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Effects of dam's parity on growth performance, carcass characteristics and economic efficacy of Hanwoo steers

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어미의 산차가 거세 한우의 성장, 도체 특성 및 경제성에 미치는 영향

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Abstract This study was conducted to determine the effects of dam parity on the growth performance, carcass characteristics, and economic efficacy of Hanwoo steers. 344 Hanwoo calves were divided into five groups based on dam parity (1-2, 3-4, 5, 6, and ≥ 7). Dam's concentrates feed and roughage were feed twice per day and water was freely available. Calf-starter and roughage were provided one week after birth. Calves and dams were managed in the same pens until the pre-weaning stage and other feeding management was conducted in accordance with the practices of the Gangwon Livestock Technology Research Institute. ADG was higher in the 5 and 6 parity groups compared to the ≥ 7 parity group throughout the experiment (p〈0.05). Wither height, rump height, chest girth, and pelvic width of calves at birth showed a positive correlation with dam parity (p〈0.05). Body weight and all body conformation traits of 3-month-old calves had positive correlations with dam parity (p〈0.05). Net income was higher in the 3-4, 5, and 6 parity groups compared to the 1-2 parity group. Therefore, this study suggests extending the dam parity of Hanwoo cows from the current 2.5 to 5 or 6, considering the increased birth weight, growth performance, and farmer's net income.

요 약 본 연구는 어미의 산차가 거세한우의 성장, 도체 특성 및 경제성에 미치는 영향을 구명하기 위해 수행 되었다. 공시동물은 1-7산차의 한우 번식우에서 태어난 송아지 344두를 공시 하였으며, 처리구는 1-2산차, 3-4산차, 5산차, 6산차, 7산차 이상으로 처리하였다. 시험축의 사양관리는 암소의 경우 1일2회 사료를 제공하였으며, 물은 자유롭게 섭취 할 수 있도록 하였다. 송아지는 출생 1주일뒤 송아지 스타터 및 조사료를 급이하였고, 어미와 송아지는 이유 전단계(3개월령)까지 동일한 우방에서 관리하였으며, 그 외 관리는 강원도 축산기술연구원의 관행에 따라 실시하였다. 전체 시험기간 동안 한우 송아지의 일당증체량은 7산차 이상의 그룹에 비해 5 및 6산차 그룹에서 높게 나타났다(p〈0.05). 신생 송아지의 체고, 십자부고, 흉위 및 좌골폭이 어미의 산차와 정(+)의 상관관계를 보였으며(p〈0.05), 분만후 3개월 송아지의 체중 및 모든 체위 측정치는 어미의 산차와 정(+)의 상관관계를 나타냈다(p〈0.05). 소득은 1-2산차 그룹에 비해 3-4, 5 및 6산차 그룹에서 높 았다. 따라서 본 연구의 결과에서 송아지의 생시체중, 성장특성 및 소득 등을 고려할 경우 한우 암소의 평균 산차를 현행 2.5산차 에서 5산차 혹은 6산차까지 연장해서 사육하는 것이 바람직할 것으로 판단된다.

Keywords : Hanwoo, Hanwoo-Steer, Parity, Growth-Performane, Carcass-Charcateristisc

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1. Introduction

The purchase cost of calves accounts for the largest proportion of the production cost in the beef cattle industry, and the superior calf increase the farmer's profit with a high selling price and high-quality meat appearance in the market [1]. Therefore, the parity of cows should be importantly considered to ensure steady production of superior calves. However, Pyo et al. reported that the average parity of Hanwoo cows was only 2.5, which was highlighted as a major factor in the reduced effectiveness of selection and improvement of cows [2]. In previous studies [3-5], the birth weight of calves increased with the parity numbers of their dams. Ahn et al also reported that although the parity numbers of dams had little effect on the birth weights of female calves [6], the birth weights of male calves were higher in the 3, 4, and 5 parity groups than the 1 and 2 parity groups. Choi et al. found that the birth weights of calves increased in the 5 parity groups, and the weight of calves at 3 months old was higher in the ≥ 5 parity group than the ≤ 4 parity group [7]. Other studies [4,8] reported that the birth weights of calves were not affected by the parity numbers of their dams. Therefore, previous studies on the effect of parity of dams on the birth weight of calves are inconsistent. In addition, only few studies sought to determine the effect of cow parity on growth performance, carcass characteristics, and economic efficacy for the entire fattening period; this is because studies on cow parity were limited to the birth or weaning weights of calves. Thus, this study was conducted to determine the effect of parity of dam on the growth performance, carcass characteristics, and economic efficacy of Hanwoo calves.

