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ENVIRONMENTAL FACTORS AFFECTING VARIOUS GROWTH TRAITS OF SWAMP BUFFALO CALVES

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Data on growth traits of 1736 swamp buffalo calves collected during 1-980-1991 at the Surin Livestock Breeding and Research Station in Thailand were utilized in this study. The objective was to evaluate the environmental factors affecting various growth traits of calves. The data were analyzed, using Harvey's Mixed Model Least Squares and Maximum Likelihood computer programme. The least squares mean for birth weight was 30.11±4.49 kg with a coefficient of variation of 14.9 %. The trait was affected significantly (P<O.OI) by the calf sex, year and season of birth and parity of the dam. The least squares mean for 240-day weaning weight was 142.89±21.41 kg which was affected significantly (P<O.OI) by the year and season of birth, parity of the dam and birth weight. The effect of sex on 240-day weaning weight was found to be non-significant (P>0.05). The least squares mean for 2-year weight was 352.90±25.96 kg. This trait was significantly affected by the year and season of birth and the weaning weight but the effect of sex of the calf and the parity of the dam was non-significant. The least squares means for pre-weaning and post-weaning average daily gain were 460.50±90.0 I and 408.34±65.63 g, respectively. Both traits were significantly affected by year and season of birth and parity of the dam. The pre-weaning daily gain was also affected by the calf sex.

Key words: environmental factors, growth traits, swamp buffalo calves

INTRODUCTION

Thailand, primarily an agricultural country, supports 2.3 million head of buffaloes (Anonymous, 1998). The buffaloes are swamp type and are mainly kept for beef and draught purposes. The buffaloes contribute nearly half of the total beef consumption in the country. The size of the buffalo population has been decreasing from 5.1 million in 1990 to 2.3 million in 1998 (Anonymous, 1998). This sharp decline in number of swamp buffaloes has resulted from increased demand for beef associated with low reproductive rates. Moreover, there has been gradual reduction in the body size of the breeding animals because large sized bulls have been castrated to use for work rather than for breeding. Genetic improvement of the swamp buffaloes for enhanced beef production deserves high priority. Selection for higher body weight will also improve working ability of the animals. The growth traits of buffaloes are influenced by many environmental factors besides their genetic make up. These environmental factors may suppress the animals true genetic potential for growth and thus can make the normal selection procedures ineffective. The evaluation of the influence of such factors is thus of vital importance. The present study was therefore planned to estimate the magnitude of various environmental factors on different growth traits of these animals.

MATERIALS AND METHODS

Data about growth traits of 1736 swamp buffalo calves were collected from a performance testing programme at the Surin Livestock Breeding and Research Station, Thailand. The records were spread over a period of 12 years (1980-1991). Following data were collected: individual's identity, date of birth, body weights at various ages and date of weaning. Calf birth weights were recorded within 24 hours after birth. All calves were weaned at about 8 months of age and their weights were recorded. Weighing of the animals was conducted monthly. Various traits examined in the present study included: birth weight, weaning weight adjusted to 240-day basis, 2-year weight, pre-weaning average daily gain and post-weaning average daily gain (up to 2 years of age). Weaning weights of calves were recorded at a mean age of 240 days (from 180-300 days). Adjusted 240-day weaning weight was calculated as follows: (growth rate from birth to weaning x 240) + birth weight. The data of swamp buffaloes were checked for unrealistic entries and outliers. For this purpose records outside ±3 standard deviations from the phenotypic mean were taken out. The number of records eliminated during this editing was less than 2.5% of the total number of records.

The management and feeding of these animals were based on pasture system, where para-grass was the most prevalent. During the dry season, silage, hay or rice straw was given to the animals in order to maintain their body condition. Minimum amount of feed supplements was given to the breeding animals in order to maintain them in good body condition. Sometimes, grass was also fed in chopped form. The buffaloes received minimal amount of cheap supplement (cassava chips + rice bran etc.) during severe dry period of the year. Creep feeding for young calves was not generally practised, however, when pasture condition was very poor, the calves were given some creep feeds such as ground rice. Mineral supplements, salt and bone meal were available in the night corral at all times.

