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FACTORS AFFECTING GROWTH PERFORMANCES OF SIMMENTAL, ANGUS, CHAROLAIS AND HEREFORD BEEF CROSSBRED CALVES UNDER SUB-TROPICAL ENVIRONMENT OF PAKISTAN

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ABSTRACT

The present study was conducted with the objective to find out the comparative growth performance of beef crossbred calves. The data of growth performance traits were collected on the calves born during the year 2006 through year 2011. The data were analyzed using computer software SPSS (19.0). The overall mean for birth weight, weaning weight, yearling weight and eighteenth month weight were 29.03±0.24, 142.50±2.38, 186.89±3.02, 245.87±4.15 kg, respectively. The pre-weaning growth rate and post-weaning growth rate were 0.483±0.01 and 0.294±0.02 g, respectively. Year of birth was a significant source of variation for birth weight, weaning weight, yearling weight, eighteenth month weight, pre-weaning growth rate and post weaning growth rate (P≤0.05). The highest mean birth weight (31.82+0.56 kg) was recorded for the calves born during the year 2011 and the lowest mean birth weight 26.00±0.48 kg was recorded for the calves born during the year 2009. Season of birth was a significant source of variation for birth weight, yearling weight, 18- month weight and post-weaning growth rate (P≤0.05). The calves born during winter season had the heaviest mean birth weight (29.72±0.43 kg). Calf sex significantly affected birth weight (P≤0.01) and weaning weight (P≤0.05). The male calves were heavier than female calves for all traits under study. The mean birth weight and weaning weight were (29.84±0.31) and (150.14±3.82 kg) for male calves; (28.09±0.35 and 138.57±2.94 kg) for female calves respectively. Animal genetic group (sire breed) was a significant source of variation for weaning weight, pre-weaning growth rate (P≤0.01) and yearling weight (P≤0.05). The highest mean for weaning weight (159.22±5.39 kg) was noticed for Simmental crossbred calves followed by Angus (147.77±4.37 kg), Hereford (136.80±4.34) and Charolais (135.78±4.54 kg) crossbred calves. The Simmental crosses were heavier at weaning weight, showed better pre-weaning growth rate and yearling weight as compared to Charolais and Hereford crosses. Further crossbreeding with Simmental and Angus beef breed sires is recommended in subtropical climatic conditions of Pakistan.

Key words: Beef crossbred calves, birth weight, weaning weight, growth rate, sub-tropical environment.

INTRODUCTION

Pakistan possesses an agriculture based economy. Agriculture plays an important role in the economy of Pakistan. 45% of the total labors in the country are engaged in agriculture operations. Livestock is an integral part of agriculture and its contribution towards National GDP is 11.6 % (Economic Survey of Pakistan, 2015-16). Pakistan is very rich in cattle population. Defined breeds for milk, meat production and draught purpose are available. A substantive number of native cattle breeds have been under-utilized. These cattle breeds could be bred for production of beef crossbreds. This could help to increase beef production in the country to fulfill the needs of protein containing foods. Presently 2017 thousand tons of beef is being produced in the country. Annual availability of meat in Pakistan is 22 kg per capita (Economic Survey of Pakistan, 2015-16) which is less as compared to other developed nations. There are more than fifteen cattle breeds in Pakistan. However of the total cattle population more than 46.20 % of the cattle fall in non-descript category (GOP, 2006). These native cattle breeds have mostly low yields. However, these animals are well adapted to local climatic conditions and have resistant to diseases. The growth potential of the local non-descript cattle could be improved through selective breeding. However the improvement brought through selection is slow process. Crossbreeding of beef breeds with local cattle has been practiced in many countries to get benefit of hybrid vigor and additive and non- additive type of gene actions (Gregory and Cundiff, 1980). However the performance of cattle in tropical area has been questionable. Amongst many other factors, climatic factors are the crucial affecting livestock production of temperate cattle in hot climates (Renaudeau *et al*. 2012). Increasing air temperature, temperature

humidity index and increase in rectal temperature above critical levels have resulted decrease in dry matter intake and milk yield in dairy cattle (West, 2003). The crossbreeding has resulted in higher merit in reproduction, growth and end product to be marketed (Theunissen *et al*. 2013). Theunissen *et al*. (2013) has concluded that the Zebu crossbreed genotypes will probably have the highest potential to produce red meat sustainably in Southern Africa. Many South African countries have tropical environment. Same approach could be used with some modification in Pakistan. With this back ground a beef cattle crossbreeding initiative was taken in 1998 at Livestock Production Research Institute Bahadurnagar Okara. Semen of Simmental breed was imported to cross with native cattle to get the benefits of hybrid vigor. On the basis of this preliminary study, another project was launched in 2003-04. Semen of three beef breeds, two with British origin (Angus and Hereford) and one French (Charolais) was used. The local non-descript cows were inseminated with exotic semen to produce crossbred animals.