2. Materials and methods

2.1 Animal, treatments and methods

In this study, 344 Hanwoo dams and newborn calves (average weight, 29.2 ± 4.5 kg, born between 2010 and 2016) in the Gangwon Livestock Technology Research Institute in Hoengseong, Korea, were used. Commercial concentrates and roughage were offered as feed twice (08:00 and 17:00) per day according to the Korean Feeding Standard for Hanwoo steers. Water was freely available, and other feeding management was conducted in accordance with the practices of the Gangwon Livestock Technology Research Institute. Table 1 shows the ingredients and chemical composition of the experimental diets. Five dams and calves were allocated to each pen (5 × 10 m) with a sawdust thickness of approximately 0.2 m.

Hanwoo calves was divided based on the parity of cows. The calves were divided into five groups: 1-2 parity, 193 calves; 3-4 parity, 86 calves; 5 parity, 30 calves; 6 parity, 12 calves; and 7 parity, 23 calves. Calf starter and roughage were provided one week after birth, and calves and their respective dams were managed in the same pens until the pre-weaning stage (3 months of age). During the pre-weaning stages, calves freely sucked milk, and there was no access from the dam to the calf pen when feed was provided. The castrations were performed surgically at approximately 6–7 months of age. Acepromazine maleate (Sedaject inj, Samu Median, Seoul, Korea) was used as the anaesthetic, and no complications occurred. Every 100 kg of body weight was injected intravenously (0.5 mL) or intramuscularly (1 mL). The steers were slaughtered between 2013 and 2019 after the completion of the fattening period.

2.2 Growth performance

Body weight was measured at birth, 3, 6, 12, and 30 months using a cattle scale (size: 2400 × 1000 mm; CAS: BI-100D) before morning feeding. At the end of the experiment, body weight was measured immediately before loading for transportation. Body height, rump height, body length, chest width, chest depth, chest girth, rump length, rump width, pelvic width, and hip bone width were measured using a tapeline and measuring stick, according to MAFRA [9].

2.3 Carcass characteristics

All animals were slaughtered to assess the meat grades, and the carcass grade was evaluated according to the Korean carcass grading system criteria (Ministry of Agriculture, Food, and Rural Affairs) [9]. The Korean carcass grading system was divided into the following two large groups: meat yield grade (based on carcass weight, back fat thickness, and rib-eye area) and meat quality grade (based on marbling score, meat color, fat color, texture, and maturity). Carcass characteristics, such as meat yield and quality grades, were assessed 24 h post-mortem by a carcass grader from the Animal Products Grading Service, Korea. After 24 h of chilling, cold carcass weights were measured, and the left side of each carcass was cut between the last rib and first lumbar vertebra (determined at the 13th rib section) to assign the quality grade. The quality grade was determined summed by assessing the marbling score and texture of the cut surface of the rib eye area relative to the maturity, meat color, and fat color of the carcass. Quality grades were classified as 1^{++} (best), 1^{+}, 1, 2, and 3 (worst), according to the Korean beef quality grading system.

