggunakan semen beku dari pejantan MM dan HH sehingga performans kedua domba impor ini pada kondisi di Indonesia tidak diketahui. Sehingga keunggulan relatif dihitung berdasarkan persentase perbedaan antara rataan sifat-sifat domba hasil persilangan dengan domba GG dibagi dengan rataan sifat-sifat domba GG, kecuali untuk domba persilangan tiga bangsa (MHG dan HMG) dihitung berdasarkan perbedaan antara rataan sifat-sifat domba MHG dan HMG dengan rataan sifat-sifat tetuanya (MG dan HG). Hasil dari penelitian ini adalah bahwa domba HG dan MHG memperlihatkan produktivitas induk yang lebih tinggi dibandingkan domba GG, dilihat dari total bobot hidup anak saat lahir dan saat sapih. Pada kondisi pakan buruk GG memperlihatkan produktivitas yang lebih tinggi dibandingkan hasil persilangannya (MG dan HG), tetapi MHG/MHG memperlihatkan keunggulan relatif yang lebih tinggi dibandingkan tetuanya (MG dan HG). Pada kondisi pakan baik HG dan MHG/HMG menunjukkan produktivitas yang lebih tinggi dibandingkan domba GG. Nilai keunggulan relatif domba HG adalah 26,40% dari domba GG dan untuk domba MHG/HMG adalah 11,24% dari tetuanya (MG dan HG).

Kata Kunci: Domba Garut, Domba *St. Croix*, Domba *M. Charollais*, Keunggulan Relatif

ABSTRACT

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In attemp to increase the productivity of Garut sheep, Indonesian Research Institute for Animal Production has crossed Garut sheep (GG) with St. Croix sheep (HH) that has high frame body size and adaptable to the hot climate (in 1995) and with Moulton Charollais sheep (MM) that has high body weight gain and good milk production to raise multiple birth (in 1996). The objective of this research was to evaluate the ewe productivity of Garut sheep and its crosses with St. Croix and Moulton Charollais. This research was conducted at Animal Research Station, Bogor from 1995 to 2002. In this study the crossing was done using frozen semen of M. Charollais and ram of St. Croix so that the real performance of these sheep under Indonesian condition is not known. So that the relative superiority of these crosses is calculated from the percentage of the differences between traits mean of crossbred and purebred divided by trait means of purebred Garut, except for the threeway crosses (MHG and HMG) is calculated from the difference between the means of threeway crossbred trait with the means of two parents (MG and HG). It is concluded that HG and MHG show higher dam productivity than GG, it can be seen from their litter weight at birth and weaning. In poor feed condition GG showed higher productivity than the crossbred sheep (MG and HG), but MHG/MHG showed higher relative superiority compare to their parents (MG and HG). In good feed condition HG and MHG/HMG sheep showed higher productivity than Garut sheep. The relative superiority of HG sheep is 26.40% over GG and for MHG/HMG is 11.24% over their parents (MG and HG).

Key Words: Garut Sheep, St. Croix Sheep, M. Charollais Sheep, Relative Superiority

INTRODUCTION

Sheep in Indonesia can be classified based on the type of tail, namely thin and fat tailled sheep. Most of the thin tailled sheep can be found in West Java known as Garut sheep. Some scientists named this breed as Javanese Thin Tailled sheep. Fat tailled sheep are scattered around East Java, known as Javanese Fat Tailled sheep (DEVENDRA and MC LEROY, 1982). Garut sheep is originated from three different breeds: Merino, Kaapstad and local sheep (MERKENS and SOEMIRAT, 1926). Garut sheep is known as one of the prolific sheep in the world (BRADFORD and INOUNU, 1996), controlled by single gene FecJ and the same gene is found in Garole sheep (ELSEN *et al.,* 1991; DAVIS *et al*., 2002). It might be transmitted from Garole sheep brought by Arabian trader about two centuries ago. This sheep is well adapted to the local condition especially in West Java. Garut sheep is able to reach puberty at early age (SUTAMA *et al.,* 1988; SUTAMA, 1992), estrus can occur all year long so that lambing can happen any time along the year, and post-partum estrus occurs at one month after lambing. Moreover, this sheep is resistant to the internal parasites (FLETCHER *et al.,* 1985; DIWYANTO and INOUNU, 2000).