The data on various growth traits were analyzed to estimate the magnitude of various environmental sources of variation in these traits. The environmental factors evaluated included sex of the calf, season of birth, year of birth and parity. The seasons of birth were designated as follows: Spring, February to April; Summer, May to July; Autumn, August to October, and Winter, November to January. The statistical model assumed for the evaluation of environmental factors on growth traits was as follows: $Y_{ij} = \mu + F_i + e_{ij}$, where μ = the population mean; F_i = the effect of air fixed effects with the restriction that $\sum F_i = 0$; e_{ij} = the random error associated with each observation. Mixed Model Least Squares and Maximum Likelihood computer programme (Harvey,1990) was used to study the influence of environmental factors on various growth traits.

RESUL TS AND DISCUSSION

The influence of various environmental factors on different growth traits of swamp buffalo calves was evaluated by the analysis of variance technique using Mixed Model Least Squares and Maximum Likelihood software. The results obtained for each trait have been discussed in the following paragraphs:

1) Birth Weight: The least squares mean for birth weight was 30.11±4.49 kg with a coefficient of variation of 14.9 % (Table I). The analysis of variance for the evaluation of the influence of sex, season of birth, year of birth, and parity on birth weight has been given in Table 2. The trait was affected significantly (P<O.O1) by the sex of the calf, year and season of birth and parity of the dam. The least squares means and standard errors for birth weight of calves for different sexes, seasons and years of birth and parities have been given in Table 3. The least squares means for the birth weight fluctuated between 29.488 and 32.629 kg in the calves born during 1980 to 1991. Similarly, the least squares means for birth weight of the calves born during different seasons also varied significantly. The birth weight of the calves born during winter was the least (29. 661 kg) while the birth weight of calves born in summer was 30.939 kg followed by the birth weight of the calves born during spring. The birth weight of the male calves was higher (31.479 kg) than the females (29.447 kg). The mean birth weight of swamp buffalo calves was found to be 30.10 kg. It is in agreement with many workers who reported that the birth weight in buffalo calves ranged from 26 to 34 kg (Chantalakhana and Poogkesorn, 1982; Dahama et al:, 1990; Due et al., 1993; Jogi and Lakhani, 1996). Chantalakhana and Poogkesom (1982) reported that the mean birth weight of Thai swamp buffalo calves was 26.68 kg with a very wide range of 15-41 kg. Due et al. (1993) reported that the least square means for birth weight in Murrah male and female calves in Vietnam were 29.87 and 27.91 kg, respectively.

The significant influence of the calf sex, season of birth, year of birth and parity on birth weight as obtained in the present study was in agreement with the findings of many workers. Chantalakhana et al. (1982) observed a significant effect of sex of the calf and parity of dam on birth weight of Thai swamp buffalo calves; the male calves were heavier (28.7 kg) than the female calves (27,2 kg). Moreover, birth weight of the calves increased with parity of the dam. The buffaloes in the earlier parities produced lighter calves than those in the later parities. Basu (1985) observed an increase in the birth weight of calves associated with an increase in the age of the dams until the peak lactation (4^{th}) production was reached. It was, therefore, suggested that flushing of the pregnant cows would help in obtaining higher birth weights of calves. Verma et al. (1989) and Dahama et al. (1990) also reported year / period of year as a significant source of variation in birth weight.. Due et al. (1993) also found a significant influence of sex, year and season of birth on birth weight in Murrah calves in Vietnam. Similar findings were also reported by Thevamanoharan et al. (1984) and Goonawardene and Thevamanoharan (1994) in the swamp buffalo calves of Sri Lanka. On the contrary, Rohilla and Chaudhry (1992) showed that the birth weight in buffalo calves was not affected significantly by season. Similarly, the findings of Nawale et al. (1997) were also not in conformity with the findings of the present study. They reported rather low birth weights in Nagpuri (26.3 kg) and Murrah (23.6 kg) buffalo calves in India.