The present study was designed to compare the growth performance of beef crossbreds and find out the suitable crossbred animals with better pre-weaning and post weaning growth performance. The results of the current study will help in future planning for beef production strategies in the country.

MATERIALS AND METHODS

Management and Location of the farm: The beef cattle crossbreeding program was started at Livestock Production Research Institute Bahadurnagar Okara. The institute has been given the mandate to do applied research on different aspects of livestock production. The farm owns three thousand acres of canal irrigated land for fodder production and cash crop production. Generally the beef crossbred animals were offered green fodder at the rate of 10 percent of their body weight on fresh basis. In general the animals were fed concentrate ration at the rate of 0.5 to 1 percent of their body weight. The new born calves were allowed to suck milk from their dams up to weaning age (210-days). The calves were creep fed concentrate ration along with milk feeding from their dams. The calves were separated from their dams after weaning and kept in separate pens. The weight of the animals was recorded on monthly basis on a weigh bridge.

Breeding practices: The semen of the beef breeds was procured. The crossing of exotic beef breeds was made with local non-descript cows. The non-descript cows were inseminated with imported beef breeds semen to produce crossbred animals. The exotic breeds included in the crossbreeding program were Simmental, Angus, Hereford and Charolais.

Data collection and analysis: The data on animal identification, pedigree and growth performance records were collected and computerized from the birth year 2006 to 2011. The weight of the calves recorded within twenty four hours after birth was taken as birth weight. The weaning weight, yearling weight and 18 month weight of the crossbreed animals were adjusted for age of calves in days as per (Lasely, 1987). The data was analyzed using computer software Statistical Package for Social Sciences (SPSS) 19.0. The one way analysis of variance was performed to see the effect of fixed effects on each of the growth traits. The post-hoc tests were performed to compare the means for factors affecting the traits significantly. The Duncan's multiple range test was applied for comparison of means at probability level of 0.05. The post hoc test was performed for the factors having more than two levels. The factors were sex, year of birth, season of birth and sire breed. The detail of factors along with their levels is given in Table 1.

RESULTS AND DISCUSSION

The descriptive statistics are presented in Table 2. The overall mean±standard error for birth weight, weaning weight, yearling weight, eighteenth month weight were 29.03±0.24, 142.50±2.38, 186.89±3.02, 245.87±4.15 kg, respectively. The pre-weaning growth rate and post-weaning growth rate were (0.483±0.01 and 0.294±0.02 g), respectively. The pre-weaning growth rate was higher than post-weaning growth rate. The differences might be because of weaning stress on the calves. The calves might have not started taking good daily allowance of their feed that could support their body requirements. The average birth weight, weaning weight and average daily gain reported for Fogera cattle as (20.7±0.11 kg), (88.6±1.3 kg) and 297±3.63 g were lower than results of the current study (Menale *et al*. 2011). The mean weaning weight (212.80 kg) for South Dakota beef cattle of cooperative herds was higher than current study (Dooley *et al*. 1982.) The average least square means for birth weight and weaning weight of Charolais and Hereford sired crossbred calves were higher than current study (Dadi *et al*. 2002). Rotational crossbreeding system was practiced for production of these crossbred calves that probably maintained higher degree of heterosis. This might be one of the reasons for higher weights as compared to current study. The mean birth weight and weaning weight of Brahman x Hereford F_1 was higher than current study for respective traits in subtropical environment at Grafton Australia (Arthur *et al*. 1999). The crossbred calves at Grafton were weaned at 240 days whereas in current study the weaning age was 210 days. The weaning age could cause variation in weight at weaning. The post weaning growth rate and yearling weight (261±156 g and 151.5±38.9 kg) of Droughtmaster x Bhagnari beef crossbred calves were

lower than current study (Khan *et al*., 1998). The birth weight, weaning weight and pre-weaning growth rate (24.5±4.4 kg), (111.4±23.1 kg) and (414±104.8 g) for Droughtmaster x Bhagnari beef crossbred calves was lower than current study means (Khan and Khan, 1999). The environment and management differences might be the cause of variation for the mean in these two studies. The mean weaning weight (202.4±24.5 kg), pre-weaning growth rate (705±100 g) and eighteenth month weight (315.1±32.5 kg) of beef crossbreds having Zebu blood were higher than current study means (Mangana and Segura-Correa 2006).