Under rural condition, Garut sheep are generally raised in small scale as additional sources of income (BRADFORD and INOUNU, 1996). Consequently farmer put less attention to their animal especially in providing feed. Therefore the prolific trait of this sheep is not advantageous to farmers, since the pre-weaning mortality rate is high and growth rate is low (INOUNU *et al.*, 1999). So, to reach an ideal slaughter weight of 35 kg it needs a longer time and a higher input than the non-prolific sheep.

One of the efforts in improving the productivity of local sheep is done by introducing St. Croix blood. This sheep is known to have a big frame size and high adaptability to hot climate and poor feed condition. In 1996 another blood was introduced through AI, when frozen semen of Moulton Charollais were imported. This sheep was famous for its milk production, big body size and high growth rate. The crossbreeding then was done to create composite sheep which has three blood with the composition of 50% Garut, 25% St. Croix and 25% Moulton Charollais. It is expected that the composite sheep resulted from this study will have high: growth rate, body weight and litter size to get higher ewe productive performance.

MATERIALS AND METHOD

This study was done from 1995 to 2002, in the Sheep Research Station of The Indonesian Research Institute for Animal Production located on Jl. Raya Pajajaran, Bogor. Data collected consisted of mating between Garut and the introduced breeds (St. Croix and M. Charollais) and mating of the pure Garut as control treatment.

In 1995 three rams of St. Croix sheep were mated to 70 dams of Garut sheep to produce HG sheep (50% St. Croix and 50% Garut). In 1996, 100 dams of Garut sheep were inseminated with frozen semen (produced from 3 rams) of Moulton Charollais to produce MG sheep (50% M. Charollais and 50% Garut). The offsprings at one year of age then were selected and male MG was mated to female HG to produce composite breed of MHG (50% Garut, 25% St. Croix and 25% M. Charollais). Besides, male HG was mated to female MG to produce HMG (50% Garut, 25% St. Croix and 25% M. Charollais). Garut Sheep was also mated between them as a control.

Rams and ewes were given 3-4 kg chopped King grass head^{-1} day^{-1} or about 10% of body weight. Concentrate was given 2.0-2.5% of body weight, based on the physiological status. At 14-week of gestation period the concentrate was increased to 1100 g ewe^{-1} day^{-1}. At 4 week post-partum the concentrate was given 2.5% of ewe body weight, to maintain milk production and at the same time lambs started to eat concentrate. Shortage of feed given to the animal happened in the year of 2001 and 2002 due to very long dry seasons. The roughage fed to the animal only 60% of normally given. At the same time the amount of concentrate given was also reduced up to 10% of the normally fed. Based on the above condition, the sheep management was differentiated as namely (1) poor feed supply and (2) good feed supply.

Data analysis

Traits observed for this study were litter size, litter weight at birth, survival rates and litter weight at weaning. Ninety days of age was used to make a correction factor for weaning weight for having different age at weighing time. The formula used was:

$$Wt_i = Wt_j + (t_i - t_j) * (Wt_k - Wt_j) / (t_k - t_j)$$

where:

Wt_i = lamb body weight at day t_i , t_i = 90 day
Wt_j = lamb body weight at day t_j, $t_j < t_i$
Wt_k = lamb body weight at day tk, $t_k > t_j$.

Corrected body weight at 90 days of age then were used in making calculation for litter weight at weaning.

Data obtained were unequal; therefore the data was analyzed using least square model for unbalanced data (SEARLE, 1987) and General Linear Model (GLM) procedure (SAS, 1998) was applied in data analysis. Trait means presented are least square means that have been corrected by the significant fixed effect. Genotypes, feed condition, parity, genotype by feed condition interaction are considered as fixed effect. Ewe body weight was recorded prior to mating time and was included in the model as a covariate. The model used is as presented in Table 1.

Analysis of relative superiority of crossbred sheep

The aim of the crossing is not only to combine the superior trait of the parents but also to obtain heterosis or the hybrid vigor, which is the difference between the means of crossbred trait with the means of two purebred parents. In this study the crossing was done using frozen semen of M. Charollais and ram of St. Croix so that the real performance of these sheep in Indonesian condition is not known. So that the relative superiority of these crosses is calculated from the percentage of the differences between trait means of crossbred and purebred divided by trait means of purebred Garut, as seen in the following equation:

$$RS_{XP}\,(\%) = \frac{\overline{XG} - \overline{GG}}{\overline{GG}} \times 100\%$$

$$RS_{XP1}\,(\%) = \frac{\dfrac{\overline{MHG} + \overline{HMG}}{2} - \dfrac{\overline{HG} + \overline{MG}}{2}}{\dfrac{\overline{HG} + \overline{MG}}{2}} \times 100\%$$

where:

RS_{XP} = Relative superiority for two way crosses (MG/HG)

RS_{XP1} = Relative superiority for three way crosses (MHG/HMG)

$\overline{XG}$ = Trait means of crossbred (MG and HG)

$\overline{GG}$ = Trait means of purebred Garut sheep

$\overline{MHG}/\overline{HMG}$ = Trait means of three way crosses

RESULTS AND DISCUSSION

Table 2 presents the number of observations, least square means of litter size, total litter weight at birth, survival rate and litter weight at weaning based on genotypes, feed condition and its interaction, parity of the dam as well as ewe body weight at mating.