2) Weaning Weight: The least squares mean for 240-day weaning weight was 142.89±21.41 kg (Table 1). The analysis of variance for the evaluation of the influence of the calf sex, season of birth, year of birth and parities has been given in Table 2. The analysis of the data indicated that the effect of season of birth, year of birth and parity was significant while the effect of sex of the calf on weaning weight was found to be non-significant. . The regression of weaning weight on birth weight (2.09±0.12) was significant (P<O.O1). The least squares means for weaning weight of the calves for different sexes, seasons and years of birth and parities have been given in Table 4. The data showed that the weaning weights in different seasons varied from 133.495 to 147.684 kg. This difference was observed to be sign~ficant statistically. The weaning weight was' the maximum (147.684 kg) in the calves born during spring, followed by those (146.890 kg) born in winter season. However, it was the minimum (133.495 kg) in the calves born during summer season.

The weaning weight of the calves born during different years also varied significantly. The weaning weight of the calves born during 1980 was 142.862 kg and showed almost an increasing trend in the subsequent years attaining its peak (151.450 kg) in the calves born during 1990, indicating improvement in feeding and management over the years. The weaning weight also varied from 132.175 kg in the calves born to buffaloes in first parity to 148.654 kg in the calves of the 8^{th} parity buffaloes, showing an increasing trend from parity 1 onward.

The average weaning weight of 142.8 kg obtained from the present study is supported by the findings of many workers (Alim, 1991; Ansari et al., 1991; Peeva et al., 1994; Rao and Rao, 1996). They reported that the weaning weight in different breeds of buffaloes varied from 134 to 146 kg. The weaning weight was also reported to be influenced by different environmental factors. Alim (1991) reported that sex of calves and season had a significant effect on the weaning weight in Egyptian buffalo calves. Peeva et al. (1994) studied the effect of some genetic and non-genetic factors on the body weights of the Bulgharian Murrah and the crossbreds. It was reported that the weaning weight was significantly affected by the sex of calves and year of birth. Rao and Rao (1996) reported that the weaning weight was significantly lower in first parity calves than those born in later parities. This too is in line with the findings of the present study.

3) 2-Year Weight: The least squares mean for 2-year weight was 352.90±25.96 kg. The analysis of variance for the evaluation of the influence of sex of the calf, year and season of birth and parity on 2-year weight in swamp buffaloes is given in Table 6. The effect of season and year of birth was significant while the calf sex and parity of dam had non-significant effect on 2-year weight.. The regression of 2-year weight on weaning weight (0.929±0.0756) was significant (P<O.OI). The least square means for 2-year weight for different sexes, seasons of birth, years of birth and parities have been given in Table 5. The data showed that 2-year weight fluctuated .widely between the animals born during different seasons. It was the highest (359.7S7 kg) in the animals born during summer, followed by the animals born during autumn and was the minimum (347.034 kg) in the animals born during spring season.

The data in Table 5 also revealed that 2-year weight in the swamp buffaloes born during different years fluctuated from 327.081 to 379.798 kg. The 2- year weight was 344.290 kg

in the animals born during 1980 but it sharply declined to 327.081 kg in the animals born during 1981, Thereafter, it again showed an increasing trend with a slight variation up to 1989.

The body weight at 2 years of age (352.9 kg) conforms to the findings of Momongan et al.(1989); Dahama et al:(1991); Konanta (1992) and Jogi and Lakhani (1996). They reported that weight at 2 years varied from 307.21 to 369:40 kg in different breeds of buffaloes. However, the body weight at 2 years of age was much higher ih almost all other breeds of buffaloes being raised in European countries than all the important breeds of buffaloes (Surti, Nili-Ravi and Murrah) in Indo-Pakistan sub-continent. Similarly, the crossbred buffaloes were also heavier at 2 years of age than many Indian and Pakistani breeds. Tien and Tripathi (1992) and Georgoudis (1993) reported that body weight at 2 years in buffaloes ranged from 398 to 512 kg. This may be attributed to better feeding, management and climatic factors in European countries. This contention is substantiated by the findings of Chantalakhana et al. (1982) who observed that buffalo calves born during the cooler months of ~he year (October-March) gained more weight than those born in hot months due to the availability of good quality fodder. The higher weights of calves at birth and weaning as well as at 2 years of age from buffaloes of many European countries support the contention of many workers who believed that the low growth rate of buffaloes in Asia is related to poor nutrition and management including harsh weather conditions, rather than being an inherent trait of the species.

