S.Ü. Ziraat Fakültesi Dergisi 10(13) : 125-140, 1996

EFFECT OF BREED TYPE, SEX BIRTH YEAR AND SEASON OF BIRTH AND THEIR INTERACTIONS ON LIVEWEIGHT CHANGE IN BEEF CATTLE

Yalçın BOZKURT and Ioan AP DEWI

ABSTRACT

This study was designed to examine main and interaction effects of breed type, sex, birth year and season on liveweight change in beff cattle as a represantative 18-Month commercial beef system.

The study involved 351 animals in total (82 strees, 132 heifers and 137 bulls) which were either slaughtered or sold at mean liveweight of 380 and 280 kg, respectively. The breeds used were Limousins (145); Herefords (90), Friesians (72), Welsh Blacks (22) and Belgian Blues (22). Mean age of animals was 17 months old and there were 154 and 189 spring and autummn born animals. The animal data included the records belonging to years from 1985 to 1988, which were recorded at the University of Wales, university farm, Bangor, UK.

The results obtained by using least-squares analysis showed that there were significant ($P<0.05$) differences between breeds for liveweight. Belgian Blues were superior (355 kg) and Welsh Blacks (310 kg) were inferior to other breeds while Limousinis (321 kg), Herefords (327 kg) and Friesinas (329 kg) were almost similar. Whilst age had a significant ($P<0.05$) effect on liveweight there was no significant ($P>0.05$) differences in sex groups. Autumn-born animals (350 kg) were significantly ($P<0.05$) heavier than those born in spring (306 kg). Significant ($P<0.05$) differences in liveweight were also found between the data recorded years. The liveweights of the animals increased significantly each year from 1985 to 1988, from 263 to 388 kg respectively. Statistically significant ($P<0.05$) interactions were found between birth season x sex, birth year x sex and breed x birth season.

Key Words : Beef cattle, liveweight, breed and sex, birth year and season, interactions.

ÖZET

IRK, CİNSİYET, DOĞUM YILI VE DOĞUM MEVSİMİNİN VE BUNLARIN İNTERAKSİYONLARININ KÜLTÜR IRKI ET SIĞIRLARINDA CANLI AĞIRLIK DEĞİŞİMİNE OLAN ETKİLERİ

Bu araştırma 18-Aylık ticari et sistemi çerçevesinde farklı ırk ve cinsiyetin, doğum yılı ve mevsiminin, kültür ırkı et sığırlarında canlı ağırlık değişimine olan etkilerinin ve interaksiyonlarının incelenmesi amacıyla yapılmıştır.

School of Agricultural and Forest Sciences, University of Wales, Bangor, UK.

Bu çalışmada toplam 351 hayvan kullanılmış olup; bunlardan 82 kastre edilmiş hayvan, 132'si düve ve 137'si boğalardan oluşmaktadır. Hayvanların bir kısmı ortalama 380 kg canlı ağırlıkta kesime gönderilmiş diğer bir kısmı da ortalama 280 kg canlı ağırlıkta satılmışlardır. Kullanılan ırklar Limosin (145), Herford (90), Siyah Alaca (72), Galler Siyahı (22) ve Belçika Mavisi (22)'dir. Hayvanların ortalama yaşı 17 ay olup 154 ilkbahar ve 189 sonbahar mevsimi doğumludur. Bu çalışmada kulanılan veriler İngiltere'de Galler Üniversitesi çiftliğinin 1985-1988 yılları arasındaki kayıtlarından oluşmaktadır.

En küçük kareler analizleri ile elde edilen sonuçlar ırkların ağırlıkları arasında farklılıkların önemli ($P<0.05$) olduğunu göstermiştir. Canlı ağırlık bakımından diğer ırklara göre Belçika Mavisi (355 kg) hayvan daha üstün ve Galler Siyahı (310 kg) hayvanlar daha düşük bulunmuşlardır. Limosin (321 kg), Hereford (327 kg) ve Siyah Alacalar (329 kg) ise hemen hemen birbirine yakın ağırlıkta olmuşlardır. Yaşın canlı ağırlık üzerine olan etkisi önemli ($P<0.05$) iken cinsiyetler arasında bu parametreler bakımından önemli bir farklılık ($P>0.05$) bulunmamıştır. Sonbaharda doğan hayvanların (350 kg) canlı ağırlıklarının, ilkbaharda doğanlara (306 kg) kıyasla istatistiki olarak önemli derecede ($P<0.05$) daha fazla oldukları tesbit edilmiştir. Hayvanların canlı ağırlıklarında yıllara göre önemli farklılıklar bulunmuş ve canlı ağırlıkların 1985'den 1988'e her yıl arttığı gözlenmiştir (263 kg'dan 388 kg). Ayrıca doğum mevsimi x cinsiyet ; doğum yılı x cinsiyet ve ırk x doğum mevsimi arasında istatistiki olarak önemli ($P<0.05$) interaksiyonlar bulunmuştur.

Anahtar Kelimeler : Et sığırları, canlı ağırlık, ırk ve cinsiyet, doğum yılı ve mevsimi, interaksiyon.

INTRODUCTION

Conformation and growth potential vary greatly between different breeds of cattle. While there are certainly differences between breeds in growth rate, the liveweight gain which can be achieved from a given area of grass of quantity of feed is similar for most breeds, provided that each breed is fed and managed according to its own particular requirements (Wilkinson, 1985).