Litter size

Population means of litter size from this study is 1.85 ± 0.91 lambs/dam (n = 1,151), with coefficient of variation 49.04%. This result is higher than that of INOUNU (1996) for Garut sheep of 1.70 ± 0.64 lambs/dam. This higher litter size might be resulted from the high frequency of $FecJ^F$ gene found in Garut sheep that has undergone selection for some generations in the previous research (INOUNU *et al.,* 1999). DOLOKSARIBU *et al.* (2000) found that the litter size of Sumatran crossbred with hair sheep (St. Croix and Barbados Black Belly) was 1.52 ± 0.04 lambs/dam.

The litter size found in this study varied between 1 to 6 lambs with the distribution of 42.42, 36.93, 15.42, 5.23% respectively for singles, twins, triplets and quadruplets or more lambs (Table 3). In this study there was 5.23% dams with litter size of four up to six. Ewes with litter size of six were found in Finn, D'Man, Booroola Merino and Cambridge sheep but always followed by high mortality rate at the first week of life (BINDON and PIPER, 1986; MAIJALA, 1996).

The highest proportion of litter size of two and three was found in the HG genotype respectively 38.01 and 21.27% and produced litter size of 2.01 ± 0.06 and it was significantly higher (P<0.01) than other crossbred. Performance of crossbred sheep with St. Croix in general has higher litter size than the purebred. Rambouillet x St. Croix in Utah, USA, had litter size of 1.44 while pure Rambouillet only 1.36 lambs/dam (FOOTE, 1983). Similar results was found by POND *et al.* (1991) that reported the litter size of Suffolk was 1.78 while the crossed to St. Croix had 2.00 lambs/dam.

Litter size was also affected by feed condition, parity and interaction between feed condition and genotypes (Table 2). In good feed condition litter size reached 1.92 ± 0.07 lambs/dam, significantly higher than litter size from poor feed condition: 1.67 ± 0.03 lambs/dam. This result is in line with HOHENBOKEN and CLARCKE (1981) for Finn sheep, higher litter size was found in irrigated areas than in the mountain area. Results from study conducted in Central for Agricultural and Livestock Research in Grenbel Canada, on Arcott sheep, showed that litter size in June was 2.30 ± 0.02, higher than in February and October, that was 2.20 ± 0.02 (HANSEN and SHRESTHA, 2002). Study on Alpine and Nubian goats in Venezuela resulted 1.34 ± 0.05 lambs/dam during rainy season compare to 1.29 ± 0.05 lambs/dam during dry season.

In general all genotypes of sheep produced higher litter size in the improved feed condition. HG genotype shows higher increase in litter size in the improved feed condition compared to other genotypes.

Table 1. Traits, effects and model analyzed

Traits observed	Fixed effect					N
	$B_{(i)}$	$F_{(j)}$	$P_{(k)}$	$BxF_{(l)}$	EBW	
Litter size (No.)	x	x	x	x	x	1,151
Litter weight at birth (kg)	x	x	x	x	x	1,148
Lambs survival rate (%)	x	x	x	x	x	1,148
Litter weight at weaning (kg)	x	x	x	x	x	1,148

B: effect of i^{th} genotype i = (GG), (MG), (HG), (MHG) dan (HMG); j: F: effect of j^{th} feed condition j = 1 (Poor), 2 (Good); P: effect of k^{th} ewe parity k = 1, 2, ≥3; BxF = Interaction between B and F; EBW = ewe body weight at mating as covariate; N = number of observations; x = independent variable included in the model

Table 2. Number of observations (N), means of litter size, litter weight at birth, survival rate and litter weight at weaning