4) Pre-weaning Average Daily Gain: The least squares mean for pre-weaning average daily gain was 460.50±90.0 1 g. The analysis of variance for the evaluation of the influence of sex of the calf, season of birth, year of birth and parity of dam on pre-weaning average daily gain has been given in Table 6. The effect of all these factors on pre-weaning average daily gain was found to be significant. The least squares means for pre-weaning average daily gain of male and female calves, seasons of birth, years of birth and parities have been given in Table 7. The pre-weaning average daily gain in male and female animals differed significantly. The pre-weaning average daily gain showed wide variations in the animals born during different seasons. It was the maximum (488.827 g) in the animals born during winter season and the minimum (433.719 g) in those born during summer.

The pre-weaning average daily gain in the animals born in different years also fluctuated greatly. The pre-weaning average daily gain was the maximum (502.194 g) in the animals born during 1986 while it was the minimum (398.219 g) in the animals born during 1982. This reflected the variation in feeding and management of the herd during different years. The pre-weaning average daily gain in the animals of this herd also varied significantly due to parity (Table 7). An increasing trend in the pre-weaning average daily gain was obvious from parity I onward, being the maximum (491.976 g) in the calves from buffaloes of 7th parity. The pre-weaning average daily gain in the present study was 460.5 g (Table I). This was in close agreement with many workers who reported that the pre-weaning average daily gain ranged from 405-468 g in different breeds of buffaloes. The pre-weaning average daily gain in the Thai swamp buffaloes was 390 and 400 g in male and female calves respectively (Chantalakhana et al., 1984). Rohilla and Chaudhary (1992) reported that pre-weaning average daily gain in Murrah buffaloes was 436.5 g. Tien and Tripathi (1992) found 436 g as pre-weaning average daily weight gain up to 6 months which was found to be significantly affected by the month of birth. Similarly, Jogi and Lakhani (1996) obtained 478 and 408 g per day weight gain in female and male calves respectively up to 6 months of age, but from 6 -12 months, the males had a higher growth rate than females (477 and 421 g per day respectively). Nawale et al. (1997) however, observed 448 and 418 g average daily gain in male and female Murrah calves while in the Nagpuri male and female calves it was 391 and 348 g respectively.

5) Post-weaning Average Daily Gain: The least squares mean for post-weaning average daily gain was 408.34±65.63 g (Table I). The analysis of variance for the evaluation of the influence of different environmental factors on post-weaning average daily gain has been given in Table 6, showing significant effect of all environmental factors (year and season of birth and parity) with the exception of sex which was non-significant. The least squares means for post-weaning average daily gain of calves for different sexes, seasons of birth, years of birth and parities have been given in Table 8. The data showed that the post-weaning average daily gain of the calves born during different seasons varied from 388.564 to 431.409 g in different seasons. Similarly, the post-weaning average daily gain in the calves born during different years showed great fluctuations and varied from 362.806 to 476.456 g in the calves born during 1980-87. The post-weaning average daily gain as obtained in the present study was much higher. than that found by several workers. They reported that the average daily gain at 2 years ranged from 230-400 g in different breeds of buffaloes (Chantalakhana et al., 1984 and Zava et al., 1994).