World-wide, there are many published reports of comparisons of the main beef breed crossesin terms of growth rates and slaughter end points, but the results of these cmparisons may not be applicable to regional farming conditions and systems other than those in which they were conducted (Keane and More O'Ferral, 1992).

The productivity of beef cattle is related to sex type. Bulls grow faster, utilise food more efficiently and have a higher carcass lean proportion than steers (Harte *et al.*, 1965). Streers in turn are similar or superior to heifers in growth rate, food

conversion efficiency and carcass lean proportion at the same age or weight (Hedrick *et al.*, 1969; Galbraith and Topps, 1981).

There is no agreed age or weight at which growth rates of females and males start to differ and the magnitude of the difference between the sexes may depend on breed type (Keane and Drennan, 1987).

The published results on the defferences in lifetime productivity between heifers and strees are not consistent. The advantages and disadvantages of using spring or autumn-born calves for beef production has always been an important issue of decisionmaking for farmers. The advantage of autumn-calving is that at the autumn sales, the calves are older, heavier and therefore more saleable than those from spring-born cows (Allen and Kilkenny, 1984). However, autumn-calving requires a higher investment in buildings, conservation equipment and conserved feed during the winter (Cooper and Willis, 1989).

Information on the comparative performance and slaughter weights of breeds and crosses in the main beef production systems has been collected from commercial beef farms recorded by the Meat and Livestock Commission (MLC) in Britain (Allen and Kilkenny, 1984). However, it is possible that the recorded breed differences are biased due to different management practices and effects of sex, age of dam and season of birth (Cooper and Willis, 1989).

Data was obtained from a commercial beef system recorded at the University Farm between 1985-1988. The objectives were to examine the effects of breeds, sexes, age, birth year and season of birth on liveweight of beef cattle in representative commercial 18 month beef system.

MATERIALS AND METHODS

Data and Animal Records

Data for this study consisted of records collected from the University Farm beef unit as part of MLC monitoring of enterprise performance between 1985-88. The recorded liveweights of animals were either slaughter weights or sale weights. Average liveweights for slaughtered and sold animals were 380 and 280 kg respectively. In addition to sale or slaughter weights, animal sex, breed type, date of birth and season of birth was also recorded. The breeds used included Friesians and their crosses with Limousin, Hereford, Belgian Blue and Welsh Black. The number of animals and their distribution by breed and sex are shown in Table 1.

The study involved a total of 351 animals; 82 steers, 132 heifers and 137 bulls. There was an unequal distribution of cattle by breed. The majority were Limousins (145). There were 90 and 72 Herefords and Friesians respectively, and smaller number of Welsh Black and Belgian Blue.

Some information on sex, birth date and season of birth was unavailable for 8 animals. Therefore, these were excluded from the statistical analysis.

The cattle were either spring-born (January to August) or autumn-born (August to December). The distribution of animals by breed and season of birth is shown in Table 1. There were 154 spring-born and 189 autumn-born cattle and there were unequal numbers of animals of each breed born in the autumn and spring periods.

Table 1. The Distribution of Animal Breeds by Season of Birth and Mean Age at Sale or Slaughter (In Parentheses).

	BIRTH SEASON		
	Spring	Autumn	Total
BREEDS			
Limousin	46 (18)	99 (18)	**145 (18)**
Hereford	38 (19)	47 (16)	**85 (17)**
Friesian	33 (18)	39 (16)	**72 (17)**
Welsh Black	19 (8)	- (-)	**19 (8)**
Belgian Blue	18 (12)	4 (11)	**22 (12)**
Total	**154 (17)**	**189 (17)**	**343 (17)**

The distribution of animals by breeds and years is shown in Table 2. The majority of animals were recorded in 1986 and 1987 with smaller numbers in 1985 and 1988. At least three breeds were represented in 1986-1988 but only records for the Limousin and Hereford were available in 1985.

The distribution of steers, heifers and bulls born in either Spring or in Autumn is shown in Table 3. There were 27 and 55 steers; 52 and 75 heifers and 75 and 59 bulls born in the spring and autumn, respectively.

Table 2. The Number of Animals by Breeds Within The Data Recorded Years.

Years	1985	1986	1987	1988	Total
Limousin	9	76	50	10	**145**
Hereford	1	35	48	1	**85**
Friesian	--	29	43	--	**72**
Welsh Black	--	--	--	19	**19**
Belgian Blue	--	--	12	10	**22**
Total	**10**	**140**	**153**	**40**	**343**

Table 3. The Number of Animals Born in Spring or Autumn by Sex Groups and Breeds

	SPRING			AUTUMN		
	Steers	Heifers	Bulls	Steers	Heifers	Bulls
Limousin	5	26	15	25	40	34
Hereford	6	10	22	15	21	11
Friesian	16	--	17	13	14	12
Welsh Black	--	4	15	--	--	--
Belgian Blue	--	12	6	2	--	2
Subtotal	**27**	**52**	**75**	**55**	**75**	**59**
Total		**154**			**189**	

Animal Management

Animals were reared together from birth to slaughter or to the time of sale at a mean age of 17 months. Theyat pasture in summer and were housed and offered were grass silage an concentrates in winter. Specific information about animal management such as the amount of concentrates fed and food intake was not available.