Independent variable	Litter size		Litter weight at birth		Survival rate (%)		Litter weight at weaning	
	n	means	n	means	n	means	n	means
Means	1151	1.85 ± 0.91	1148	4.87 ± 1.38	1148	78.12 ± 34	1148	16.69 ± 8.18
Genotypes:		**		**		ns		**
GG	596	1.91 ± 0.04[bc]	593	4.72 ± 0.06[a]	593	78.47 ± 1.44	593	17.09 ± 0.71[a]
MG	131	1.60 ± 0.08[ab]	131	4.79 ± 0.12[a]	131	77.77 ± 3.06	131	16.41 ± 0.33[a]
HG	220	2.01 ± 0.06[c]	220	5.50 ± 0.09[c]	220	79.39 ± 2.37	220	19.43 ± 0.55[b]
MHG	145	1.76 ± 0.08[b]	145	5.16 ± 0.11[b]	145	79.53 ± 2.91	145	19.92 ± 0.67[b]
HMG	56	1.45 ± 0.12[a]	56	4.69 ± 0.18[a]	56	77.88 ± 4.69	56	17.69 ± 1.08[ab]
Feed conditions:		**		**		ns		**
Poor (1)	315	1.67 ± 0.05[a]	312	4.67 ± 0.08[a]	312	77.28 ± 1.98	312	14.20 ± 0.46[a]
Good (2)	836	1.92 ± 0.03[b]	836	4.94 ± 0.05[b]	836	78.43 ± 1.21	836	17.79 ± 0.28[b]
Parity:		**		**		ns		**
1	427	1.74 ± 0.04[a]	427	3.97 ± 0.07[a]	427	79.00 ± 1.70	427	15.96 ± 0.40[a]
2	275	1.90 ± 0.06[b]	273	4.53 ± 0.08[b]	273	79.90 ± 2.12	273	17.09 ± 0.50[ab]
≥3	449	1.93 ± 0.04[b]	448	4.84 ± 0.07[c]	448	76.40 ± 1.66	448	17.14 ± 0.39[b]
Genotypes x feeds:		**		**		ns		**
GG 1	107	1.84 ± 0.97[b]	104	4.58 ± 0.13[a]	104	76.75 ± 3.43	104	14.93 ± 0.78[b]
MG 1	39	1.46 ± 0.64[a]	39	4.53 ± 0.22[ab]	39	75.36 ± 5.61	39	12.10 ± 1.28[a]
HG 1	68	1.60 ± 0.78[ab]	68	4.67 ± 0.16[ab]	68	74.15 ± 4.25	68	14.66 ± 0.97[ab]
MHG 1	74	1.70 ± 0.74[ab]	74	5.04 ± 0.16[b]	74	74.66 ± 4.07	74	15.64 ± 0.93[b]
HMG 1	27	1.41 ± 0.84[a]	27	4.18 ± 0.26[a]	27	70.22 ± 6.74	27	12.53 ± 1.54[a]
GG 2	492	1.92 ± 0.91[b]	492	4.70 ± 0.06[b]	492	80.93 ± 1.58	492	16.35 ± 0.36[b]
MG 2	92	1.65 ± 0.91[a]	92	4.79 ± 0.14[bc]	92	77.93 ± 3.65	92	16.24 ± 0.83[b]
HG 2	152	2.20 ± 1.00[c]	152	5.76 ± 0.11[d]	152	80.82 ± 2.84	152	20.67 ± 0.65[c]
MHG 2	71	1.82 ± 0.98[ab]	71	5.05 ± 0.16[c]	71	82.79 ± 4.16	71	20.25 ± 0.95[c]
HMG 2	29	1.48 ± 0.69[a]	29	4.96 ± 0.25[bc]	29	83.12 ± 6.50	29	20.82 ± 1.49[c]
Ewe body weight at mating		0.04[ns]		0.04[ns]		-0.045[ns]		0.046[ns]

Values in same column for each traits with different superscripts differ (P<0.05)
** significantly different at P<0.01; ns = not significantly different (P>0.05)

Table 3. Distribution of litter size (%) from different genotypes

Genotypes	Distribution of litter size			
	1	2	3	4
Garut	38.43	39.09	15.77	6.21
M. Charollais x Garut (MG)	57.25	30.53	9.16	3.05
St. Croix x Garut (HG)	34.39	38.01	21.27	3.62
MG x HG (MHG)	44.83	39.31	12.41	2.76
HG x MG (HMG)	69.64	17.86	10.71	1.79
Means	42.42	36.93	15.42	5.23

In good feed condition HG genotype showed superiority to other genotypes with the relative superiority of 0.28 lambs/dam or 14.6% over pure Garut (Tabel 4). On the other hand in poor feed condition HG genotype showed lower litter size 0.24 lambs/dam than Garut or –13.1%. This is an indication that feed condition has great impact on the productivity of HG genotype. Therefore in order to obtain maximum productivity of this sheep good feed condition should be provided, especially when this sheep is raised as commercial sheep. The 2.01 lambs/dam of mean litter size of HG dam as the results of the crossing is very important to be maintained, since this trait gives high contribution to the productivity of dam in terms of litter weight at birth or litter weight at weaning.