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Table 1. Least squares means, standard deviation (SO) and coefficient ofvariation (C.V) of different growth traits of swamp buffalo calves

Traits	No. of observations	Mean ± SD	C.V. (%)
Birth weight (kg)	1736	30.11± 4.49	14.9
Weaning weight (kg)	1449	142.89±21.41	14.9
2-year weight (kg)	429	352.90±25.96	7.4
Pre-weaning average daily gain (g)	1I29	460.50±90.0 I	19.6
Post-weaning average daily gain (g)	429	408.34±65.63	16.0

Table 2. Analysis of variance for the evaluation of environmental effects on birth weight, weaning weight and 2- year weight of swamp buffalo calves

Source of variation	Birth weight		Weaning weight		2- year weight	
	d.f.	Mean squares	d.f.	Mean squares	d.f.	Mean squares
Sex of calf	1	1766.92**	1	135.51 NS	1	969.41 NS
Season of birth	3	130.77**	3	11951.65**	3	4015.66**
Year of birth	11	135.66**	11	6908.92**	9	7224.73**
Parity of dam	8	426.66**	8	3916.26**	7	476.25 NS
Birth weight	-	-	1	134085.07**	-	-
Weaning weight	-	-	-	-	1	101598.18**
Residual	1712	20.16	1424	458.35	407	673.67

** P<O.O1; NS = Non-significant.

Table 3. Least squares means(LSM) and standard errors (SE) for birth weight of male and female calves, seasons of birth, years of birth and parities

Independent variable	No. of Obs.	LSM ± SE	Independent variable	No. of Obs.	LSM ± SE
Sex			1987	193	30.202±0.378
Male	871	31.479±0.247	1988	186	32.629±0.368
Female	865	29.447±0.248	1989	190	29.488±0.366
Seasons of birth			1990	200	30.109±0.369
Winter	442	29.661±0.284	1991	208	29.643±0.351
Spring	282	30.747±0.345	Parities		
Summer	436	30.939±0.292	1	330	27.436±0.261
Autumn	576	30.506±0.265	2	340	29.850±0.253
Years of birth			3	334	30.763±0.253
1980	66	29.675±0.616	4	288	31.657±0.278
1981	66	31.031±0.602	5	214	31.225±0.322
1982	109	30.919±0.490	6	127	30.754±0.413
1983	105	31.568±0.492	7	67	30.886±0.564
1984	106	29.815±0.482	8	25	31.424±0.909
1985	139	30.473±0.428	9	11	30.171± 1.369
1986	168	30.004±0.399			

Table 4. Least squares means (LSM) and standard errors (SE) for weaning weight of calves of different sexes, seasons of birth, years of birth and parities

Independent variable	No. of Obs.	LSM± SE	Independent variable	No. of Obs.	LSM ± SE
Sex			1988	169	130.002 ± 1.900
Male	740	142.602 ± 1.367	1989	191	147.003 ± 1.807
Female	709	141.975 ± 1.383	1990	195	151.450 ± 1.848
Seasons of birth			1991	41	140.230 ± 3.540
Winter	435	146.890 ± 1.507	Parities		
Spring	306	147.684 ± 1.702	1	299	132.175 ± 1.419
Summer	260	133.495 ± 1.756	2	272	140.944 ± 1.395
Autumn	448	141.087 ± 1.528	3	275	143.745 ± 1.354
Years of birth			4	250	1430481 ± 1.474
1980	29	142.862 ± 4.239	5	178	144.316 ± 1.708
1981	38	144.985 ± 3.702	6	95	147.519 ± 2.299
1982	76	125.340 ± 2.795	7	53	147.226 ± 3.035
1983	99	142.746 ± 2.463	8	19	148.654 ± 4.967
1984	116	143.660 ± 2.292	9	8	132.540 ± 7.662
1985	145	144.904 ± 2.086	Birth weight		2.093 ± 0.122
1986	164	150.940 ± 1.993	(Regression-Linear)		
1987	186	143.345 ± 1.911			

Table 5. Least squares means (LSM) and standard errors (SE) for 2-year weight of calves of different sexes, seasons of birth, years of birth and parities