The majority of the calves were born at the University farm. Mean date of birth was 16 September for autumn-born and 2 February for spring-born animals. Animals were either sold (198) or slaughtered (118) as they reached sale condition, assessed by subjective handling.

Statistical analysis

The data for breed, sex, season of birth and birth year were analysed by leastsquares analysis of variance (Harvey, 1990) using the following model :

$$Y_{ijklmn} = \mu + \alpha_i + \beta_j + \gamma_k + \lambda_l + \phi_m + \alpha\beta_{ij} + \alpha\gamma_{ik} + \beta\gamma_{jk} + \beta\lambda_{jl} + \Sigma\iota_{jklmn}$$

where Yijklmn is the ijklmn the observation of animal weight,

μ is the overall mean,

α_i is the effect of breed,

β_j is the effect of sex,

γ_k is the effect of season of birth,

λ_l is the effect of birth year,

ϕ_m is the effect of age,

ε_{ijklmn} is the residual effect or random error associated with the individual animal and $\alpha\beta_{ij}$, $\alpha\gamma_{ik}$, $\beta\gamma_{jk}$ and $\beta\lambda_{jl}$ are the two -way interactions of breed x sex, breed x season, sex x season and sex x birth year, respectively. Breed type, sex,

season of birth and year factors were fitted as fixed effects, and age was included in the model as a covariate.

It was not possible to fit a model including the interaction between breed type and year because there was insufficient data for all breeds in each year.

The significance of differences between individual breed means, birth year means and interaction means were examined using Scheffé's pairwise comparison test.

RESULTS

The least-squares means and standard errors for liveweights for breed type, sex, birth season and birth year and the levels of significance of main effects and interactions are shown in Table 4.

Probability levels and least-squares means for main effects of breed and birth season and the interactions between breed x birth season are shown in Table 5.

Main Effects

Breed type

There were significant ($P<0.05$) differences between breeds for liveweight (Table 4). Mean liveweights for Limousins, Herefords, Friesians, Welsh Blacks and Belgian Blues were 321, 327, 329, 309 and 353 kg respectively. The liveweights of Belgian Blues were significantly greater ($P<0.05$) than both Limousin and Welsh Blacks. There were no significant ($P>0.05$) differences in liveweight between the other breeds although the difference between Herefords and Belgian Blues was close to being statistically significant.

Average breed weights for bulls and heifers from MLC on-farm performance records 1985-1990 are illustrated in Figure 2 for comparison with breeds weights obtained in this study. Belgian Blues had the highest weights followed by Friesians, Herefords and Limousins. Welsh Blacks were the poorest among the breeds. As illustrated in Figures 1 and 2, the results obtained in this study generally agree with the MLC results.

Age and Sex Groups

Age at the time of slaughter or sale averaged 17 months (s.e. = 0.39). Age had a significant ($P<0.05$) effect on liveweight with R^2 of 0.91. The regression equation for age was positive linear and the estimated weight gain from the regression equation was 17.7 kg (s.e=1.17) per month of age corresponding to a liveweight gain of 0.59 kg per day. Least-squares means for the liveweight of sex groups are shown in Table 4. Weight declined in the order Bulls > Steers > Heifers but there were no significant differences in liveweight ($P>0.05$) between sex groups.

Table 4. Least-Squares Means of Liveweight (kg), Standard Errors (s.e.) and Levels of Significance (P) for the Effects of Breed, Birth Season, Birth Year and Sex*

SEX	Steers			Heifers			Bulls			BREED MEANS		
	Weight	n	s.e.	Weight	n	s.e.	Weight	n	s.e.		n	s.e.
BREEDS					**(P=0.13)**					**(P=0.04)**		
Limousin	319	30	10.7	301	66	10.8	343	49	8.8	**321a**	145	6.3
Hereford	335	21	11.3	318	31	12.5	328	33	10.2	**327ab**	85	6.7
Friesian	343	29	10.8	308	14	17.5	335	29	9.8	**329ab**	72	7.8
Welsh Black	--	--	--	292	4	23.7	327	15	15.4	**309a**	19	13.9
Belgian Blue	334	2	32.9	360	12	22.5	364	8	16.8	**353b**	22	12.3
BIRTH SEASON					**(P=0.04)**					**(P=0.04)**		
Autumn	343ab	55	11.2	346a	75	13.8	359a	59	9.1	**349a**	189	7.3
Spring	314bcd	27	16.6	285c	52	13.9	320d	75	10.2	**306b**	154	9.3
BIRTH YEAR					**(P=0.01)**					**(P=0.04)**		
1985	290abc	3	31.6	235abc	1	44.9	264bd	6	27.7	**263a**	10	27.1
1986	282b	43	12.6	293b	49	13.2	331ad	48	13.2	**302b**	140	10.1
1987	353ac	36	12.8	344a	61	11.2	376c	56	7.1	**358c**	153	7.4
1988	--	--	--	390c	16	17.1	386c	24	17.4	**388d**	40	16.4
SEX MEANS	**328**	**82**	**11.8**	**316**	**127**	**11.8**	**339**	**134**	**7.6**			**P=0.1**

* Means followed by the same superscripts do not differ significantly (P>0.05).
n= Number of observations., s.e. = Standart error of means.