The mean litter size of St. Croix in Florida, USA was 1.40 with 71% survival rate, while its crossbred to the local Florida sheep produced 1.20 with 96% survival rate. Moreover, it was found that St. Croix crossed in Ohio produced 1.72 lambs/dam. The research in North Carolina found that St. Croix crossed to Dorset and Suffolk produced litter size of 1.50 and 2.00 lambs/dam respectively (POND *et al.*, 1991).

All crossbred sheep showed lower litter size in both good and poor feed condition except HG. This result is in agreement with BOUJENANE and KANSARI (2002) that for composite of D'Man and Lacauna in the blood composition of 50:50 and 75:25 produced lower litter size than the pure D'Man.

The litter size of all genotypes increases as the parity of the dam increase. The highest litter size produced in third parity or beyond: 1.93 ± 0.04, significantly higher than litter size from first parity: 1.74 ± 0.04 lambs/dam (Table 2). This result is similar to that of Romanov sheep reported by FAHMY (1996). During lifetime productivity HG genotype produced relatively higher litter size compared to pure Garut. This higher litter size is produced in the first up to the third parity or beyond. On the other hand other genotype (MG, MHG, and HMG) produced lower litter size than pure Garut.

Litter weight at birth

The mean litter weight at birth resulted from this research is 4.87 ± 1.38 kg/dam with coefficient of variation 28.39% (n = 1,148) (Table 2.). This result is higher than that reported by INOUNU *et al*. (1999) and INIGUEZ *et al.* (1991) for Garut (3.43 ± 1.00 kg) and Sumatran (2.74 kg) respectively. This high litter weight resulted in this study is caused by the crossing of Garut ewes to St. Croix and Moulton Charollais rams, and in line with the result of crossbred between Sumatran and St. Croix reported by DOLOKSARIBU *et al.* (2000).

Genotypes significantly (P<0.01) affected litter weight at birth. The highest litter weight at birth is 5.50 ± 0.09 kg produced by HG genotype and it is significantly higher than other genotypes. While MHG genotype produced litter weight at birth 5.15 ± 0.10 kg, it is significantly higher (P<0.01) than that of Garut, MG and HMG (Table 2). DOLOKSARIBU *et al*. (2000) also reported this superiority of St. Croix cross at litter weight at birth.

Litter weight at birth was not only affected by genotypes but also affected by feed condition, parity, and interaction between genotypes and feed condition (Table 2).

In general the litter weight at birth produced by all genotypes increased as the feed condition become better. The result obtained in this research is in agreement with that of reported by HANSEN and SHRESTA (2002) that litter weight at birth produced by Arcott sheep in Canada at three lambing seasons: February, June, and October respectively 8.50 ± 0.06; 8.40 ± 0.06 and 7.50 ± 0.06 kg/dam. Prolific Garut sheep produced litter weight at birth of 4.04 ± 0.07 kg/dam in good feed condition, higher than that produced in medium feed condition: 3.52 ± 0.04 and that produced in poor feed condition: 3.48 ± 0.06 kg/dam (INOUNU *et al.*, 1999).

Tabel 4. Relative superiority (RS) on litter size (%) from sheep of different genotypes in different feed condition

Genotypes	Feed conditions	
	Poor	Good
	RS (%)	RS (%)
MG	-20.7[a]	-14.1[a]
HG	-13.1[a]	14.6[a]
Threeway crosses (MHG or HMG)	1.63[b]	-14.3[b]

[a]Relative superiority to Garut sheep, [b]Relative superiority to MG and HG

The HG and HMG genotypes showed a drastic increase in litter weight at birth when raised in improved feed condition compared to other genotypes especially Garut. In good feed condition HG produced the highest litter weight at birth: 5.76 ± 0.11 kg/dam, significantly higher than Garut, MG, MHG, and HMG: 4.70 ± 0.06; 4.79 ± 0.14; 5.05 ± 0.16 and 4.96 ± 0.25 kg/dam respectively. This rank of litter weight at birth changed when the dams were raised in poor feed condition. In this condition MHG produced the highest litter weight at birth (5.04 ± 0.16) and significantly higher than Garut (4.58 ± 0.13), HMG (4.18 ± 0.26 kg/dam) but not significantly different from HG.