Factors Affecting Growth Traits: The analysis of variance is presented in Table 3 and least square means for fixed effects are presented in Table 4.

Year of birth effect: Year of birth was a significant source of variation for birth weight, weaning weight, yearling weight, eighteenth month weight, pre-weaning growth rate and post weaning growth rate (P≤0.05). The highest mean birth weight (31.82+0.56 kg) was recorded for the calves born in 2011 and the lowest mean birth weight (26.00±0.48 kg) was recorded for the calves born in 2009. The year effect depicts the management differences in different years. The highest mean weaning weight (165.44±5.46 kg) was observed in 2010 and lowest mean weaning weight 129.77±3.20 kg was observed for the calves born in 2008. The highest mean yearling weight, pre-weaning and post-weaning growth rate 220.93±8.24 kg, 0.582±0.02 and 0.434±0.04 g were observed in 2010 while lowest mean yearling weight (170.40±5.96 kg) was observed for the calves born in 2007. The highest mean eighteenth month weight was (269.65±10.42 kg) for 2006 and lowest mean eighteenth month weight 214.20±7.88 kg was noticed in 2007. The post weaning growth rate was lower than pre-weaning growth rate for all the years. The withdrawal of milk feeding at weaning probably might be one of the factors affecting post-weaning growth rate and calves adjustment for total feeding on fodder and concentrates. Contrary to current study, findings birth year was a non-significant source of variation for birth weight, however weaning weight was affected significantly in the study by Manzi *et al*. (2012). Similar to current study, the combined effect of year and season was significant source of variation for birth weight, weaning weight and pre-weaning daily gain of Charolais beef calves (El Saied *et al*. 2006).

Season of birth effect: Season of birth was a significant source of variation for birth weight, yearling weight, 18-month weight and post-weaning growth rate (P≤0.05). The calves born during winter season were the heaviest with mean birth weight (29.72±0.43 kg). The lowest birth weight (27.95±0.57 kg) was observed for the calves born during spring. The spring born calves were heavier at yearling age with mean yearling weight (204.87±6.80) kg. The lowest yearling weight (178.02±4.79 kg) was observed for the calves born in summer. The highest mean 18-month weight (265.78±12.35 kg) was noticed for the fall born calves. The lowest mean 18-month weight (231.24±6.47 kg) was observed for the calves born during summer. The highest mean for post-weaning growth rate was (0.398±0.03 g) for the spring born calves and lowest mean post-weaning growth rate was (0.235±0.04 g) was noticed for calves born during fall. Contrary to current study, season of birth was a non-significant source of variation for birth weight and significant source of variation for weaning weight of six breed groups in Rwanda (Manzi *et al*. 2012). Different from this study, season of birth was non-significant source of variation for birth weight in study of Simmental and Red Angus crosses with local cattle in Sudan (Ibrahim *et al*. 2015). Similar to current study findings, season of birth affected birth weight in Nguni (Mpofu *et al* 2017) and Fogera cattle (Menale *et al*. 2011), but average pre-weaning growth rate was not influenced in Fogera cattle (Menale *et al*. 2011).. Similar to current study, season of birth significantly affected weaning weight, post-weaning growth rate and 18 month weight of beef crossbred calves at Mexico (Mangaña and Segura-Correa, 2006)

Sex of calf effect: Sex of calf significantly affected birth weight (P≤0.01) and weaning weight (P≤0.05) which were in agreement with findings of Dadi *et al*. (2002), Krupa *et al* (2005) and Menale *et al*. (2011), The male calves were heavier than female calves for all traits under study. The mean birth weight and weaning weight were (29.84±0.31) and (150.14±3.82 kg) for male calves, (28.09±0.35) and (138.57±2.94 kg) for female calves respectively. The findings of Manzi *et al*. (2012) and Ibrahim *et al*. (2015) by which sex of calf was a non-significant source of variation for birth weight for calves of six breed were different from current study. Similar to current study findings, sex of the calf was found to be a significant source of variation for weaning weight of Hereford calves (Leighton *et al*. 1982). Menale *et al*. (2011) found that average daily pre-weaning growth rate was not influenced by sex of calf in Fogera cattle. Similar to current study findings, the sex was a significant source of variation for birth weight and weaning weight of beef calves whereas contrary to present study sex was also significant source of variation for yearling weight and growth traits (Krupa *et al*. 2005).