Table 5. Least-Squares Means, Standard Errors and Levels of Significance (P) For the Effects of Breed and Birth Season*

	BIRTH SEASON						BREED MEANS		
	Spring			Autumn					
	Weight	n	s.e.	Weight	n	s.e.		n	s.e.
				(P=0.01)			(P=0.04)		
Limousin	315 ab	46	10.5	327ae	99	5.6	321a	145	6.3
Hereford	317 abc	38	10.2	337ae	47	7.2	327ab	85	6.7
Friesian	307ab	33	12.6	350ce	39	8.0	329ab	72	7.8
Welsh Black	288fbd	19	15.3	--	--	--	308a	19	13.9
Belgian Blue	304ab	18	18.8	401e	4	21.8	353b	22	12.3
Season Means	308a	154	9.3	349b	189	7.3			P=0.0

* Means followed by the same superscripts do not differ significantly (P>0.05).
n = Number of observations.
s.e. = Standard error of means.

Birth Season

Significant (P<0.05) differences in liveweight between birth seasons were recorded. Liveweights were 349 kg for autumn-born animals and 306 kg for spring born animals (Table 5).

Birth Year

The differences in liveweight between years were significant (P<0.05). The liveweights of the animals increased significantly each year from 1985 to 1988, from 263 to 388 kg, respectively (Table 4 and Figure 3).

Interactions

Least-squares means for the two-way interactions are shown in Tables 4 and 5. There were statistically significant (P<0.05) interactions between birth season x sex, birth year x sex, and breed x birth season. There was no significant (P>0.05) interaction between breed type and sex.

Birth season and sex interaction

Liveweights of the autumn born cattle did not differ significantly (P>0.05) between sexes. However, bulls born in the spring were significantly heavier than spring born heifers (P<0.05) but not steers. Autumn born cattle were heavier than spring born cattle, but the difference was only significant (P<0.05) for bulls and heifers.

Birth year and sex interaction

There was a significant (P<0.05) interaction between birth year and sex (Table 4 and Figure 3). There was a general trend for weight to increase annually form 1985 to 1988. However, a consistent trend was not observed for steers, and bulls gave

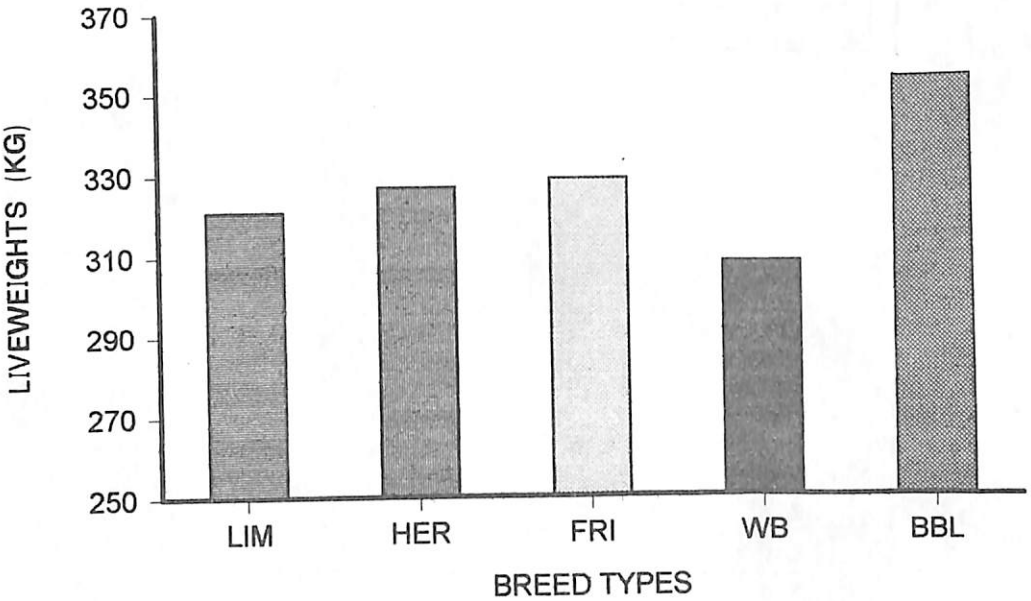

Figure 1. Mean liveweights for breeds.
LIM = Limousins; HER = Herefords ; FRI = Friesians; WB = Welsh Black; BBL = Belgian Blue.