Relative superiority on litter weight at birth per dam of sheep on different genotypes and feed condition is presented Tabel 5.

When it is assumed that the difference in performance of crossbred genotypes to purebred of Garut or to the twoway crossed is a relative superiority, then table 5 shows the shift of relative superiority of crossbred genotypes in different feed condition. BARLOWE (1981) reported that generally the growth trait in beef cattle showed maximum heterosis when raised in good feed condition. But if the percentage is calculated, poor feed condition resulted in higher proportional of heterosis.

During lifetime productivity, HG and MHG were more consistent in producing higher litter weight at birth than Garut (Figure 1).

The litter weight at birth increased as the parity becomes higher. The highest increase (14.11%) was achieved from first to second parity. SINGH *et al*. (1985) reported that total litter weight at birth from second parity and beyond (3.20 kg) was higher than litter weight at birth from first parity (2.78 kg).

Tabel 5. Relative superiority (RS) on litter weight at birth per dam of sheep on different genotypes in different feed condition

Genotypes	Feed condition			
	Poor		Good	
	Litter weight at birth (kg)	RS (%)	Litter weight at birth (kg)	RS (%)
MG	4.53	-1.1[a]	4.79	1.9[a]
HG	4.67	1.9[a]	5.76	22.6[a]
Threeway crosses (MHG or HMG)	4.61	0.21[b]	5.01	-5.11[b]

[a]Relative superiority to Garut sheep, [b]Relative superiority to MG and HG

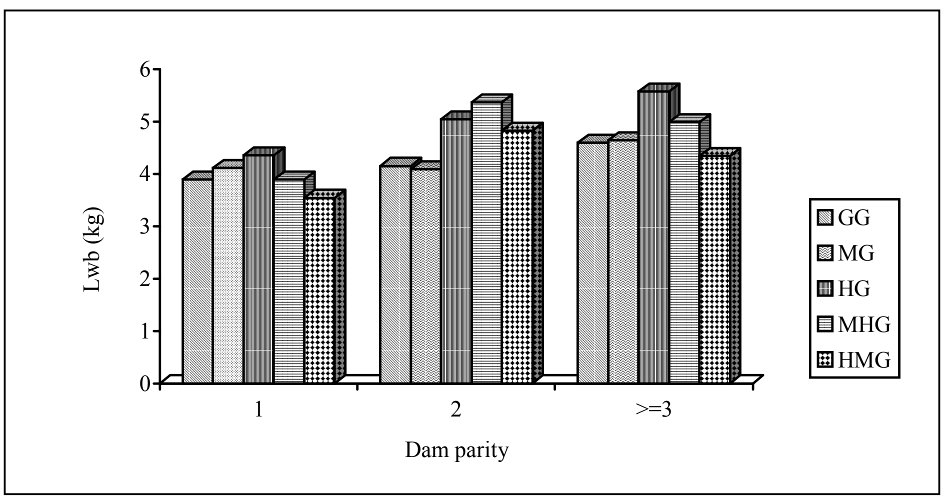

Figure 1. Litter weight at birth (Lwb, kg) on different dam parity

Survival rate

The survival rate resulted from this research was 78.12 ± 34% with the coefficient of variation 43.76% (n= 1,148; Table 2). This result is higher than that of prolific Garut sheep: 73.93 ± 34.26 (INOUNU, 1996), but it is lower than Sumatran and its crosses to St. Croix and Barbados Blackbelly at second generation that reached 81.1% (DOLOKSARIBU *et al.*, 2000). FITZHURGH and BRADFORD (1983) observed Barbados Blackbelly in Africa and America found that their survival rate reached 78.5%, while St. Croix in Virginia Island reached survival rate of 85% (WILDEUS *et al.*, 1991). D"Man, Lacaune and Timahdite sheep and their crosses had survival rate ranged from 75 to 88%. The highest survival rate of those sheep was related to the high individual birth weight that ranged between 2.76 ± 0.02 to 3.96 ± 0.04 kg/head (BOUJENANE and KANSARI, 2002).