Independent variable	No. of Obs.	LSM ± SE	Independent variable	No. of Obs.	L~M ~SE
Sex			1986	59	353.401 ± 3.865
Male	215	355.274 ± 2.504	1987	57	374.663 ± 3.774
Female	214	352.180 ± 2.466	1988	46	347.904 ± 4.127
Seasons of birth			1989	13	379.798 ± 7.545
Winter	142	348.648 ± 2.897	Parities		
Spring	77	347.032 ± 3.519	I	48	355.516 ± 4.134
Summer	84	359.787 ± 3.520	2	92	351.586 ± 2.969
Autumn	126	359.441 ± 2.940	3	115	351.505 ± 2.565
Years of birth			4	78	356.799±3.103
1980	29	344.290 ± 5.656	5	49	356.186 ± 3.975
1981	38	327.081 ± 4.852	6	29	346.664 ± 5.081
1982	33	343.280 ± 5.298	7	12	353.700 ± 7.697
1983	49	364.855 ± 4.264	8	6	357.858 ±10.819
1984	46	353.620 ± 4.238	Weaning weight		00.928 ± 0.075
1985	59	348.376 ± 3.760	(Regression-Linear)		

Table 6. Analysis of variance for the evaluation of environmental effects on pre- weaning and post-weaning average daily gains of swamp buffalo calves

Source of variation	Pre-weaning average daily gain		Post-weaning average daily gain	
	d.f	Mean squares	d.f	Mean squares
Sex of calf	1	51309.30*	1	3949.43N~
Season of birth	3	133155.63**	3	32767.19**
Year of birth	9	90614.33**	9	62285.45**
Parity of dam	8	99620.92**	7	10788.15*
Residual	1107	8101.58	408	4271.96

** P<O.O1; * P<0.05; NS = Non-significant.

Table 7. Least squares means (LSM) and standard errors (SE) for pre-weaning average daily gain of calves of different sexes, seasons of birth, years of birth and parities

Independent variable	No. Obs.	LSM ± SE	Independent variable	No. Obs.	LSM ± SE
Sexes			1986	164	502.194 ± 9.248
Male	586	472.991± 7.198	1987	186	470.236 ± 8.923
Female	543	459.409 ± 7.300	1988	169	429.319± 8.513
Seasons of birth			1989	107	472.675 ± 10.712
Winter	347	488.827 ± 7.928	Parities		
Spring	229	475.242 ± 8.827	1	247	406.578 ± 6.427
Summer	231	433.719 ± 8.580	2	227	457.748 ± 6.505
Autumn	322	467.012 ± 8.121	3	235	474.830 ± 6.032
			4	182	477.276 ± 7.067
Years of birth	29	475.521 ± 18.353	5	123	471.774 ± 8.595
1980	38	482.466± 16.126	6	67	477.672 ± 11.472
1981	76	398.219 ± 12.526	7	29	491.976± 17.120
1982	99	474.689 ± 11.158	8	15	462.255 ± 23.538
1983	116	472.547 ± 10.450	9	4	475.689 ± 45.609
1984	145	484.134 ± 9.614			
1985					

Table 8. Least squares means(LSM) and standard errors (SE) for post-weaning average daily gain of calves for different sexes, seasons of birth, years of birth and parities

Independent variable	No. Obs.	LSM± SE	Independent variable	No. Obs.	LSM ± SE
Sexes •			1985	59	413.996± 9.403
Male	215	411.760 ± 6.300	1986	59	393.987 ± 9.233
Female	214	405.629 ± 6.139	1987	57	476.456 ± 9.502
Seasons of birth			1988	46	385.595 ± 10.380
Winter	142	400.355 ± 7.181	1989	13	448.763 ± 18.973
Spring	77	388.564 ± 8.862	Parities		
Summer	84	414.450 ± 8.580	I	48	433.590 ± 10.079
Autumn	126	431.409 ± 7.387	2	92	400.610 ± 7.416
Years of birth			3	115	397.463 ± 6.451
1980	29	362.806 ± 13.889	4	78	416.437± 7.812
1981	38	354.205 ± 12.048	5	49	406.950 ± 9.941
1982	33	431.429 ± 12.882	6	29	382.180± 12.793
1983	49	444.136 ± 10.738	7	12	392.896 ± 19.327
1984	46	375.568 ± 10.663	8	6	439.427 ± 27.201

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