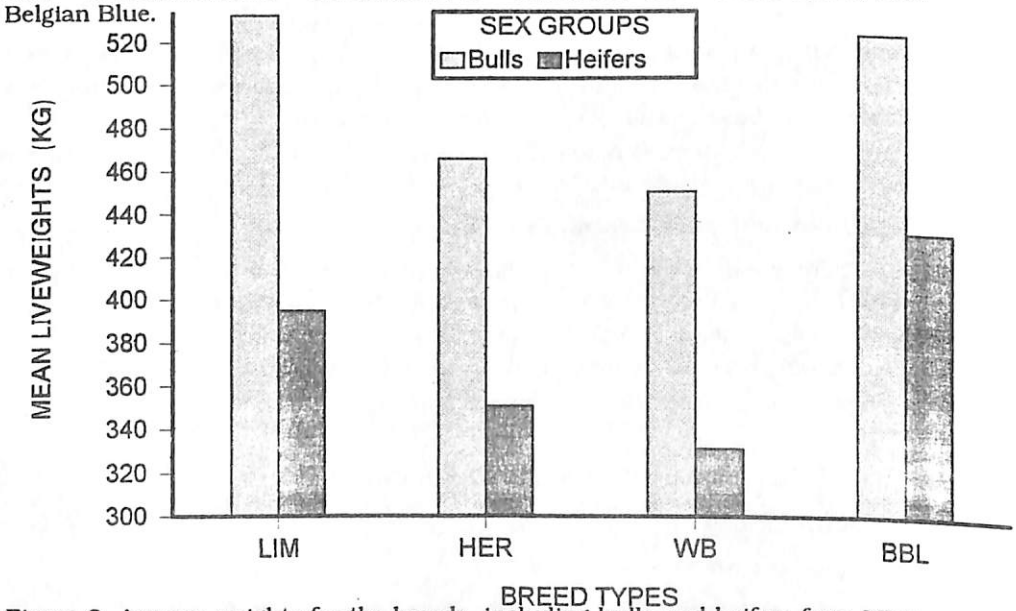

Figure 2. Average weights for the breeds, including bulls and heifers from MLC on farm performance records 1985-1990.
LIM = Limousins; HER = Herefords ; WB = Welsh Black; BBL = Belgian Blue.

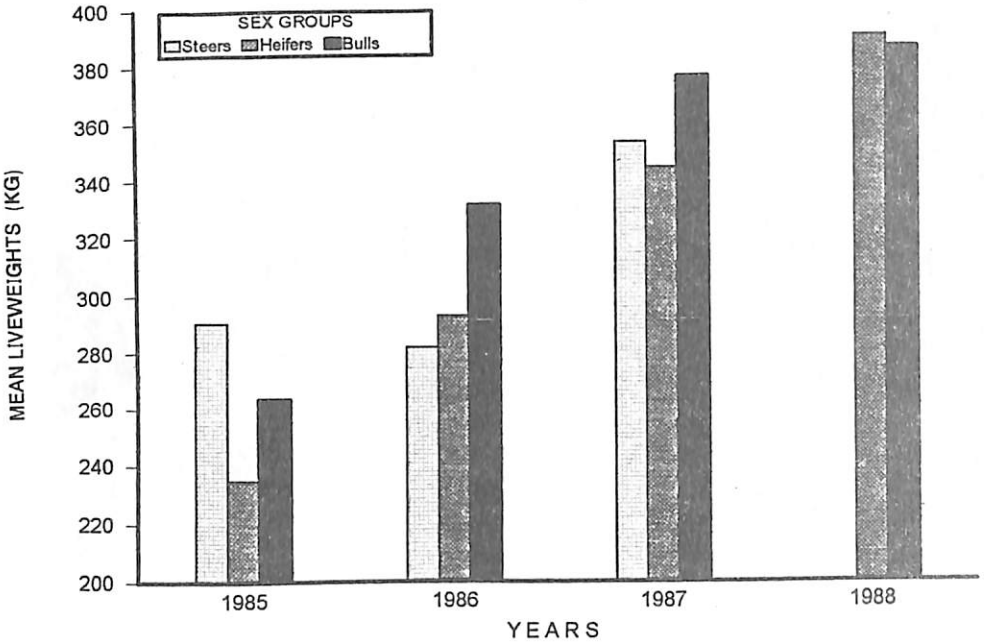

Figure 3. A comparison of performance of steers, heifers and bulls during the data recorded years.

almost similar results in 1987 and 1988. Whilst significant differences between sexes were not observed in the overall means, differences were noted within years. For example, bulls in 1986 were significantly heavier than both steers and heifers. However, in 1987 they were only heavier than heifers and similar to steers. Steers were heavier than heifers in all recording years, except in 1985.

Breed and Birth Season Interaction

There was a significant ($P<0.05$) interaction between breed type and season of birth (Table 5). Whilst there was a general tendency for autumn born calves to be heavier than spring born calues a significant difference was not observed for each breed. Spring born calves were significantly lighter than those born in the autumn for Friesian and Belgian Blue but not the Limousin and Hereford.

DISCUSSION AND CONCLUSION

Main Effects

Breed comparisons

The significant differences in liveweight observed between breeds were generally consistent with the published reports. Weight declined in the order

Belgian Blue > Friesian > Hereford > Limousin > Welsh Black (Figure 1). It should be noted that significant differences were observed between the heaviest and the lightest breeds.

The results of this study are in general agreement with the relative performance of breeds in commercial on-farm recording by the Meat and Livestock Commission (Figure 2) (MLC, 1987, 1988 and 1990; Allen and Kilkenny, 1984).

The superior weights of the Belgain Blue in this study are in agreement with the results of Keane (1990) and Nyson and Hansen (1990) who made lifetime breed comparisons and Anderson et al. (1991) who made comparisons from 7 to 13 months. In contrast, Madsen (1992) reported that, from 13 months age onwards, the performance of Herefords was better than both Belgain Blues and Limousins in terms of both DLWG and LW. Whilst Belgain Blues were heavier than Limousins their DLWGs were lower than those of Limousins.