The degree of marbling was evaluated using the Korean beef marbling standard, and meat and fat color scores were determined using a color standard. The scores for texture and maturity were calculated using the Korean carcass grading system reference index [9]. Maturity is evaluated by looking at the degree of ossification of the vertebral cartilage. It refers to the physiological age of livestock that produces carcasses and is closely related to the age of beef in relation to the connective tissue, and it is also related to the change in the composition of the tissues and the degree of flavor. The texture was evaluated by looking at the degree of the water holding capacity and elasticity of the ribeye area cross-sectional area. The marbling score ranged from 1 to 9, with higher numbers indicating better quality (1 = devoid, 9 = abundant), meat color (1 = bright red, 7 = dark red), fat color (1 = creamy white, 7 = yellowish), and texture (1 = soft, 3 = firm). Furthermore, the quality grades ranged from 3 (low quality) to 1^{++} (very high quality). The rib-eye area was measured at the 13th rib. Backfat thickness was also measured at the 13th rib. The yield index from July 2013 to November 2019 was calculated as follows: Yield index = {68.184 − [0.625 × back fat thickness (mm)] + [0.130 × rib eye area (cm2)] − [0.024 × carcass weight (kg)]} × 3.23. Yield grades were classified as A (best), B, and C (worst) according to the Korean beef yield grading system, as determined by the yield index (grade A = more than 67.20, grade B = more than 63.30, but less than 67.20, and grade C = less than 63.30) [9].

Economic efficacy was calculated using the calf purchase price, carcass sales cost, including by-product sales cost, and feed cost. For other operating expenses, data of Korean beef cattle production cost was used [8].

2.4 Statistical analysis

Statistical analyses to obtain averages and standard differences were performed using IBM SPSS (Statistical Package for the Social Sciences, SPSS Inc. Chicago, IL, USA). One-way analysis of variance was also used to calculate the average value for each treatment group. Based on the parity of dam and in consideration of the differences between groups statistically significant differences between treatments were determined using Duncan's multiple range test, with $p<0.05$ indicating significance. For correlation and regression analyses, the correlation coefficients were calculated for each trait, and the growth performance, body conformation traits, carcass traits, and economic efficacy of the Hanwoo steers were reviewed relative to the parity of dam.

Table 1. Ingredient and chemical composition of experimental diets (as-fed basis)

Item	Cow(dam)		Calf			
	A[1]	B[2]	C[3]	D[4]	E[5]	F[6]
	Ingredient composition					
Corn grain (%)	40.30	29.99	10.00	24.90	29.04	33.99
Wheat grain (%)	-	3.00	8.86	8.00	10.00	11.00
Rice with hull (%)	3.00	-	-	-	3.00	3.00
Cane molasses (%)	4.60	3.00	2.00	3.00	4.00	4.00
MSG-CMS (%)	-	-	-	0.50	0.50	-
Wheat bran (%)	6.00	2.06	6.70	6.92	3.00	5.00
Rice bran (%)	-	-	-	-	-	2.00
Corn gluten feed (%)	23.00	22.00	10.00	21.00	23.00	17.32
Soybean meal (%)	1.40	11.30	30.40	5.20	4.00	4.00
Rapeseed meal (%)	4.00	6.00	-	-	-	-
Coconut meal (%)	5.00	-	-	3.00	5.00	-
Palm kernel meal (%)	2.00	12.00	11.00	12.00	12.00	12.00
Beet pulp (%)	-	-	6.00	-	-	-
Corn cob (%)	-	-	10.60	-	-	-
Corn-DDGS[7] (%)	6.00	6.00	-	8.00	0.20	-
Lupin (%)	-	-	-	3.00	2.00	2.00
Cottenseed (%)	-	-	-	-	-	2.00
Protected fat	-	-	-	-	-	0.06
Salt dehydrate (%)	0.60	0.60	0.50	0.60	0.60	0.70
Limestone (%)	2.90	2.77	1.84	2.90	2.88	2.05
Sodium bicarbonate (%)	0.30	0.30	0.30	0.30	0.30	0.40
Vitamin premix[8] (%)	0.10	0.10	0.15	0.10	0.10	0.10
Mineral premix[9] (%)	0.10	0.10	0.15	0.10	0.10	0.10
Fees additives (%)	0.70	0.78	1.50	0.48	0.28	0.28
	Chemical composition					
Dry matter (%)	87.35	87.96	89.06	87.79	87.50	87.26
Crude protein (%)	14.51	18.00	20.97	16.04	14.02	13.04
Ether extract (%)	2.99	3.47	3.52	3.62	3.21	4.19
Crude fiber (%)	5.95	6.39	10.02	6.90	6.19	6.05
NDF[10] (%)	21.98	24.72	28.08	25.38	24.21	21.98
Crude ash (%)	7.75	7.41	6.65	7.21	6.90	6.02
NFE	57.18	53.07	54.83	55.29	58.74	59.87
Ca	1.20	1.20	0.90	1.20	1.20	0.90
P	0.45	0.50	0.45	0.48	0.43	0.43
TDN[12]	70.28	71.50	71.49	71.46	72.00	73.51