Survival rate is highly related to prolificacy of the dam. Garut sheep bear low prolificacy can rear their lambs up to weaning time with survival rate of 84.32 ± 1.68%. This rate then become 71.95 ± 1.63% for dam with medium prolificacy and only 59.18 ± 2.22% for dam with high prolificacy (INOUNU, 1996). SHRESTHA *et al.* (1992) reported that increase of litter size caused the decease of survival rate. Dams borne single lamb can wean their lamb with 84% survival rate. This rate decrease as the litter size increase and at litter size of 5 the rate reached 55% only. Low survival rate is the consequences of low individual birth weight. Small lambs usually have difficulty to stand up and also in getting colostrums. Colostrums is the important factor in increasing survival rate. According to OWENS *et al.* (1985) lamb with high birth weight will be able to stand up and suckle as soon as they were born so that their survival rate increase.

No significant effect of genotype, feed condition, parity and dam body weight on survival rate (Tabel 2). This is the proof of the superiority trait of this sheep that is highly adapted to smallholder management practice. High survival rate will contribute high litter weight at weaning. Based on the result above it is assumed that this crossbred are potential sheep to be more developed as a new breed and it can be distributed as meat type sheep provided management practice is improved.

Litter weight at weaning

The mean litter weight at weaning in this study was 16.69 ± 8.18 kg/dam with coefficient of variation 49.03% (Table 2). This is higher than that of: Sumatran, reported by INIGUEZ *et al.* (1991): 11.45 kg; prolifik Garut, reported by INOUNU *et al.* (1999): 13.12 ± 4.33 kg; F2 Sumatran cross: 11.69 kg (DOLOKSARIBU *et al.*, 2000). Compare to the cross of St. Croix, Suffolk and Targhee in Illinois USA (BUNGE *et al.*, 1995), the litter weight at weaning found in this research is lower (24.8 kg vs. 16.69 kg). St. Croix cross in Ohio USA produced litter weight at weaning 18.8 kg/dam (MC. CLURE and PARKER, 1991) while it is for D'Man and Timahdite: 17.77 ± 0.34 and for Lacauna and D'Man cross 22.9 ± 0.55 kg/dam (BOUJENANE and KANSARI, 2002). In this study high litter weight at weaning is contributed by crossbred sheep.

Crossbred sheep HG and MHG produced the highest litter weight at weaning 19.43 ± 0.55 and 19.92 ± 0.67 kg/dam, respectively and it is significantly higher than that of purebred Garut and HMG (Table 2). GATENBY *et al.* (1997) reported that St. Croix ram crossed to Sumatran produced higher litter weight at weaning than that of Sumatran. Moreover DOLOKSARIBU *et al.* (2000) reported that the F2 of St. Croix ram crossed to Sumatran produced 9.6 ± 0.2 while the indigenous Sumatran produced only 6.9±.2 kg/dam.

Productive efficiency of the dam is calculated based on the ratio of dams' litter weight at weaning and their body weight at mating. The average of productive efficiency resulted from this study is 0.53, higher than that of Sumatran 0.52, Dorset 0.41, Finn sheep 0.42 (INIGUEZ *et al.,* 1991) and it is close to prolific Garut's 0.55 (INOUNU, 1996). HANSEN and SHRESTHA (2002) reported the productive efficiency of Arcott sheep was 0.796, 0.766 and 0.774 for those that born in February, June and October respectively. That was higher than that of this study. Productive efficiency of HG (0.59) is higher ($P<0.01$) than that of MG (0.46) but not significantly different from that of Garut (0.58), MHG (0.58) and HMG (0.51).

Litter weight at weaning was significantly affected by feed condition, parity, and the interaction between feed condition and genotype of sheep (Table 2.). The mean of litter weight at weaning in poor feed condition was 14.2 ± 0.46, while in good feed condition it was 17.79 ± 0.25 kg/dam. This result is in line with that of HANSEN and SHRESTHA (2002) for Canadian local sheep. They reported that the litter weight at weaning from February lambing season was higher than that of from June and October.

Tabel 6, generally shows that litter weight at weaning increase as the feed condition improved. On the contrary, litter weight at weaning of HG and HMG were badly affected by the decline of feed condition. Therefore these sheep should be given more attention since they could produce higher litter weight at weaning compare to other genotypes.