Animal Genetic Group (Breed of sire effect): Breed of sire was a significant source of variation for weaning weight, pre-weaning growth rate (P≤0.01) and yearling weight (P≤0.05). The highest mean for weaning weight (159.22±5.39 kg) was noticed for Simmental crossbred calves followed by Angus crossbred calves (147.77±4.37 kg), Hereford (136.80±4.34 kg) and Charolais (135.78±4.54 kg). The purebred Simmental cows are

considered medium milk producers. It looks that Simmental crossbred dams showed a good mothering ability as compared to other crossbred dams. The mean pre-weaning growth rate for Simmental crossbred calves (0.552±0.02 g) was also higher than other beef crossbred calves. The mean pre-weaning growth rate for Angus beef crossbred calves (0.521±0.02 kg) was non-significantly different from Simmental crossbred calves. The mean pre-weaning growth rate for Charolais and Hereford crossbred calves was reasonably low than Simmental and Angus crossbred calves. The Charolais and Hereford crossbred calves showed similar performance in pre-weaning growth period. At yearling age, the weight of Simmental and Angus crossbred animals (197.65±6.99 kg) and (197.27±5.84 kg) respectively were almost of similar magnitude. Similarly the mean yearling weight (178.33±5.78) and (178.55±5.28 kg) were of similar magnitude for Charolais and Hereford crossbred calves respectively. Contrary to present study, breed of sire was a significant source of variation for birth weight for Shorthorn and beef crossbred calves. The birth weight was higher than those found in the current study (Hidiroglou *et al*. 1966). These beef crossbreds were produced as a result of crossing amongst Bos-taurus cattle breeds. However in present study the beef breed bulls were mated with non-descript cattle of Zebu origin. The findings of Ibrahim *et al*. (2015) were in agreement to current study where by sire breed group was a non-significant source of variation for birth weight of Simmental and Red Angus beef breeds with local cattle of Sudan. Similar to present study breed differences were significant for weaning weight, pre-weaning gain and yearling weight of beef calves (Krupa *et al*. 2005). Similar to current study, breed of sire effects were significant for 205-day weaning weight and average daily weight gain from birth to weaning (Özlütürk.*et al*. 2006). The crossbred calves of Simmental with local cattle of Bangladesh grew faster than other beef crossbred calves similar to current study findings (Mostari *et al*., 2017).

Table 1. Factors, their levels and descriptions.

Factors	Levels	Description
Year of birth	6	Year 2006 to year 2011
Season of birth	4	1) Winter (December to March) 2) Spring (April to May) 3) Summer (June to August) 4) Fall (October to November)
Sex of the animal	2	1) Male 2) Female
Breed of sire	4	1) Angus cross 2) Charolais cross 3) Hereford cross 4) Simmental cross

Table 2. The overall descriptive statistics for growth traits of beef crossbred calves.

Traits	Number	Minimum	Maximum	Mean	Standard error
Birth weight (kg)	293	16	43	29.03	0.24
Weaning weight (kg)	182	56.30	243.77	142.50	2.38
Yearling weight (kg)	184	66.51	350.83	186.89	3.02
Eighteenth month weight (kg)	142	110.00	445.83	245.87	4.15
Pre-weaning growth rate (g)	182	0.133	0.904	0.483	0.01
Post-weaning growth rate (g)	153	0.110	1.000	0.294	0.02

Table 3 Analysis of variance for growth performance traits of beef crossbred animals.

Traits	Season of Birth	Year of Birth	Sex of Calf	Animal Genetic Group
Birth weight	**	***	***	NS
Weaning weight	NS	***	**	***
Yearling weight	**	***	NS	**
18-month weight	**	***	NS	NS
Pre-weaning growth rate	NS	***	NS	***
Post-weaning growth rate	***	***	NS	NS

NS=Non significant (P>0.05), ** P≤0.01, *** P≤0.001.

Table 4. Least square means for fixed effects for growth performance traits of beef crossbred calves*.