[1]A: gestation; [2]B: lactation; [3]C: calf; [4]D: Growing; [5]E: early fattening; [6]F: late fattening [7]Corn-DDGS: corn dried distiller's grains with solubles; [8]Vitamin premix: vitamin premix provided the following quantities of vitamins per kilogram of diet: vitamin A, 10,000 IU; vitamin D3, 1,500 IU; vitamin E, 25 IU; [9]Mineral premix: mineral premix provided the following quantities of minerals per kilogram of diet: Fe, 50 mg; Cu, 7mg; Zn, 30 mg; Mn, 24 mg; I, 0.6 mg; Co, 0.15 mg; Se, 0.15 mg; [10]NDF: neutral detergent fiber; NFE: nitrogen free extract (calculated values); [12]TDN: total digestible nutrient (calculated values).

3. Results and discussion

Table 2 shows the birth weights and body conformation traits of calves according to the parity of the dam. The birth weight of calves tended to be higher in the 3-4 parity, 5 parity, 6 parity, and ≥ 7 parity groups than the 1-2 parity group; however, no statistically significant difference was found. The wither height, rump height, chest girth, and hip bone width were higher in the 6 parity group than the 1-2 parity group and the ≥ 7 parity group ($p<0.01$). In addition, other body conformation traits were slightly, but not significantly, higher in the 3-4 parity, 5 and 6 parity groups than the 1-2 parity and ≥ 7 parity groups. In this study, the birth weight and most body conformation traits of newborn calves had higher tendencies up to the 6 parity groups relative to the parity of dam. Han et al. reported similar results to this study, as they revealed that the birth weights of male calves were higher in the 3, 4, and 5 parity groups than the 1 and 2 parity groups [1]. Shin reported that the birth weight of calves showed the lowest trend at 1 parity; however, the parity of dams (1 to 5 parity) had no significant effect on the birth weight of calves, supporting the results of this study [4]. Lee et al also reported similar results to this study, as they found that the birth weight of calves was significantly increased from 3 to 6 parity but decreased above 7 parity [3]. Similarly, Shin found that the body conformation traits of calves were higher with an increase in the parity of the dam [4]. Kwon et al reported that this phenomenon is affected by various factors such as genetic ability, specification management, nutrition supply and environment inherited from dams [10]. Cushman et al suggested the need to extend the parity of dams because the birth weight of calves increases up to 6 parity as the number of deliveries increases [11].

Therefore, the results of this study showed that calf birth weight and body conformation units were higher in the 3-6 parity group than the 1-2 parity or ≥ 7 parity groups. As the average parity of Hanwoo cows is 2.5, the present results imply that it is necessary to extend the parity of cows up to 6.