The non-significant differences between Friesians, Limousins, Herefords and Welsh Blacks in this study agree with the findings of More O'Ferral and Keane (1990) which showed that Friesians were heavier than Herefords by only 2 %. This also agrees with earlier results by Southgate *et al.* (1982 ad 1988). The data reviewed by Kempster and Southgate (1984) also indicated that there was little difference in growth rate between Friesians and Limousin crosses in some British trials. Southgate *et al.* (1988) reported similar performance results for Friesian, Hereford x Friesian and Limousin x Friesian steers in a 16-month beef system but in a 24-month system the Limousin crosses were superior. In another study, Keane *et al.* (1989) found no significant difference between Friesians and Limousins in daily liveweight gain.

Therefore, the majority of published results together with the present results indicate that performance of Limousin, Hereford and Friesian crosses were similar. Belgian Blues are superior to other breeds examined.

Age and Sex Comparisons

As expected, liveweight increased significantly ($P<0.05$) with age. Preston and Willis (1982) stated that there is a linear relationship between age and liveweight and that liveweight generally increases with age. The mean LWG of 0.59 kg per day is slightly lower than performance targets but it is within the range of bottom third commercial units recorded by MLC.

Although there were no statistically ($P>0.05$) significant differences in liveweight between sex groups, bulls were heavier than steers and were 7.3 % heavier than heifers. Similarly, steers were 3.4 % heavier than heifers (Table 4 and Figure 1). The trends in the results are similar to those found in commercial on-farm recording work (Allen and Kilkenny, 1984). The performance efficiency of bulls compared to strees and heifers; and steers compared to heifers were similar

to those efficiency rates suggested by Price and Yeates (1969) who reported that bulls were 5-10 % heavier than steers; Keane (1987) (10 % steers *over* heifers); Keane and Drennan (1990) (5.6 % steers *over* heifers); Raue (1991) (8.5 % bulls *over* steers, 26 % bulls *over* heifers and 16 % steers *over* heifers) and Shwarz *et al.* (1992) (17 % bulls *over* steers, 23 % bulls *over* heifers and 4 % steers *over* heifers).

Keane and Drennan (1987) compared lifetime growth of steers and heifers and found that there was no difference between steers and heifers in growth rate up to 13 months of age and 30 kg LW but from 13 to 24 months steers grew faster than heifers. It would appear that the failure to observe statistically significant differences between the sexes in the present study could be due to insufficient or missing data for sexes within breeds and also to the smaller than usual responses. It could also be a reflection of the different managemenet systems used. The possible explanation is that feeding strategies for sexes might have been different during the years that data was collected.

Birth Season Comparisons

Animals born in the autumn (349 kg) were 14 % heavier than animals born in spring (306 kg). These statistically significant ($P<0.05$) differences in this study for liveweight between birth seasons are in agreement with previous studies. Oni *et al.* (1988) and Nautiyal and Bhat (1989) reported a significant effect of season of birth on liveweight at 6, 12 and 18 months of age. Pons *et al.* (1989) also found that animals born in autumn (July-September) performed better than those born at other times. Similar results were also observed in work by Simm *et al.* (1985) who measured growth rate of Hereford bulls and Shrivastas *et al.* (1985) who found differences in season of birth and observed that animals born between September and November had the highest growth rate. Barcellos and Lobato (1992) reported that calves born in spring were 15.5 % heavier at 205-days than those born in the autumn, however, they were 27.7 % lighter at 365-days and 24.7 % heavier at 550-days. In contrast, Wilson *et al.* (1983) reported that there was no significant effect of birth seasons on 205-305 and 365-days liveweights and carcass characteristics of British (Hereford) and Continental European breeds (Charolais, Chianina, Limousin and Simmental). Similar performance of spring and autumn born calves was attributed to the effect of *ad-libitum* grazing of high quality pastures by spring born calves, in comparison to a lower quality forage available to the autumn born calves.

Birth Year Comparisons

Significant ($P<0.05$) differences in liveweight between years were observed. Animals born in 1988 performed better than animals born in other recorded years. The liveweights of the animals increased annually from 1985 to 1988. An increase of 48 % was observed from 1985 to 1988.

The results are in agreement with the findings of Simm *et al.* (1985), Shrivastav *et al.* (1985) and Pons *et al.* (1990) who reported significant differences in animal performance between birth years. However, Keane *et al.* (1989) found that there were no significant effects of year of birth on the performance and no significant difference between breed types (Friesian, Limousin and Blonde d'equtain).

The significant birth year effects on liveweights reflected possible variations in environmental conditions and animal management from year to year. Although the detailed information on animal management is not available, the apparent improvement observed in animal performance from 1985 to 1988 could be attributed to the improvement in animal management system implemented at the University Farm since breed types, sex and age were accounted for in the statistical model used for the analysis of the data. This could be due to improved cattle handling facilities, adjustment of stocking rates and feeding levels and to improved performance monitoring.

Interactions

Breed and Sex Interaction

Although there was no significant ($P>0.05$) interaction between breed and sex groups, generally bulls of each breed tented to be heavier than heifers and steers with the exception of Hereford and Friesian bulls. Steers of each breed were also heavier than the heifers of other breeds with the exception of Belgian Blue steers.