Factor	Level	Birth Weight (kg)			Weaning Weight (kg)			Yearling Weight (kg)			18-Month Weight (kg)			Pre-weaning Growth Rate (g)			Post-weaning Growth Rate (g)		
		N	Mean	SE	N	Mean	SE	N	Mean	SE	N	Mean	SE	N	Mean	SE	N	Mean	SE
Season of birth	Winter	108	29.72^{a}	0.43	60	142.78	4.50	69	184.40^{b}	4.90	49	242.56^{ab}	6.50	60	0.483	0.02	53	0.262^{b}	0.03
	Spring	58	27.95^{b}	0.57	37	144.92	5.07	38	204.87^{a}	6.80	21	249.99^{ab}	9.15	37	0.491	0.02	37	0.398^{a}	0.03
	Summer	91	28.54^{ab}	0.43	54	135.40	3.89	52	178.02^{b}	4.79	51	231.24^{b}	6.47	54	0.460	0.02	42	0.279^{b}	0.02
	Fall	55	29.31^{ab}	0.46	42	153.64	5.50	33	186.79^{b}	8.60	28	265.87^{a}	12.35	42	0.526	0.02	29	0.235^{b}	0.04
	Overall	312	28.97	0.24	193	143.49	2.38	192	187.14	3.02	149	244.10	4.15	193	0.488	0.01	161	0.293	0.02
Year of birth	2006	44	31.23^{a}	0.58	15	134.60^{b}	5.22	29	202.68^{b}	7.70	29	269.65^{a}	10.42	15	0.446^{b}	0.10	15	0.376^{ab}	0.04
	2007	74	29.43^{b}	0.56	47	135.55^{b}	4.40	49	170.40^{d}	5.96	39	214.20^{b}	7.88	47	0.451^{b}	0.02	34	0.194^{c}	0.03
	2008	66	28.27^{bc}	0.48	57	129.77^{b}	3.20	60	174.72^{cd}	3.78	48	243.66^{a}	5.99	57	0.418^{b}	0.01	58	0.286^{bc}	0.02
	2009	38	26.00^{d}	0.48	31	156.83^{a}	6.12	25	192.51^{bc}	7.34	22	264.60^{a}	9.78	31	0.569^{a}	0.03	25	0.228^{c}	0.03
	2010	52	27.40^{cd}	0.39	42	165.44^{a}	5.46	29	220.93^{a}	8.24	11	243.62^{a}	9.75	42	0.582^{a}	0.02	29	0.434^{a}	0.04
	2011	38	31.82^{a}	0.56	-	-	-	-	-	-	-	-	-	1	0.299	-	-	-	-
	Overall	312	28.97	0.24	192	143.49	2.38	192	187.14	3.02	149	244.10	4.15	192	0.488	0.01	161	0.293	0.02
Sex of calf	Male	158	29.84	0.31	82	150.14	3.82	80	191.02	4.64	51	253.52	8.07	82	0.510	0.02	61	0.304	0.03
	Female	154	28.09	0.35	111	138.57	2.94	112	184.36	3.96	98	239.09	4.65	111	0.471	0.01	100	0.286	0.02
	Overall	312	28.97	0.24	193	143.49	2.38	192	187.14	3.02	149	244.10	4.15	193	0.488	0.01	161	0.293	0.02
Animal Genetic group (Sire breed)	Angus cross	90	28.12	0.41	51	147.77^{ab}	4.37	54	197.27^{a}	5.84	44	253.26	7.29	51	0.521^{a}	0.02	40	0.340	0.03
	Charolais cross	82	29.18	0.49	53	135.78^{b}	4.54	54	178.33^{b}	5.78	42	242.02	8.32	53	0.455^{b}	0.02	47	0.305	0.03
	Hereford cross	81	29.07	0.46	54	136.80^{b}	4.34	50	178.55^{b}	5.28	41	233.29	8.23	54	0.446^{b}	0.02	45	0.259	0.02
	Simmental cross	59	29.85	0.56	35	159.22^{a}	5.39	34	197.65^{a}	6.99	22	249.89	9.14	35	0.552^{a}	0.02	29	0.258	0.05
	Overall	312	28.97	0.24	193	143.486	2.38	192	187.135	3.02	149	244.10	4.14	193	0.488	0.01	161	0.293	0.02

*To compare means post hoc test has been performed for factors having more than two levels. The means with same super script are statistically not different (P≤.05) from each other. However, the means with different superscript are statistically different (P≤.05) from each other.

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