Table 2. Effect of the parity of dam on body conformation traits of Hawnoo male calves at birth

Item	Parity					SEM	p-value
	1-2	3-4	5	6	over 7		
Birth weight (kg)	28.67	29.92	29.68	30.90	28.86	0.244	0.065
Wither height (cm)	67.41^{b}	68.62^{ab}	68.53^{ab}	69.63^{a}	67.51^{b}	0.192	0.006
Rump height (cm)	70.08^{c}	71.04^{bc}	71.88^{ab}	72.67^{a}	70.80^{bc}	0.197	0.001
Body length (cm)	55.89	55.65	56.97	57.10	56.34	0.204	0.246
Chest width (cm)	13.02	13.25	13.06	13.43	12.86	0.195	0.486
Chest depth (cm)	25.18	25.31	25.15	26.27	25.49	0.080	0.140
Chest girth (cm)	68.14^{b}	68.98^{ab}	69.24^{ab}	70.50^{a}	69.34^{ab}	0.088	0.006
Rump length (cm)	20.	20.13	20.74	20.57	20.	0.091	0.246
Rump width (cm)	12.60	12.96	12.65	13.13	12.66	0.070	0.145
Pelvic width (cm)	15.74	15.92	15.76	15.80	15.63	0.073	0.886
Hip bond width (cm)	9.12^{c}	9.38^{bc}	9.68^{ab}	9.97^{a}	9.14^{c}	0.063	0.001

[ab]Means followed by different latters in the same row are significantly different (p 〈 0.05); [1]SEM: standard error mean.

Table 3 shows the body weight and ADG by the growth stage of calves according to the parity of the dam. From birth to 3 months old, the ADG was higher in the groups with ≥ 3 parity than the 1-2 parity group ($p<0.01$). From 3 to 6 months old, the ADG was slightly, but not significantly, higher in the 1-2 parity, 3-4 parity and 5-6 parity groups than the ≥ 7 parity group. In particular, ADG was higher in the 6 parity group than the ≥ 7 parity group in birth to 3 months and 3 to 6 months period ($p<0.05$). From 6 to 30 months old, ADG was similar between all parity groups. From birth to 30 months old, the ADG was higher in the 5 and 6 parity groups than the ≥ 7 parity group ($p<0.05$). Choi et al. reported similar results to this study, as they found that the ADG of calves were proportionally higher with the parity of the dam [3]. However, in this study, as the ADG of calves was higher in the ≤ 6 parity groups than the ≥ 7 parity group, the present results indicate that it is not necessary to exceed the 6 parity unless the cow's reproductive ability is high [11].

Table 3. Effect of the parity of dam on growth performance of Hanwoo steers

Item	Parity					SEM[1]	p-value
	1-2	3-4	5	6	over 7		
Brith-3 months old							
Initial BW[2] (kg)	28.67^{b}	29.92^{ab}	29.68^{ab}	30.90^{a}	28.86^{ab}	0.244	0.045
Final BW (kg)	81.86^{b}	90.27^{ab}	90.42^{ab}	93.08^{a}	88.87^{ab}	0.905	〈0.001
ADG[3] (kg)	0.60^{b}	0.68^{a}	0.70^{a}	0.68^{a}	0.68^{a}	0.009	〈0.001
3-6 months old							
Initial BW (kg)	81.86^{b}	90.27^{ab}	90.42^{ab}	93.08^{a}	88.87^{ab}	0.905	〈0.001
Final BW (kg)	178.65	184.73	188.30	184.92	167.39	2.305	0.344
ADG (kg)	0.97^{ab}	0.96^{ab}	0.95^{ab}	0.99^{a}	0.86^{b}	0.019	0.021
6-12 months old							
Initial BW (kg)	178.65	184.73	188.30	184.92	167.39	2.305	0.344
Final BW (kg)	362.83^{ab}	361.63^{ab}	372.27^{ab}	387.00^{a}	343.04^{b}	3.257	0.042
ADG (kg)	1.00	1.09	1.13	1.16	1.16	0.009	0.383
12-30 months old							
Initial BW (kg)	362.83^{ab}	361.63^{ab}	372.27^{ab}	387.00^{a}	343.04^{b}	3.257	0.042
Final BW (kg)	747.47^{ab}	745.09^{ab}	764.23^{a}	729.67^{ab}	711.57^{b}	4.024	0.039
ADG (kg)	0.62^{a}	0.63^{a}	0.63^{a}	0.63^{a}	0.59^{b}	0.007	0.017
Birth-30 months old							
Initial BW (kg)	28.67^{b}	29.92^{ab}	29.68^{ab}	30.90^{a}	28.86^{ab}	0.244	0.045
Final BW (kg)	747.47^{ab}	745.09^{ab}	764.23^{a}	729.67^{ab}	711.57^{b}	4.024	0.039
ADG (kg)	0.76^{ab}	0.76^{ab}	0.78^{a}	0.78^{a}	0.74^{b}	0.004	0.189