Tabel 6. Relative superiority of litter weight at weaning of sheep of different genotype in different feed condition

Genotypes	Feed condition			
	Poor		Good	
	Litter weight at weaned (kg)	RS (%)	Litter weight at weaned (kg)	RS (%)
MG	12.10	-19.00[a]	16.24	-0.70[a]
HG	14.66	-1.80[a]	20.67	26.40[a]
Threeway crosses (MHG or HMG)	14.09	5.27[b]	20.53	11.24[b]

[a]Relative superiority to Garut sheep, [b]Relative superiority to MG and HG

The relative superiority of crossbred sheep over purebred Garut is affected by feed condition. In good feed condition relative superiority of HG to Garut sheep, and the threeway crosses (MHG or HMG) to MG and HG sheep in term of litter weight at weaning are 26.4; and 11.24; on the other hand MG has negative relative superiority (-0.7%) over Garut. In bad feed condition all MG and HG genotypes have negative response of litter weight at weaning than their parents did with –19.0 and -1.80 of relative superiority, respectively. While the threeway crosses MHG or HMG in poor feed condition has 5.27% of relative superiority. DOLOKSARIBU *et al.* (2000) reported that the relative superiority of Barbados Blackbelly x Sumatra and St. Croix Sumatra crosses were declined when exposed to poor feed condition.

Based on litter weight at weaning regardless of feed condition, HG and MHG or HMG were superior compared to Garut, with 13.69 and 8.21% of relative superiority, respectively. On the other hand MG has 3.98% lower than Garut do. BOUJENANE and KANSARI (2002) found that the composite of D'Man x Lacauna at the blood composition of 50%: 50% and 75%: 25% produced lower litter weight at weaning than pure D'Man with 2.14 and 5.56% respectively.

Although the litter weight at weaning produced by crossbred in this research, especially HG and MHG (Figure 2), is still fluctuated among parity of the dam but along their lifetime productivity from first to third parity or beyond, they consistently showed higher relative superiority over Garut. It is assumed that HG, which is the crossbred between St. Croix ram and Garut dam, has combining ability or breed complementary so that it can produce higher litter weight at both birth and weaning compared to pure Garut and MG. It might also be the case for MHG that is the cross between male MG and female HG (25% M. Charollais; 25% St. Croix and 50% Garut) make a perfect combination between the three breeds. Garut sheep inherits the ability to adapt to the local nature, while St. Croix sheep has the trait of high heat resistance and big frame size, and M. Charollais inherits the trait of high body weight gain.

Based on litter size and litter weight at both birth and weaning, HG and MHG show the strong indication that they are good sheep to be further developed into a new breed of meat sheep and later be released to farmer. In order to get the maximum relative superiority of these breeds an intensive management practice should be applied especially in feed management. High quality of roughage should be given minimally 10% of body weight; high quality concentrate should be given 2% of body weight; especially to the pregnant and lactating dams.

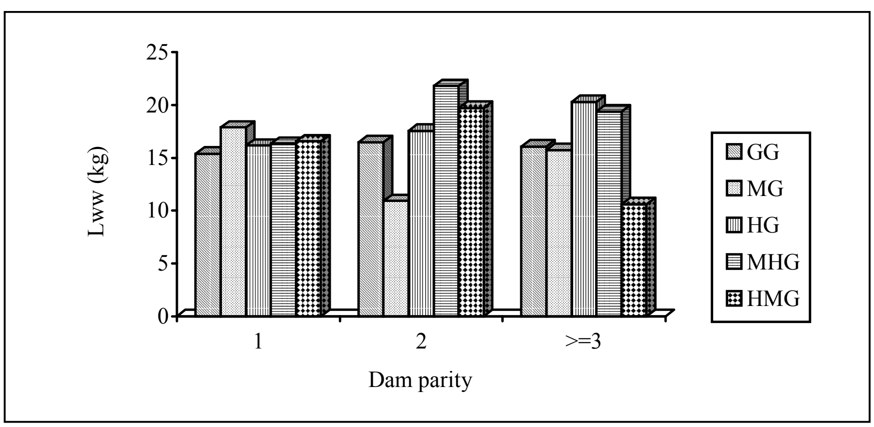

Figure 2. Litter weight at weaning (Lww, kg) based on dam parity

CONCLUSION

It is concluded that HG and MHG show higher dam productivity than pure Garut breed, it can be seen from their litter weight at birth and weaning. In poor feed condition Garut sheep showed higher productivity than the crossbred sheep (MG and HG), but threeway crossed sheep (MHG or MHG) showed higher relative superiority compare to their parents (MG and HG). In good feed condition HG and the threeway crossed sheep (MHG and HMG) showed higher productivity than Garut sheep. The relative superiority of HG sheep is 26.40% over GG and for the threeway crossed is 11.24% over their parents (MG and HG). It is concluded that crossbred sheep should be raised under good feed condition in order to get a maximum production performance.

It is advisable that HG and MHG are further developed into a new composite meat type sheep breed with application of intensive management.

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