The absence of a two-way interaction between breed type and sex was also observed by Sharma *et al.* (1982) and Wilson *et al.* (1983). However, McNally (1970) and Haycock and Stewart (1973) observed significant sex x breed interactions in British and Continental breeds. Haycock and Stewart (1973) reported there was a greater difference between sexes for Charolais than for other breeds (Herefords and Friesians) which led to a significant interaction between sex and breed. In this study, a larger (though non-significant) difference between sexes for Limousin and Friesian crosses than for other breeds was observed. McNally (1970) also reported that there was a consistent tendency for the difference between breeds to depend on Charolais male rather than females and found the interaction between breed and sex to be highly significant.

Birth Season and Sex Interaction

The interaction between birth season and sex groups was statistically significant ($P<0.05$). Bulls were heavier than steers and heifers for both spring and autumn calvings but differences between sexes were less apparent for spring calving. There was a consistent trend for autumn born steers, heifers and bulls to be heavier than those born in spring. A similar trend was also reported by Pons *et al.* (1989) that male calves born between July and September performed better

than both males and females born at other times. Gaertner *et al.* (1991) reported a significant interaction between sex and season of birth for weaning weight that autumn born steer calves were 26.4 kg heavier than winter born steer calves, whereas autumn born heifers were 22.2 kg heavier than winter born heifers. However, *et al.* (1983) found that there was no significant interaction between sex and season of birth.

Birth Year and Sex Interaction

A significant ($P<0.05$) interaction between birth year and sex groups was recorded. The bulls born in all data recorded years generally tended to be heavier than steers and heifers with the exception of 1985 and 1988 in which bulls were not heavier than steers and heifers respectively (Figure 3).

A consistent trend was observed for weight to increase annually within sexes, especially for heifers and bulls.

Breed and Birth Season Interaction

The significant ($P<0.05$) interaction between breed type and season of birth was observed. This interaction was also demonstrated by Henningsson (1986) on data from performance-tested Swedish Friesian and Swedish Red-and-White bulls. However, Wilson *et al.* (1983) reported that there was no significant interaction between breed and season of birth.

The general trend was for differences in liveweights was to be non-significant ($P>0.05$) between breeds within seasons. However, the Belgian Blue had the highest weight for autumn born calves whereas the Hereford was the heaviest breed from spring births (Figure 3).

ACKNOWLEDGEMENTS

The authors thank the University of Wales, Bangor farm manager who provided animal data and records for this study. Dr. Yalçın Bozkurt acknowledges the scholarship given by the Turkish Government.

REFERENCES

Allen, D. and Kilkenny, B., 1994. Planned Beef Production. Collins, London.

Andersen, B.B., Madsen, P., Klastrup, P. and Ovesen, E., 1991. Performance testing for beef in 1989/1990. Bretming fra, Statens Husdyrbrugsforsog. No. 692, pp. 66.

Barcellos, J.O.J. and Lobato, J.F., 1992. Effects of season of birth on growth in purebted and crossbred Hereford calves. 2-Body weight at weaning and at 12 and 18 months of age. Revista da Sociedade Brasileira de Zootecnia. 21 : 150-157.

Cooper, M. McG. and Wills, M.B., 1989. Profitable Beef Production. Farming Press. LTD, Ipswick, UK.

Gaertner, S.J., Rouquette, F.M.Jr., Turner, J.W. and Long, C.R., 1991. Season of birth and stocking rate effects on preweaning traits of Simmental-sired calves from Brahman x Hereford (F1) dams. Progress report, Texas Agric. Exp. St. No. PR-4819 pp. 5-8.

Galbraith, H. and Topps, J.H., 1981. Effect of hormones on the growth and body composition of animals. Nutr. Abstr. and Rev. Series B., 51 : 521-540.

Harte, F.J., Curran, S. and Vial, V.E., 1965. The production of beef from young bulls. 1. Ir. J. Agric. Res. 4 : 189-204.

Harvey, W.R., 1990. User's Guide for LSMLMW and MIXMDL, PC-2 Version. Ohio State University.

Haycock, R.E. and Stewart, D.A., 1973. A comparison of the Charolais, British Friesian and Hereford breeds as sires of crossbred single-suckled calves for beef production. Anim. Prod. 17 : 267-273.

Hedrick, H.B., Thompson, G.B. and Krause, G.F., 1969. Comparison of feedlot performance and carcass characteristics of half-sib bulls, steers and heifers. J. Anim. Sci. 29 : 687-694.

Henningsson, T., 1986. Studies on performance testing for growth rate of dual purpose bulls. 1. General introduction and effects of breed and non-genetic factors. Acta Agric. Scand. 36 : 3-17.

Keane, M.G., 1987. Heifer Beef Production Services. No. 2 An Foras Talumtais.

Keane, M.G., 1990. Crossbreeding of Friesian dairy cows. Ir. Grassld. and Anim. Prod. Assoc. J. 24 : 125-136.

Keane, M.G. and Drennan, M.J., 1987. Lifetime growth and carcass composition of heifers and steers non-implanted or sequentially implandet with anabolic agents. Anim. Prod. 45 : 359-369.

Keane, M.G. and Drennan, M.J., 1990. Comparison of growth and carcass composition of heifers and steers in three production systems and effects of implantation with anabolic agents. Ir. J. Agric. Res. 29 : 1-13.