[ab]Means followed by different latters in the same row are significantly different (p 〈 0.05); [1]SEM: standard error mean; [2]BW: body weight; [3]ADG: average daily gain.

Table 4 shows the carcass characteristics of Hanwoo steers according to the parity of dam. The carcass weight tended to increase up to 6 parity with the parity of dam, and was especially higher in the 6 parity group than the ≥ 7 parity group. The parity of dam had no effect on the back fat thickness and rib eye area of Hanwoo steers. The marbling score showed a slightly lower tendency in the ≥ 7 parity group than the other parity groups; however, the difference was not statistically significant. The parity of dam had no effect on meat color, fat color, texture, and maturity. In this study, the marbling scores of steers were not affected by the parity of dam. Cho et al was reported the marbling scores of steers improved as the parity of dam increased, but that was inconsistent by this study [7]. In this study, the effect of the parity of dam on the carcass characteristics of Hanwoo steers was small; however, carcass weight related to carcass price showed a tendency to increase up to 6 parity. Therefore, in this study was increased of parity (up to 6 parity) was related increasing carcass weight. So we draw a conclusion that the extension of parity was beneficial to farmers income.

Table 4. Effect of the parity of dam on carcass characteristics of Hanwoo steers

Item	Parity					SEM[1]	*p*-value
	1-2	3-4	5	6	over 7		
Carcass weight (kg)	440.95	444.10	446.29	454.23	426.60	2.628	0.135
Back-fat thickness (mm)	12.95	12.83	12.24	14.40	13.54	0.268	0.458
Rib-eye area (cm^2)	89.04	96.15	85.68	85.77	84.40	0.564	0.140
Yield index (%)	64.16	64.03	64.33	62.33	63.78	0.203	0.153
Marbling score	4.35	4.04	4.15	4.27	3.94	0.093	0.629
Meat color	4.91	4.88	4.94	4.87	4.97	0.026	0.903
Fat color	3.02	3.00	3.00	3.00	2.97	0.010	0.771
Texture	1.25	1.27	1.26	1.23	1.37	0.035	0.902
Maturity	2.28	2.35	2.40	2.30	2.41	0.027	0.502

[1]SEM: standard error mean.

Table 5 shows the effect of dam parity on the economic efficacy of Hanwoo steers. The gross receipt was in the order of 5 parity 〉 3-4 parity 〉 1-2 parity 〉 6 parity 〉 7 or more parity. The net income was higher in the 3-4 parity, 5 parity, and 6 parity groups than the 1-2 parity group; however, the ≥ 7 parity group had lower results than the 1-2 parity group. When the net income of the 1-2 parity group was the basis (100%), the relative net income ratios of the 3-4 parity, 5, 6, and ≥ 7 parity groups were 105, 106, 104, and 31%, respectively. Compared to the 1-2 parity group, the 3-6 parity groups showed an increase in gross receipts and net income, which was related to the increase in ADG (Table 3) and carcass weight (Table 4). For the group with ≥ 7 parity, the decrease in carcass weight and marbling score was considered to have contributed to the significant lowering of gross receipts and net income compared to other parities. Therefore, we recommend extending the parity of Hanwoo from the current 2.5 parity to 5 or 6 parities in consideration of the farmer's income.

Table 5. Effect of the parity of dam on economic efficacy of Hanwoo steers

Item	Parity				
	1-2	3-4	5	6	over 7
Gross receipts[1] (×US $/steer)	6,564	6,569	6,620	6,555	5,919
Operating cost[2] (×US $/steer)	5,694	5,648	5,698	5,653	5,646
Calf	2,268	2,268	2,268	2,268	2,268
Commercial concentrate	2,316	2,272	2,320	2,276	2,269
Straw	481	480	481	479	479
Other	629	629	629	629	629
Net income (×US $/steer)	870	920	922	903	274
Relative net income ratio	100	105	106	104	31

[1]Selling price of carcass and by product; [2]Concentrate 0.41 dollar/kg; rice straw: 0.16 dollar/kg; livestock cost(dollar/kg): 2,321.22; water, power and Fuel cost: 33.38 dollar; veterinary and medicine cost: 29.83 dollar; automobile cost: 41.03 dollar; farm implements cost: 169.99 dollar; farm building and facilities cost: 124.29 dollar; miscellaneous materials cost: 75.23 dollar; interest on borrowed capital: 61.46 dollar; land rent: 4.42 dollar; hired labor cost: 45.24 dollar; excretion disposal cost: 23.31 dollar; production management cost: 18.61 dollar.

Table 6 shows the correlation between the parity of dam and body conformation traits of calves from birth to 12 months old. The wither height, rump height, chest girth, and hip bone width of calves at birth had a positive (+) correlation with the parity of the dam ($p<0.05$). Although statistical significance was not found, most body conformation traits, except pelvic width, showed a tendency to increase with the dam parity. The body weights and all body conformation traits of calves at 3 months old had positive (+) correlations with the parity of the dam ($p<0.05$). In particular, the chest width, chest depth, and rump length had a PCC of 0.23 or more in the 3 month old calves. This result is similar to that of previous studies [1,6,7,12] where the growth performance of the calf was found to be better as the parity of the dam increased. Although statistical significance was not found, the body weight and most body conformation traits of calves at 6 months old had a negative (-) correlation with the parity of the dam. The body weight and most body conformation traits of calves at 12 months old showed similar tendencies to the results at 6 months old. Therefore, the growth performance in calves was positively correlated as the dam's parity increased due to the dam's care and genetic ability, but it is thought that after 6 months old, it was more affected by external factors such as feed and breeding environment.

Table 6. Correlation analysis between the parity of dam and body conformation traits in Hanwoo steers

	Item	Parity		
		PCC[1]	*p*-value	N
Birth	Body weight (kg)	0.078	0.147	344
	Wither height (cm)	0.124	0.021	344
	Rump height (cm)	0.173	0.001	344
	Body length (cm)	0.087	0.109	344
	Chest width (cm)	0.000	1.000	344
	Chest depth (cm)	0.103	0.057	344
	Chest girth (cm)	0.166	0.002	344
	Rump length (cm)	0.039	0.473	344
	Rump width (cm)	0.073	0.177	344
	Pelvic width (cm)	-0.014	0.799	344
	Hip bone width (cm)	0.120	0.025	344
3 months old	Body weight (kg)	0.191	0.001	344
	Wither height (cm)	0.177	0.001	344
	Rump height (cm)	0.216	0.001	344
	Body length (cm)	0.154	0.004	344
	Chest width (cm)	0.239	0.001	344
	Chest depth (cm)	0.244	0.001	344
	Chest girth (cm)	0.194	0.001	344
	Rump length (cm)	0.263	0.001	344
	Rump width (cm)	0.221	0.001	344
	Pelvic width (cm)	0.118	0.029	344
	Hip bone width (cm)	0.169	0.002	344
6 months old	Body weight (kg)	-0.012	0.821	344
	Wither height (cm)	-0.053	0.323	344
	Rump height (cm)	-0.059	0.275	344
	Body length (cm)	-0.046	0.393	344
	Chest width (cm)	0.066	0.224	344
	Chest depth (cm)	-0.037	0.495	344
	Chest girth (cm)	-0.043	0.430	344
	Rump length (cm)	-0.033	0.544	344
	Rump width (cm)	-0.019	0.731	344
	Pelvic width (cm)	-0.029	0.592	344
12 months old	Body weight (kg)	-0.020	0.711	344
	Wither height (cm)	-0.097	0.073	344
	Rump height (cm)	-0.067	0.217	344
	Body length (cm)	-0.064	0.239	344
	Chest width (cm)	-0.047	0.389	344
	Chest depth (cm)	-0.071	0.190	344
	Chest girth (cm)	-0.066	0.222	344
	Rump length (cm)	-0.044	0.413	344
	Rump width (cm)	-0.062	0.253	344
	Pelvic width (cm)	-0.095	0.079	344
	Hip bone width (cm)	0.127	0.019	344