Keane, M.G. and More O'Ferrall, G.J., 1992. Comparison of Friesian, Canadian Hereford x Friesian steers for growth and carcass composition. Anim. Prod. 55 : 377-387.

Keane, M.G., More O'Ferrall, G.J. and Connoly, J., 1989. Growth and carcass composition of Friesian, Limousin x Friesian and Blonde Daqutaine x Friesian steers. Anim. Prod. 48 : 353-365.

Kempster, A.J. and Southgate, J.R., 1984. Beef breed comparisons in the U.K. Lives. Prod. Sci. 11 : 491-501.

Madsen, P., 1992. Performance testing to bulls of beef breeds in 1990/91. Beretning fra, Statèns, Husdyrbrugsforsog. No. 707, 129-130.

McNally, D.H., 1970. A note on the weights and weight gains of some Charolais and contemporary calves of other breeds in Northern Ireland. Anim. Prod. 12 : 539-542.

MCL, 1987. Beef Yearbook, Meat and Livestock Commission Bletchley, Bucks.

MCL, 1988. Beef Yearbook. Meat and Livestock Commission Bletchley, Bucks.

MCL, 1990. Beef Yearbook. Meat and Livestock Commission Bletchley, Bucks.

More, O'Frerral, G.J. and Keane, M.G., 1990. A comparison for liveweight and carcass production of Charolais, Hereford and Friesian steer progeny from Friesian cows finished on two energy levels and serially slaughtered. Anim. Prod. 50 : 19-28.

Nautiyal, L.P. and Bhat, P.N., 1989. Body weights of Harina crosses. Indian J. Anim. Sci. 59 : 1007-1010.

Nysom, B. and Hansen, M., 1990. Summary of annual report 1990: National Committee on Dairy Cattle Husbandry, 1990, 45-50. Danish Agricultural Advisory centre, Aarhus, Denmark.

Oni, O.O., Buvanendran, V. and Dim, N.I. 1988. The influence of some environmental factors on the growht rate of two Nigerian cattle breeds and the hybrid with the Charolais. J. Anim. Prod. Res. 8 : 121-131.

Pons, S.B. Milagre, J.C., Teixeira, N.M., Brasil-Pons, S., Camilo-Milagres, J. and Milagres-Teixeira, N., 1989. Effect of genetic and environmental factors on growth and body conformation score in Hereford cattle in Rio Grande do Sul. 1. Bodyweight and conformation score at weanning. Revista da Sociedade Brasileira de Zootecnia. 18 : 391-401.

Pons, S.B., Milagres, J.C., Regazzi, A.J. and Brasil-Pons, S., 1990. Effects of genetic and environmental factors on growth and conformation score of Hereford cattle in Rio Grande do Sul. 3. Bodyweight and conformation score at slaughter. Revista da Sociedade Brasileira de Zootecnia. 19 : 77-82.

Preston, T.R. and Willis, M.B., 1982. Intensive Beef Production, Second Ed. Pergamon press, Oxford, England.

Price, M.A. and Yeates, N.T.M., 1969. Growth rates and carcass characteristics in steers partial castrates. In : Meat Production from Entire Male Animals (Ed. D. N. Rhode) pp. 69-77. Churchill, London.

Raue, F., 1991. Economic aspects of the production of quality beef from the point of view of the breeder. 2-Steers, heifers or bulls ? Lohmann Information, Nov./Dec., 9-12.

Sharma, A.K., Willms, L., Hardin, R.T. and Berg, R.T., 1982. Sex of calf and age of dam adjustments for some performance traits in two populations of beef cattle. Can. J. Anim. 62 : 699-708.

Shrivastav, A.K., Katpatal, B.G. and Singh, C.S.P., 1985. Effect of genetic and non-genetic factors on growth rate in crossbred dairy cattle. Indian J. Dairy Sci. 38 : 92-96.

Shwarz, F.S., Kirchgessner, M., Augustini, C. and Branscheid, W., 1992. Growth-specific in carcass quality of German Simmental cattle. 1-Growth of bulls, steers and heifers at different levels of nutrition. Fleischwirtschaft, 72 : 1584-1589.

Simm, G., Smith, C. and Prescott, J.H.D., 1985. Environmental effects on bull performance test results. Prod. 41 : 177-185.

Southgate, J.R., Cook, G.L. and Kempster, A.J., 1982. A comparison of the progeny of British Friesian dams and different sire breeds in 16- and 24-month beef production systems. Anim. Prod. 34 : 155-166.

Southgate, J.R., Cook, G.L. and Kempster, A.J., 1988. Evaluation of British Friesian, Canadian Holstein and beef breed x British Friesian steers slaughtered over a commercial range of fatness from 16-month and 24-month beef production systems. 1-Liveweight gain and efficiency of food utilization. Anim. Prod. 46 : 353-364.

Wilkinson, J.M., 1985. Beef Production from Silage and Other Conserved Forage. Longman, London and Newyork.

Wilson, L.L., Abdul-Jamak, E., LeVan, P.J., Todd, R.F., Watkins and Ziegler, J.H., 1983. Effects of season of birth, breed of sire and sex of calf in a singlesuckled Aberdeen Angus Holstein beef herd. Anim. Prod. 37 : 365-374.