[1]PCC: pearson correlation coefficient

Table 7 shows the correlation between parity of dam and the body conformation traits of calves. Carcass weight, rib eye area, auction price, and gross receipts had negative correlations with the parity of the dam ($p<0.05$). Although statistical significance was not found Yield index and Marbling score was negative correlation. Thus, the results of this study are related to a sharp decline in the ≥ 7 parity after the farmer's net income and gross receipts (Table 5) increases up to 5-6 parity. Therefore, we recommend extending the parity of Hanwoo cows from the current 2.5 parity to 5 or 6 parity.

Table 7. Correlation analysis between the parity of dam and carcass traits in Hanwoo steers

Item	Parity		
	PCC[1]	*p*-value	N
Parity	1	-	344
Live weight (kg)	-0.103	0.057	344
Carcass weight (kg)	-0.127	0.019	344
Back fat thickness (mm)	0.035	0.521	344
Rib eye area (cm2)	-0.182	0.001	344
Yield index (%)	-0.063	0.246	344
Marbling score	-0.088	0.104	344
Meat color	0.048	0.370	344
Fat color	-0.089	0.099	344
Texture	0.058	0.281	344
Maturity	0.059	0.272	344
Auction price (×US $/steer)	-0.112	0.037	344
Gross receipts (×US $/steer)	-0.159	0.003	344

[1]PCC: pearson correlation coeffcient

4. Conclusion

In this study, as the birth weight of calves was higher in the ≤ 6 parity groups than the ≥ 7 parity group. The wither height, rump height, chest girth, and hip bone width were higher in the 6 parity group than the 1-2 parity group and the ≥ 7 parity group ($p<0.01$). From birth to 3 months old, the ADG was higher in the groups with ≥ 3 parity than the 1-2 parity group ($p<0.01$). In particular, ADG was higher in the 6 parity group than the ≥ 7 parity group in birth to 3 months and 3 to 6 months period ($p<0.05$). The gross receipt was in the order of 5 parity 〉 3-4 parity 〉 1-2 parity 〉 6 parity 〉 7 or more parity. The net income was higher in the 3-4 parity, 5 parity, and 6 parity groups than the 1-2 parity group; however, the ≥ 7 parity group had lower results than the 1-2 parity group. When the net income of the 1-2 parity group was the basis (100%), the relative net income ratios of the 3-4 parity, 5, 6, and ≥ 7 parity groups were 105, 106, 104, and 31%, respectively.

Therefore we suggest extending the parity of Hanwoo cows from the current 2.5 to 5 or 6 based on the increase in birth weight, growth performance, carcass weight, and the farmer's income.

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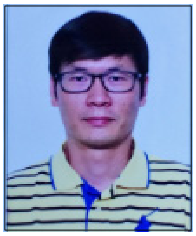

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